

DIVISION 26 - ELECTRICAL

260010 - BASIC ELECTRICAL REQUIREMENTS

1.01 QUALITY ASSURANCE

- A. All electrical work shall be in accordance with the following codes and agencies:
 - 1. The National Electrical Code (NFPA-70), 2023 Edition with Georgia Amendments.
 - 2. The Life Safety Code (NFPA 101), 2018 Edition.
 - 3. The International Building Code, 2018 Edition with Georgia Amendments.
 - 4. Regulations of the local utility company concerning metering and service entrance.
 - 5. 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.

1.02 PERMITS

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

1.03 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.

1.04 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 Mechanical and Electrical Work.

1.05 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, devices and lighting fixtures 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.

1.06 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:

Receptacle	Light Poles
Wiring Devices	Lighting Fixtures
Surge Protection	Junction Boxes
Panels	Mini-Power Centers
- 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.

1.07 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.

1.08 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 buildings in service. Provide for the removal, reinstallation, reconnection or relocation of existing circuit wiring, wiring devices, lighting fixtures, 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.

1.09 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.

1.10 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 lighting fixtures, panelboard and cabinet trims, and equipment enclosures with paint manufactured specifically for that purpose. Paint plywood backboards used to mount electrical equipment with two coats of light grey semi-gloss enamel. All other painting shall be done under the "Painting" section of these specifications.

PART 2 - BASIC MATERIALS

2.01 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 3/4", but shall not be less than size indicated on the drawings or required by the NEC.
- C. Provide complete conduit system including boxes, fittings, supports, etc. Conduits shall be rigid aluminum above grade and schedule 40 PVC below grade.
- D. Transition from below grade PVC to above grade shall be made with a rigid aluminum elbow and not a PVC elbow.

- E. Conduits shall be:
 - 1. Conduits installed in direct contact with earth shall be schedule 40, heavy wall PVC.
 - 2. 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.
- F. ARC fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Non-metallic conduit fittings shall be of the same material as the conduit furnished and shall be the product of the same manufacturer.
- G. All conduit support parts and hardware shall be stainless steel.
- H. 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.
- I. 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 penetrating building exterior or refrigerated spaces with insulating electrical putty to prevent entrance of moisture.

2.02 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. Fixture wire shall be No. 16 AWG silicone

rubber insulated, stranded fixture wire type SFF-2 or No. 16 thermoplastic nylon jacketed stranded fixture wire type TFFN.

- F. Color code all conductors. No. 10 and smaller shall have solid color compound or coating. No. 8 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. 230/115 volt single phase three wire system: Phase A-black, Phase B-red, Phase C-blue, neutral-white.
 - 2. 208Y/120 volts, 3 phase, 4 wire: Phase A-black, Phase B-red, Phase C-blue, Neutral-white, Ground-green
 - 3. 480Y/277 volt three phase four wire wye system: Phase A-brown, Phase B-orange, Phase C-yellow, neutral-grey.
 - 4. Grounding conductors shall be green or green traced. Grounding conductors for isolated ground circuits shall be green with a yellow trace.
- 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, witchboards, 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.

2.03 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. Outlet boxes for switches and receptacles in exposed wiring systems shall be cast FS type with matching device plate. For exterior installations, use spring loaded in-use metal heavy duty hinged covers. Boxes for individual devices flush mounted in exposed concrete block shall be single gang masonry boxes 3 1/2" deep. Boxes installed in poured concrete or cast in place shall be concrete-tight type; box depth shall allow 2" minimum concrete cover. Provide larger boxes as required for special purpose devices.
- C. 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.

- D. All boxes shall be completely accessible and as required by the NEC. Box sizes shall be increased from those outlined above if required by Article 314 of the NEC.

2.04 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. Single pole, 20 amp, 277 volt toggle switches shall be Hubbell 1221. Three-way, 20 amp, 277 volt switches shall be Hubbell 1223. Weatherproof, 20 amp, 277 volt switches shall be Hubbell 1281-1750. Equivalent switches manufactured by Arrow Hart, General Electric, Legrand, or Leviton are acceptable.
- C. Fifteen amp, 125 volt grounded duplex receptacles (NEMA 5-15R) shall be Hubbell 5252. Twenty amp, 125 volt grounded duplex receptacles (NEMA 5-20R) shall be Hubbell 5352. Ground fault interrupter (GFI) receptacles shall be Hubbell GF-8200. Special purpose receptacles shall be as specified on the drawings. Equivalent receptacles manufactured by Arrow Hart, General Electric, Legrand, or Leviton are acceptable.
- D. All devices installed in areas exposed to the weather shall be provided with a weatherproof device plate. For receptacles, provide heavy duty metal in use cover with locking tabs.
- E. All devices shall be provided with ivory finish.

2.05 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 GE/ABB, 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 one enclosure for all interior dry locations, and NEMA type 3R for all damp, wet, or exterior locations unless other types are indicated on the drawings.
- 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, 250 volt rating for systems below 250 volts.
 8. Rejection clips to accept only RK1 or RK5 fuses when switch is fusible type.
- E. 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.

2.06 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.

2.07 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.
- B. Apply cable/conductor identification, including voltage, phase, and feeder number, on each cable/conductor in each box or enclosure where wires are present, except where another form of identification (such as color-coded conductors) is provided.

PART 3 - DISTRIBUTION EQUIPMENT

3.01 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 and switch 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 building steel 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. A feeder serving more than one panelboard shall have a continuous grounding conductor which shall be connected to each related cabinet grounding bar. 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.

3.02 TRANSFORMERS/MINI-POWER CENTERS

- 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 Eaton or Square D 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. Provide rain shields for transformers located outside. For open transformers, provide painted expanded metal covers over all openings.
- E. Ratings shall be as noted on the drawings.
- 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. 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.
- H. In mini power centers, distribution equipment to meet 3.03 below.

3.03 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 Eaton or Square D which comply with these specifications are acceptable.

- C. All panels and circuit breakers shall be UL listed and bear a UL label. Where panels serve as service entrance equipment, panel shall bear a UL label indicating such. 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 24 and 30 inches; depth shall be 8" 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.
- 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 or 230 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. Mount enclosure to metal channel for installations on steel structure.
- H. Provide in each panel board a typewritten 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.
- I. Provide integral surge protection as shown on the drawings.

PART 3 EXECUTION

3.1 CONDUIT SYSTEMS

- A. Exposed conduits shall be installed parallel or at right angles to structures.

- B. Conduit supports devices, i.e., straps, channel, etc., shall be attached to structure with wood screws on wood, toggle bolts on hollow masonry, lead shields on masonry and machine bolts on steel. Nails are not acceptable.
- C. Rigid aluminum conduit shall be attached to sheet metal enclosures with threaded hubs. All rigid conduit stub ups not attached to enclosures or attached to nonmetallic enclosures shall be terminated with insulated throat, grounding bushing.
- D. All conduits installed below grade shall be schedule 40 PVC and shall be installed 24 inches below finished grade. Where conduits turn up provide rigid aluminum elbow.
- E. Protect conduits against dirt, plaster, etc., with conduit plugs. Plug shall remain in place until all masonry is complete.
- F. 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.
- G. All conduits entering electrical equipment from below grade shall be sealed with electrical putty.

3.2 CONDUCTORS

- A. All conductors shall be color-coded as follows:

System	Phase A	Phase B	Phase C	Neutral
240/120V 1 Phase, 3 Wire	Black	Red		White
208Y/120V 3 Phase, 4 Wire	Black	Red	Blue	White
480Y/277 3 Phase, 4 Wire	Brown	Orange	Yellow	Grey

Ground Conductor: Green

- B. Splices in branch circuit conductors shall be made with Skotchlok insulated connectors, Ideal Wing Nuts, or Buchanan Steel Crimping Sleeves, and nylon caps. Splices in motor junction boxes, wiring troughs and splices in conductors larger than No. 8 AWG shall be made with split bolt connectors, taped with Scotch No. 88 Tape.

- C. Only one conductor shall be installed under terminal of individual circuit breakers.

3.3 EQUIPMENT CONNECTIONS

- A. All equipment requiring electrical connections shall be connected under this section of these specifications. Where electrical connections to equipment requires specific locations, such location shall be obtained from shop drawings. Do not scale drawings for location of conduit stub-ups to serve specific equipment.
- B. Electrical circuits to equipment furnished under other sections of these specifications are based on design loads. If actual equipment furnished has loads other than design loads, electrical circuits and protective devices shall be revised to be compatible with equipment furnished and in compliance with the National Electrical Code at no additional cost to the Owner.
- C. Equipment furnished under other sections of these specifications to be connected under this section of the specifications shall consist of, but not be limited to, the following:
 - 1. Grinder Pumping Station Equipment
- D. The Contractors attention is directed to other sections of these specifications, where equipment requiring electrical service is specified, to become aware of the scope of work under this section of these specifications requiring electrical service and connections to equipment specified elsewhere.

3.4 GROUNDING

- A. The neutral conductor shall be grounded to a ground rod system. The minimum system grounding conductor shall be No. 6 Bare Copper.
- B. All non-current carrying parts of electrical equipment shall be grounded. The continuity of the ground shall be maintained using a green insulated grounding conductor installed in all raceways.
- C. Ground rods shall be installed with the top of the rod 12 inches below finished grade. Connections to ground rods shall be made with chemical weld connections.
- D. Upon completion of the ground rod installation the Contractor shall record the ground reading. This ground reading shall not be taken within 48 hours of rainfall. Results of ground readings shall be forwarded immediately to the Engineer. Provide a minimum of three rods, the resistance to ground shall be below 25 OHMS. Provide additional ground rods as required to attain specified ground resistance.
- E. Grounding terminal of receptacles shall be grounded to grounding conductor and to outlet box with green insulated pigtail with 10/32 washer head machine screw.

3.5 EQUIPMENT IDENTIFICATION

- A. All electrical equipment shall be identified.
- B. Install engraved plastic – laminate sign on each major unit of electrical equipment. Provide a single line of text, ½” high lettering on 1 ½” high sign (or 2” high sign if 2 lines required). Provide signs for each unit of the following:
 - 1. Service Disconnect/Main Breaker
 - 2. Panels
 - 3. Disconnect Switches
 - 4. Control Panels

3.6 GUARANTEE AND TEST

- A. Upon completion of the project all systems shall be tested for proper operation as directed by the Engineer or his representative. Equipment covers, i.e., panelboard, motor controls, etc., shall be removed where required for inspection of internal wiring. The Contractor shall furnish the personnel, tools and necessary equipment to inspect and test the system.
- B. Where ground readings are required, the Contractor shall provide a typewritten copy of certification of ground reading. Data shall indicate date readings were taken and lowest resistance recorded.
- C. All systems and component parts shall be guaranteed for one year from date of final acceptance of the completed project. Defects found during this guarantee period shall be promptly corrected at no additional cost to the Owner.

END OF SECTION

SECTION 26 56 68 – EXTERIOR ATHLETIC LIGHTING

Lighting System with LED Light Source

PART 1 – GENERAL

1.1 SUMMARY

- A. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.
- B. The purpose of these specifications is to define the lighting system performance and design standards for Anchor Park Project using an LED Lighting source. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these specifications.
- C. The sports lighting will be for the following venues:
 - 1. Field 1
 - 2. Field 2
 - 3. Bleachers
- D. The primary goals of this sports lighting project are:
 - 1. Guaranteed Light Levels: Selection of appropriate light levels impacts the safety of players and the enjoyment of spectators. Therefore, light levels are guaranteed to not drop below specified target values for a period of 25 years.
 - 2. Environmental Light Control: It is the primary goal of this project to minimize spill light to adjoining properties and glare to players, spectators, and neighbors.
 - 3. Cost of Ownership: To reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated for the duration of the warranty.
 - 4. Control and Monitoring – To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system. Fields should be proactively monitored to detect luminaire outages over a 25-year life cycle. All communication and monitoring costs for 25-year period shall be included in the bid.
 - a. Control and monitoring system shall provide contactor control of all existing circuits. Key switches shall be provided to provide field-level control of existing circuit groups.

1.2 ONFIELD LIGHTING PERFORMANCE

- A. Illumination Levels and Design Factors: Playing surfaces shall be lit to an average target illumination level and uniformity as specified in the chart below. Lighting manufacturers will provide a guarantee that light levels will be sustained over the life of the warranty period. Lighting calculations shall be developed, and field measurements taken on the grid spacing with the minimum number of grid points specified below.

Manufacturers will provide lumen maintenance data of the LED luminaires used per TM-21-11 and will incorporate the lumen maintenance projections into the lighting designs to ensure target light levels are achieved throughout the guaranteed period of the system. Per IES guidelines, lumen maintenance hours should be reported based on the 6x multiplier of testing hours.

Area of Lighting	Average Target Illumination Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Field 1	50 FC	2:1	96	30' x 30'
Field 2	50FC	2:1	96	30' x 30'

- B. Color Temperature: The lighting system shall have a minimum color temperature of 5700K and a CRI of 75.
- C. Playability: Lighting design and luminaire selection should be optimized for playability by reducing glare onfield and providing sufficient uplight.
 - 1. Aiming Angles: To reduce glare, luminaire aiming should ensure the top of the luminaire field angle (based on sample photometric reports) is a minimum of 10 degrees below horizontal.
 - 2. Glare Control Technology – Luminaires selected should have glare control technology including, but not limited to: external visors, internal shields and louvers. No symmetrical beam patterns are acceptable.
 - 3. Aerial lighting – Adequate illumination must be provided above the field to see the ball in flight. It is recommended that a lighting analysis be performed above the field of play to evaluate the visibility of the ball over its typical trajectory to ensure the participants will adequately see the ball. Calculation planes should be evaluated up to the maximum anticipated height for the level of play.
 - 4. Mounting Heights: To ensure proper aiming angles, minimum mountings heights shall be as described below. Higher mounting heights may be necessary for luminaire with lesser glare control to meet field angle requirements of section 1.2.C.1.

# of Poles	Pole Designation	Pole Height
8	F1-F8	70'

1.3 ENVIRONMENTAL LIGHT CONTROL

- A. Light Control Luminaires: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers, and external shields. No symmetrical beam patterns are accepted.
- B. Spill Light and Glare Control: To minimize impact on adjacent properties, spill light and candela values must not exceed the following levels taken at 3 feet above grade.

	Average	Maximum
150' Specified Spill Line Horizontal Footcandles	0.0475 fc	0.25 fc
150' Specified Spill Line Max Vertical Footcandles	0.1103 fc	0.35 fc
150' Specified Spill Line Max Candela (taken at 5 ft above grade)		8750 cd

- C. Spill Scans: Spill scans must be submitted indicating the amount of horizontal and vertical footcandles along the specified lines. Light levels shall be provided in 30-foot intervals along the boundary line at 3 ft above grade.

- D. Sample Photometry: The first page of a photometric report for all luminaire types proposed showing horizontal and vertical axial candle power shall be provided to demonstrate the capability of achieving the specified performance. Reports shall be certified by a qualified testing laboratory with a minimum of five years experience or by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products. A summary of the horizontal and vertical aiming angles for each luminaire shall be included with the photometric report.

- E. Field Verification: Lighting manufacturer shall supply field verification of environmental light control using a meter calibrated within the last 12 months:
 - 1. Spill verification: Illumination levels shall be taken in accordance with IESNA RP-6-22. The light sensing surface of the light meter should be held 36 inches above the playing surface with the sensing surface horizontal (for horizontal readings) or vertically pointed at the brightest light bank (for max vertical readings)

1.4 COST OF OWNERSHIP

- A. Manufacturer shall submit a 25 year Cost of Ownership summary that includes energy consumption, anticipated maintenance costs, and control costs. All costs associated with faulty luminaire replacement - equipment rentals, removal and installation labor, and shipping - are to be included in the maintenance costs.

PART 2 – PRODUCT

2.1 SPORTS LIGHTING SYSTEM CONSTRUCTION

- A. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers and other enclosures shall be factory assembled, aimed, wired and tested.

- B. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected

from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the cross-arms, pole, or electrical components enclosure.

C. System Description: Lighting system shall consist of the following:

1. Galvanized steel poles and cross-arm assembly.
2. Non-approved pole technology:
 - a. Square static cast concrete poles will not be accepted.
 - b. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long term performance concerns.
3. Lighting systems shall use concrete foundations. See Section 2.4 for details.
 - a. For a foundation using a pre-stressed concrete base embedded in concrete backfill the concrete shall be air-entrained and have a minimum compressive design strength at 28 days of 3,000 PSI. 3,000 PSI concrete specified for early pole erection, actual required minimum allowable concrete strength is 1,000 PSI. All piers and concrete backfill must bear on and against firm undisturbed soil.
 - b. For anchor bolt foundations or foundations using a pre-stressed concrete base in a suspended pier or re-enforced pier design pole erection may occur after 7 days. Or after a concrete sample from the same batch achieves a certain strength.
4. Manufacturer will supply all drivers and supporting electrical equipment.
 - a. Remote drivers and supporting electrical equipment shall be mounted approximately 10 feet above grade in aluminum enclosures. The enclosures shall be touch-safe and include drivers and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure. Integral drivers are not allowed.
 - b. Manufacturer shall provide surge protection at the pole equal to or greater than 40 kA for each line to ground (Common Mode) as recommended by IEEE C62.41.2_2002.
5. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
6. All luminaires, visors, and cross-arm assemblies shall withstand 150 mi/h winds and maintain luminaire aiming alignment.
7. Control cabinet to provide remote on-off control and monitoring of the lighting system. See Section 2.3 for further details.
8. Manufacturer shall provide lightning grounding as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A.

- a. Integrated grounding via concrete encased electrode grounding system.
 - b. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding electrode shall be minimum size of 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.
- D. Safety: All system components shall be UL listed for the appropriate application.

2.2 ELECTRICAL

- A. Electric Power Requirements for the Sports Lighting Equipment:
 - 1. Electric power: 480 Volt, 3 Phase
 - 2. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.
- B. Energy Consumption: The kW consumption for the field lighting system shall be 110.73 kW.

2.3 CONTROL

- A. Instant On/Off Capabilities: System shall provide for instant on/off of luminaires.
- B. Lighting contactor cabinet(s) constructed of NEMA Type I aluminum, designed for easy installation with contactors, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.
- C. Contactor control of lights: To minimize wear on drivers and other electrical components and prevent lights from turning on due to communication loss, circuits must be controlled via contactor switching, not dimming driver output to zero.
- D. Dimming: System shall provide for 3-stage dimming (high-medium-low). Dimming will be set via scheduling options (Website, app, phone, email).
- E. Remote Lighting Control System: System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.

The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute “early off” commands by phone. Scheduling tool shall be capable of setting curfew limits.

Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.

- F. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).
- G. Management Tools: Manufacturer shall provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of luminaire outages, control operation and service. Mobile application will be provided suitable for IOS and Android devices.

Hours of Usage: Manufacturer shall provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the owner.
 - 1. Cumulative hours: shall be tracked to show the total hours used by the facility.
 - 2. Report hours saved by using early off and push buttons by users.
- H. Communication Costs: Manufacturer shall include communication costs for operating the control and monitoring system for a period of 25 years.
- I. Communication with luminaire drivers: Control system shall interface with drivers in electrical components enclosures by means of powerline communication.
- J. Provide fused control power transformer for lighting panel for controls.

2.4 STRUCTURAL PARAMETERS

- A. Wind Loads: Wind loads shall be based on the 2018 International Building Code. Wind loads to be calculated using ASCE 7-16, an ultimate design wind speed of 140 mph and exposure category C.
- B. Pole Structural Design: The stress analysis and safety factor of the poles shall conform to 2013 AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LTS-6).
- C. Foundation Design: The foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2018 IBC Table 1806.2.

PART 3 – EXECUTION

3.1 SOIL QUALITY CONTROL

- A. It shall be the Contractor's responsibility to notify the Owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the Owner's approval / payment for additional costs associated with:
 - 1. Providing engineered foundation embedment design by a registered engineer in the State of Georgia for soils other than specified soil conditions.
 - 2. Additional materials required to achieve alternate foundation.

3. Excavation and removal of materials other than normal soils, such as rock, caliche, etc.

3.2 DELIVERY TIMING

- B. Delivery Timing Equipment On-Site: The equipment must be on-site 8 – 12 weeks from receipt of approved submittals and receipt of complete order information.

3.3 FIELD QUALITY CONTROL

- A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA RP-6-22.
- B. Field Light Level Accountability
 1. Light levels are guaranteed not to fall below the target maintained light levels for the entire warranty period of 25 years. These levels will be specifically stated as “guaranteed” on the illumination summary provided by the manufacturer.
 2. The contractor/manufacturer shall be responsible for conducting initial light level testing and an additional inspection of the system, in the presence of the owner, one year from the date of commissioning of the lighting.
 3. The contractor/manufacturer will be held responsible for any and all changes needed to bring these fields back to compliance for light levels and uniformities. Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.
- C. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles, uniformity ratios, upright for aerial visibility, and offsite candela readings are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be required to make adjustments to meet specifications and satisfy Owner.

3.4 WARRANTY AND GUARANTEE

- A. 25-Year Warranty: Each manufacturer shall supply a signed warranty covering the entire system for 25 years from the date of shipment. Warranty shall guarantee specified light levels. Manufacturer shall maintain specifically funded financial reserves to assure fulfillment of the warranty for the full term. Warranty does not cover weather conditions events such as lightning or hail damage, improper installation, vandalism or abuse, unauthorized repairs or alterations, or product made by other manufacturers.
- B. Maintenance: Manufacturer shall monitor the performance of the lighting system, including on/off status, hours of usage and luminaire outage for 25 years from the date of equipment shipment. Parts and labor shall be covered such that individual luminaire outages will be repaired when the usage of any field is materially impacted. Manufacturer is responsible for removal and replacement of failed luminaires, including all parts, labor, shipping, and equipment rental associated with maintenance. Owner agrees to check fuses in the event of a luminaire outage.

PART 4 – DESIGN APPROVAL

4.1 PRE-BID SUBMITTAL REQUIREMENTS (Non-Musco)

- A. Design Approval: The owner / engineer will review pre-bid submittals per section 4.1.B from all the manufacturers to ensure compliance to the specification 10 days prior to bid. If the design meets the design requirements of the specifications, a letter and/or addendum will be issued to the manufacturer indicating approval for the specific design submitted.
- B. Approved Product: Musco's Light-Structure System™ with TLC for LED® is the approved product. All substitutions must provide a complete submittal package for approval as outlined in Submittal Information at the end of this section at least 10 days prior to bid. Special manufacturing to meet the standards of this specification may be required. An addendum will be issued prior to bid listing any other approved lighting manufacturers and designs.
- C. All listed manufacturers not pre-approved shall submit the information at the end of this section at least 10 days prior to bid. An addendum will be issued prior to bid; listing approved lighting manufacturers and the design method to be used.
- D. Bidders are required to bid only products that have been approved by this specification or addendum by the owner or owner's representative. Bids received that do not utilize an approved system/design, will be rejected.

REQUIRED SUBMITTAL INFORMATION FOR ALL MANUFACTURERS (NOT PRE-APPROVED) 10 DAYS PRIOR TO BID

All items listed below are mandatory, shall comply with the specification and be submitted according to pre-bid submittal requirements. Complete the Yes/No column to indicate compliance (Y) or noncompliance (N) for each item. Submit checklist below with submittal.

Yes / No	Tab	Item	Description
	A	Letter/ Checklist	Listing of all information being submitted must be included on the table of contents. List the name of the manufacturer's local representative and his/her phone number. Signed submittal checklist to be included.
	B	Equipment Layout	Drawing(s) showing field layouts with pole locations
	C	On Field Lighting Design	Lighting design drawing(s) showing: <ul style="list-style-type: none"> a. Field Name, date, file number, prepared by b. Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y), Illuminance levels at grid spacing specified c. Pole height, number of fixtures per pole, horizontal and vertical aiming angles, as well as luminaire information including wattage, lumens and optics d. Height of light test meter above field surface. e. Summary table showing the number and spacing of grid points; average, minimum and maximum illuminance levels in foot candles (fc); uniformity including maximum to minimum ratio, coefficient of variance (CV), coefficient of utilization (CU) uniformity gradient; number of luminaires, total kilowatts, average tilt factor; light loss factor.
	D	Off Field Lighting Design	Lighting design drawing showing initial spill light levels along the boundary line (defined on bid drawings) in footcandles. Lighting design showing glare along the boundary line in candela. Light levels shall be taken at 30-foot intervals along the boundary line. Readings shall be taken with the meter orientation at both horizontal and aimed towards the most intense bank of lights.
	E	Photometric Report	Provide first page of photometric report for all luminaire types being proposed showing candela tabulations as defined by IESNA Publication LM-35-02. Photometric data shall be certified by laboratory with current National Voluntary Laboratory Accreditation Program or an independent testing facility with over 5 years experience.
	F	Performance Guarantee	Provide performance guarantee including a written commitment to undertake all corrections required to meet the performance requirements noted in these specifications at no expense to the owner. Light levels must be guaranteed to not fall below target levels for warranty period.
	G	Structural Calculations	Pole structural calculations and foundation design showing foundation shape, depth backfill requirements, rebar and anchor bolts (if required). Pole base reaction forces shall be shown on the foundation drawing along with soil bearing pressures. Design must be stamped by a structural engineer in the state of Georgia, if required by owner. (May be supplied upon award).

H	Control & Monitoring System	Manufacturer of the control and monitoring system shall provide written definition and schematics for automated control system. They will also provide ten (10) references of customers currently using proposed system in the state of Georgia.
I	Electrical Distribution Plans	Manufacturer bidding an alternate product must include a revised electrical distribution plan including changes to service entrance, panels and wire sizing, signed by a licensed Electrical Engineer in the state of Georgia.
J	Warranty	Provide written warranty information including all terms and conditions. Provide ten (10) references of customers currently under specified warranty in the state of Georgia.
K	Project References	Manufacturer to provide a list of ten (10) projects where the technology and specific fixture proposed for this project has been installed in the state of Georgia. Reference list will include project name, project city, installation date, and if requested, contact name and contact phone number.
L	Product Information	Complete bill of material and current brochures/cut sheets for all products being provided.
M	Delivery	Manufacturer shall supply an expected delivery timeframe from receipt of approved submittals and complete order information.
N	Non-Compliance	Manufacturer shall list all items that do not comply with the specifications. If in full compliance, tab may be omitted.
O	Cost of Ownership	Document cost of ownership as defined in the specification. Identify energy costs for operating the luminaires. Maintenance cost for the system must be included. All costs should be based on 25 Years
P	Environmental Light Control Design	Environmental glare impact scans must be submitted showing the maximum candela from the field edge on a map of the surrounding area until 500 candela or less is achieved.

The information supplied herein shall be used for the purpose of complying with the specifications for the Anchor Park project. By signing below, I agree that all requirements of the specifications have been met and that the manufacturer will be responsible for any future costs incurred to bring their equipment into compliance for all items not meeting specifications and not listed in the Non-Compliance section.

Manufacturer: _____ Signature: _____

Contact Name: _____ Date: ____/____/____

Contractor: _____ Signature: _____