

DIVISION 16 - ELECTRICAL

16010 - BASIC ELECTRICAL REQUIREMENTS

1.1 QUALITY ASSURANCE

- A. All electrical work shall be in accordance with the following codes and agencies:
 - 1. The National Electrical Code (NFPA-70), 2017 Edition.
 - 2. The International Building Code, 2012 Edition with 2014, 2015, 2017 & 2018 Georgia Amendments.
 - 3. State and local ordinances governing electrical work.
- B. All materials shall be new and shall conform to standards where such have been established for the particular material. All UL listed equipment shall bear the UL label.

1.2 PERMITS

- A. Obtain all permits and inspections required for the work involved. Deliver to the owner all certificates of inspection.

1.3 WARRANTY

- A. The contractor shall warrant to the owner that all work shall be free from defects and will conform to the contract documents. This warranty shall extend not less than one year from the date of beneficial occupancy.

1.4 DRAWINGS

- A. The drawings indicate the general arrangement of electrical equipment, based on one manufacturer's product. Coordinate installation of equipment with all other trades. Do not scale drawings for connection locations. Bring all discrepancies to the immediate attention of the engineer.
- B. Contractor shall install and circuit all electrical work as indicated on drawings unless specific building construction requires a change or rerouting of this work. He shall keep a record of the location of all concealed work, including the underground utility lines. He shall document all changes in the manner specified by the General Conditions, Special Conditions and Supplementary General Conditions to the Electrical Work.

1.5 CUTTING, PATCHING, EXCAVATING & BACKFILLING

- A. All cutting and patching required to carry out the work shall be provided under other Specification Sections.
- B. All excavation and backfilling required to install conduit shall be provided under this Section. Backfill shall be compacted as required under other Specification Sections.

1.6 RECORD DRAWINGS

- A. At the time of final inspection, provide three (3) sets of data on electrical equipment used in the project. This data shall be in bound form and shall include the following items:

1. Shop drawings on equipment listed.
2. Data sheets indicating electrical characteristics of all devices.
3. Data sheets on all lighting fixtures indicating voltage, lamp, and ballast used in each fixture.
4. Test results required by "Electrical Systems Operation Test."
5. Short circuit/coordination study/arc flash hazard analysis.

1.7 SHOP DRAWINGS

- A. The Contractor shall submit for review by the Engineer a complete schedule and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, such as catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Complete electrical characteristics shall be provided for all equipment.
- B. Submittals shall be made for each of the following items:

Disconnect Switches	Conduit
Wire & Cable	Enclosed Circuit Breakers
Wiring Devices	Surge Protection
RVSS Starter	Junction Boxes
- C. Each individual submittal item for materials and equipment shall be marked to show specification section and paragraph number which pertains to the item.
- D. Prior to submitting shop drawings, review the submittal for compliance with the Contract Documents and place a stamp or other confirmation thereon which states that the submittal complies with Contract requirements. Submittals without such verification will be returned disapproved without review.

1.8 EQUIPMENT REQUIRING ELECTRICAL SERVICE

- A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment.
- B. Drawings are based on design loads of one manufacturer. If equipment actually furnished have loads, numbers of connections, or voltages other than those indicated on the drawings, then control equipment, feeders, and overcurrent devices shall be adjusted as required, at no additional cost to the owner. Such adjustments are subject to review by the engineer.
- C. Catalog numbers indicated with equipment and devices are for convenience only. Errors or obsolescence shall not relieve the furnishing of items which meet the technical description given in specifications, noted, or required by function designated.

1.9 SCHEDULING OF OUTAGES

- A. Electrical work requiring interruption of electrical power which would adversely affect the normal operation of other portions of the owner's property, shall be done at other than normal working hours. Normal working hours shall be considered 8:00 a.m. to 6:00 p.m.,

Monday through Friday. Schedule the interruption of electrical power three working days prior to actual shutdown.

1.10 SITE INVESTIGATION AND RENOVATION CONDITIONS

- A. Prior to submitting bids for the project, visit the site to become familiar with existing conditions. The project shall be restored to its existing condition, with the exception of work under this contract, prior to final payment.
- B. Provide additions and alterations to existing work required to produce a complete electrical installation. Relocate existing electrical work for other trades required to complete the work and to maintain the plant in service. Provide for the removal, reinstallation, reconnection or relocation of existing circuit wiring, wiring devices, etc., necessitated by the new work. If any portion of an existing circuit is in an area where no new work is being done, but is made electrically discontinuous by the new work, it shall be recircuited to maintain electrical continuity. Cutting, channeling, chasing, or drilling of walls, partitions, ceilings, or other surfaces and support, or anchorage of conduit, or other electrical work, shall be done without damage to other piping or building equipment. Existing surfaces shall then be patched and painted to match the surrounding areas.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Provide a dry, weather tight space for storing materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Handle and store material in accordance with standards to prevent damage. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable. Replace damaged materials.

1.12 CLEANING AND PAINTING

- A. Remove oil, dirt, grease and foreign materials from all equipment to provide a clean surface. Touch up scratched or marred surfaces of panelboard and cabinet trims, and equipment enclosures with paint manufactured specifically for that purpose.

16100 - BASIC MATERIALS

2.1 RACEWAYS

- A. The following specifications and standards are incorporated into and become a part of this specification:
 - 1. Underwriter's Laboratory, Inc. Publications 1, 6, 467, 651, 797, 1242.
 - 2. American National Standards Institute C-80.1, C-80.3.
- B. Raceway is required for all wiring, unless specifically indicated or specified otherwise. The minimum size of conduit shall be ¾" but shall not be less than size indicated on the drawings or required by the NEC.
- C. Conduits shall be aluminum rigid conduit (ARC) except for the following conditions:

1. Conduits installed within concrete slabs shall be schedule 80 heavy wall PVC. Where transition is made from raceway in slab to any type of raceway out of slab, make transition with a rigid aluminum elbow.
 2. Conduits installed in direct contact with earth shall be schedule 80, heavy wall PVC.
 3. Use flexible conduit for connections to motors, dry type transformers and all vibrating equipment.
 - a. Length shall not exceed 18."
 - b. Maintain ground continuity through flexible conduit with a green equipment grounding conductor.
 - c. Liquid-tight flexible conduit shall be used in exterior installations.
- D. ARC fittings shall be standard threaded couplings, threaded hubs, bushings, and elbows. All ARC fittings shall be aluminum alloy; set screw or non-threaded fittings are not permitted. Non-metallic conduit fittings shall be of the same material as the conduit furnished and shall be the product of the same manufacturer.
- E. All conduit support parts and hardware shall be 316 stainless steel. Conduit straps shall be one-piece assembled product of stainless steel for use with SS channels. Conduit support channels shall be 1 1/2" x 1 1/2" – 14 gauge channel. Wire or chain is not acceptable for conduit hangers. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose.
- F. Leave all empty conduits with a 200 lb. test nylon cord pull line. Complete raceway runs prior to installation of wires or cables. Deformed conduits shall be replaced. Protect conduits against dirt, plaster, and foreign debris with conduit plugs.
- G. Fasten conduit support devices to structure with wood screws on wood, toggle bolts on hollow masonry, expansion anchors on solid masonry or concrete, and machine bolts or clamps on steel. Nails are not acceptable. Seal all conduits with insulating electrical putty to prevent entrance of moisture.
- H. Conduit shall be run parallel or at right angles to structural members. Support branch circuit conduits at intervals not exceeding 10 feet, and within 3 feet of each box or change of direction. Provide an expansion and deflection coupling where conduits cross a building expansion joint.
- I. All conduits entering or exiting concrete or installed below grade shall be protected from corrosion.
1. Metallic conduits shall be protected from corrosion as follows:
 - a. Apply two coats of 3M Scotchrap pipe primer. Allow the primer to dry before application of the second coat or application of tape.
 - b. Apply two overlapping layers of 3M Scotchrap 51 tape.
 - c. Pipe primer and tape shall extend from the end of the metallic conduit to 6" above grade or concrete.

2.2 WIRES AND CABLES

- A. The following specifications and standards are incorporated into and become a part of this specification:
1. Underwriter's Laboratories, Inc. Publications 44, 83, 486, 493.

2. Insulated Cable Engineers Association Standards S-61-402, S-66-524.
 3. National Electrical Manufacturer's Standards WC-5, WC-7.
- B. Conductors shall be electrically continuous and free from short circuits or grounds.
 - C. All open, shorted, or grounded conductors and any with damaged insulation shall be removed and replaced with new material free from defects.
 - D. Conductor size shall be minimum of No. 12 AWG, unless larger size is required by the drawings or the NEC. Insulation voltage level rating shall be 600 volts. All wire and cable shall bear the UL label.
 - E. Conductors No. 10 and smaller shall be solid copper, 90 degrees C. type THWN/THHN. Conductors larger than No. 10 shall be stranded copper, 90 degrees C. type THWN/THHN, or XHHW.
 - F. Color code all conductors. No. 6 and smaller shall have solid color compound or coating. No. 4 and larger shall have solid color compound or colored phase tape; tape shall be installed on conductors in every box, termination point, cabinet, or enclosure. Coding shall be as follows:
 1. 240/120 volt single phase three wire system: Phase A-black, Phase B-red, neutral-white.
 2. 480Y/277 volt three phase four wire system: Phase A-brown, Phase B-orange, Phase C-yellow, neutral-grey.
 3. Grounding conductors shall be green or green traced.
 - G. Maintain phase rotation established per N.E.C. at service equipment throughout entire project.
 - H. Group and lace with nylon tie straps all conductors within enclosures. Make splices in conductors only within junction boxes, wiring troughs, or other NEC approved enclosures. Do not splice conductors in pull boxes, switchboards, panelboards, safety switches, or motor control enclosures. Identify each conductor as to circuit connection in all boxes and enclosures.
 - I. Terminate stranded conductors No. 10 AWG and smaller with crimp-type lug or stud. Crimp terminal shall be the configuration type suitable for terminal point.
 - J. Torque each terminal connection to the manufacturer's recommended torque value. A calibrated torquing tool shall be used to insure proper torque application.

2.3 BOXES

- A. The following specifications and standards are incorporated into and become a part of this specification:
 1. Underwriter's Laboratories, Inc. Publications 50, 467, 514.
- B. Review engineer drawings for areas where outlets occur within specific features and install outlets as shown on architectural drawings; or, if not shown, center and align boxes within the predominant features.

- C. Boxes shall be rustproof cast metal. Outlet boxes for GFI receptacles shall be 2 3/4" deep.
- D. Outlet boxes for receptacles in exposed wiring systems shall be cast FS type with matching device plate. For exterior installations, use insue type extra duty covers. Provide larger boxes as required for special purpose devices.
- E. Dimensions of pull and junction boxes shall not be less than those required by the NEC for the number, size, and position of conductors entering the box. Wood supports within pull boxes are not acceptable. Provide box covers for all boxes.
- F. All boxes shall be completely accessible and as required by the NEC. Provide an outlet box for each device. Box sizes shall be increased from those outlined above if required by Article 314 of the NEC.
- G. Support every box from structure. Secure to wood with wood screws, hollow masonry with toggle bolts, metal with sheet metal screws, solid masonry or concrete with expansion anchors, metal studs with spring steel clamp, and structure with threaded steel rod when suspended.
- H. Remove only knockouts as required and plug all unused openings. After completion, using indelible ink wide tip marker, indicate on the cover of each junction and pull box the designation of each circuit contained therein.

2.4 WIRING DEVICES

- A. The following specifications and standards are incorporated into and become a part of this specification:
 - 1. National Electrical Manufacturer's Association Publications WD-1, WD-5.
- B. Ground fault interrupter (GFI) receptacles shall be Hubbell GFTWRST83W. Equivalent receptacles manufactured by Arrow Hart, Legrand, or Leviton are acceptable.
- C. All devices installed in areas exposed to the weather shall be provided with a weatherproof in-use extra duty device plate.
- D. All devices shall be provided with white finish.

2.5 CIRCUIT AND MOTOR DISCONNECTS

- A. The following specifications and standards are incorporated into and become a part of this specification:
 - 1. Underwriter's Laboratories, Inc. Publications 98, 198.2, 198.4.
 - 2. National Electrical Manufacturer's Association Publications KS-1.
- B. Products of General Electric, Eaton, Square D, or Siemens which comply with these specifications are acceptable.
- C. Disconnect switches shall be heavy duty non-fusible safety switch type, unless fused type is indicated on the drawings, with the number of poles required to disconnect all ungrounded conductors serving the equipment.

1. Furnish a solid neutral when the circuit includes a neutral conductor.
 2. Furnish an equipment grounding conductor lug bonded to the switch enclosure.
 3. Furnish NEMA type 4X stainless steel for all damp, wet, or exterior locations unless other types are indicated on the drawings.
 4. Switches shall be fused if required by the equipment manufacturer. Fuse size shall be as shown on the equipment nameplate.
- D. Switches shall have the following features:
1. Quick-make, quick break switching mechanism.
 2. Line terminal shields.
 3. Provisions for padlocking in the "off" position.
 4. Door interlocks to prevent door from opening when switch is closed. Provide inconspicuous means to defeat this interlock.
 5. Permanent name plate indicating all ratings.
 6. Arc chute for each pole.
 7. 600 volt rating for 250 to 600 volt systems.
 8. Rejection clips to accept only RK1 or RK5 fuses when switch is fusible type.
- E. Disconnect switches for three phase motors rated two horsepower and above shall be three pole non-fusible type. Disconnect switches for three phase motors rated less than two horsepower shall be three pole manual motor starter switches without overload protection. Disconnects for single phase motors shall be single or two pole horsepower rated switches without overload protection.
- F. Locate switches to provide full accessibility and working clearances required by the NEC. Locate adjacent to equipment served unless drawings indicate otherwise. Mount switch directly to structure or to metal channel depending upon field conditions. Mount switch handle between 36" and 60" above finished floor.

2.6 REDUCED VOLTAGE SOLID STATE STARTER

- A. Reduced voltage solid state starter shall be NEMA sized for use with the specific horsepower, three phase squirrel cage induction motor indicated on the plans. The reduced voltage solid state starter shall be of the solid state type using SCR's to provide reduced voltage starting with high starting torque and smooth stepless acceleration to full speed. Maximum motor in-rush current during starting shall be 250% of normal motor full load amps. Acceleration shall be set for 30 seconds from start to full voltage. Provide with integral shorting contactor.
- B. Current sensing for motor overload shall be electronic type set at 115% of normal motor full load amps. The electronic overload device shall allow for motor starting current up to 350% of motor full load amps for not more than 40 seconds. Overload beyond limits specified herein shall trip the motor control circuit in less than 1 Hz. The electronic current sensing device shall also provide phase imbalance protection to remove the motor from the line should voltage levels be unbalanced more than 7-1/2%. The control system shall also remove the motor from the line within 45 seconds should the motor become stalled for any reason.
- C. Control power shall be 120 volts AC from a control power transformer. The electronic control shall contain pilot lamps to indicate the following:

1. Control Power On
 2. Trip Condition Due to Load Unbalance.
 3. Trip Condition Due to Overload or Locked Rotor
- D. An oil-tight pilot lamp indicating motor running shall be mounted on the compartment door.
- E. Reduced voltage starter shall be mounted in a NEMA 4X stainless steel enclosure. Furnish with fused disconnect.
- F. Provide products of Square D, Eaton, Siemens or G.E.

2.7 SUPPORTING DEVICES

- A. Provide and install supporting devices which comply with manufacturer's standard materials, design, and construction in accordance with published standards and as required for complete installation.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices. Install hangars, supports, clamps, and attachments to support piping properly from building structure only. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form water-tight seal.

2.8 ELECTRICAL IDENTIFICATION

- A. Install engraved plastic - laminate sign on each major unit of electrical equipment. Provide a single line of text, 1/2" high lettering on 1 1/2" high sign (or 2" high sign if 2 lines required). Provide signs for each unit of the following:
1. Panelboards.
 2. Electrical cabinets and enclosures.
 3. Transformers.
 4. Motor controllers.
 5. Disconnect switches.

16400 - DISTRIBUTION EQUIPMENT

3.1 GROUNDING SYSTEMS

- A. Equipment grounding system shall be established with equipment ground conductors. The use of metallic raceways for equipment grounding is not acceptable. Unless indicated otherwise, provide equipment ground the same size as phase conductors.
- B. The following specifications and standards are incorporated into and become a part of this specification:
1. Underwriter's Laboratories, Inc. Publications 44, 83, 467, 486, 493.
 2. National Electrical Manufacturer's Association Standards WC-5, WC-7.
- C. Grounding electrode conductors shall be bare or green insulated copper sized as indicated on the drawings. Equipment grounding conductors shall be green insulated type THW,

THWN, or XHHW sized as indicated on the drawings. Where sizes are not indicated, grounding conductor shall be sized in accordance with NEC Article 250.

- D. Each receptacle device shall be furnished with a grounding screw connected to the metallic device frame. Provide a conductor termination grounding lug bonded to the enclosure of each transformer, motor controller, and disconnect switch.
- E. Ground all non-current carrying parts of the electrical system, i.e., wireways, equipment enclosures and frames, junction and outlet boxes, machine frames, and other conductive items in close proximity with electrical circuits. Ground the neutral of all dry type transformers to a driven ground rod that shall serve as the grounding electrode for the separately derived system.
- F. Grounding conductors for branch circuits are not shown on the drawings; however, grounding conductors shall be provided in all branch circuit raceways and cables, including flexible conduit. Grounding conductors shall be the same AWG size as branch circuit conductors.
- G. The equipment grounding conductor shall be terminated with a screw or bolt used for no other purpose. Equipment grounding conductors shall terminate on panel board, switchboard, or motor control center grounding bus only. Do not terminate on neutral bus.

3.2 TRANSFORMERS

- A. The following specifications and standards are incorporated into and become a part of this specification:
 - 1. Underwriter's Laboratories, Inc. Publications 506.
 - 2. National Electrical Manufacturer's Association Publication ST-20.
 - 3. American National Standards Institute Publications C-57, C-89.2.
- B. Products of General Electric, Eaton, Square D, or Siemens which comply with these specifications are acceptable.
- C. Transformers shall be self-cooled, rated for continuous operation at rated KVA, 24 hours per day, 365 days per year with normal life expectancy. Transformers shall be rated for average temperature rise by resistance of 150 degrees C. in 40 degrees C. maximum ambient, 30 degrees C. average ambient unless otherwise indicated. Transformer insulation system shall be UL rated as 220 degrees C. system. Sound rating shall not exceed NEMA and ANSI standards for the KVA rating. Internal vibration dampening shall be provided on all transformers.
- D. Transformer enclosures shall be open, ventilated, drip-proof with removable front and rear cover panels, suitable for floor mounting, for transformers rated 30 KVA and up. For transformers up to 25 KVA, transformers shall be totally enclosed, non-ventilated with a resin encapsulated core and coil and drip-proof housing.
- E. Primary ratings shall be 480 volts, 3 phase, 3 wire. Secondary service shall be 208Y/120 volts, 3 phase, 4 wire. Nominal impedance shall be 4.5 percent minimum.

- F. Core assemblies and the center ground connection point of the coil secondaries shall be grounded to their enclosures by adequate, flexible ground straps. Provide grounding lug at the strap to enclosure bonding location for connection of three conductors.
- G. Dry type transformers larger than 15 kva shall be floor mounted; 15 KVA and below shall be wall mounted. Installation shall meet the requirements of the N.E.C. Article 450. Transformers shall be mounted on neoprene, waffle type vibration pads 5/8" thick minimum. Primary and secondary connections shall be made with flexible conduit. The secondary windings of each transformer shall be grounded in accordance with the NEC requirements for separately derived systems.
- H. Do not install equipment over transformers, unless indicated on the drawings. Install secondary over current protective device within 10 feet horizontally from the transformer. Where none is indicated on the plans, provide an enclosed circuit breaker within 10 feet rated 125 percent of the transformer full load ampacity but not greater than the secondary conductor ampacity. Provide full working clearances as required by the NEC.

3.3 PANELBOARDS

- A. The following specifications and standards are incorporated into and become a part of this specification:
 1. Underwriter's Laboratories, Inc. Publications 50, 67,489.
 2. National Electrical Manufacturer's Association Publications PB-1, AB-3.
- B. Products of General Electric, Eaton, Square D, or Siemens which comply with these specifications are acceptable.
- C. All panels and circuit breakers shall be UL listed and bear a UL label. Panels shall be of the dead front safety type. Provide panels complete with factory assembled circuit breakers connected to the bus bars. Number all panel boards in the following sequence: Circuits 1 and 2 - Phase A; circuits 3 and 4 - Phase B; circuits 5 and 6 - Phase C.
- D. All bus bars shall be copper. Main lugs and main breaker shall be UL approved for copper or aluminum conductors and shall be of a size range for the conductors indicated on the drawings. Each panel shall contain a full size grounding bus and, when required, a full size insulated neutral bus. The neutral and ground busses shall have a sufficient number of lugs to singularly terminate each individual conductor requiring a connection. The ground bus shall be brazed or riveted to the panel enclosure, but not attached to the panel interior. Where designated, each "space" shall include all bussing, device supports and connections for future breaker installation. Where indicated, provide sub-feed or through-feed lugs and increase box height to provide additional cable bending space; lug size shall match ampacity of mains.
- E. Branch circuit panel board width shall be between 20 and 22 inches; depth shall be 5 3/4" maximum. Distribution panel board width shall be 32" minimum and depth shall be 14" maximum. Provide gutters and bending space to conform with the NEC. Key all panels throughout the project alike. Where two section panels are required, provide a fully rated bus for each section with interconnecting copper conductors of ampacity equal to the rating of the main bus.

- F. Circuit breakers shall be quick-make, quick-break, thermal magnetic type bolted to the bus. Multi-pole breakers shall be common trip and common reset type; tie handle connections are not acceptable. Interrupting ratings on 208 volt systems shall be 10,000 RMS symmetrical amps minimum and on 480 volt systems shall be 14000 RMS symmetrical amps minimum; provide higher ratings when indicated on the drawings.
- G. Mount panel boards with top circuit not more than 6'-6" above finished floor. Enclosures shall be secured by a minimum of four fastening devices. Attach enclosure directly to masonry, concrete, or wood, maintaining a 1" rear clearance. Mount enclosure to metal channel for installations on steel structure or drywall.
- H. Provide in each panel board a typewritten, laminated circuit directory mounted under clear plastic in metal holder in the door of the panel reflecting all field changes additions. Install push-in knock-out closure plugs in any unused knock-out openings.

3.4 FUSES

- A. The following specifications and standards are incorporated into and become a part of this specification:
 - 1. Underwriter's Laboratories, Inc. Publications 198C, 198D, 198E, 198H, and 512.
 - 2. American National Standards Institute C97.1.
- B. Products of Bussman, General Electric, Shawnut, Reliance, and Littlefuse complying with these specifications are acceptable.
- C. Provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, of class L, RK1, RK5, J, or T as specified. For types and ratings required, furnish one spare set of three for each kind. Prior to energization of fusible devices, test devices for continuity of circuiting and for short circuits. Replace malfunctioning units.

END OF SECTION