

ALABAMA DEPARTMENT OF TRANSPORTATION

DATE: April 1, 2014

Special Provision No. 12-0268(2)

EFFECTIVE DATE: August 1, 2014

SUBJECT: Roadway Lighting.

Alabama Standard Specifications, 2012 Edition, shall be amended by replacing SECTION 750 and SECTION 889 as follows:

SECTION 750 ROADWAY LIGHTING

750.01 Description.

This work shall consist of furnishing and installing roadway lighting systems, or the modification of roadway lighting.

The structural requirements (design and materials) for roadway lighting are addressed in Section 718.

750.02 Materials.

Materials shall meet the requirements given in Section 889.

Prior to purchasing materials, and within 30 days after the issuance of the "Notice to Proceed", the Contractor shall submit five copies of a complete descriptive list of all materials to the Design Bureau's Traffic Design Section for approval. (The requirement for the submittal of structural designs and details is given in Section 718.) This information shall be submitted on the Department's Material Submittal Form furnished to the Contractor for this purpose. The submittal shall have each item sequentially numbered, a reference to the Specification Section and/or plan sheet, and a description of the material. The description shall include the type, model number, catalog number, and manufacturer, and shall include a legible manufacturer's catalog cut sheet with each item being submitted clearly identified. All roadway lighting components (wiring, conduits, boxes, mounting hardware, power control devices, luminaires, luminaire poles, etc.) shall be itemized on the submittal form. Submittals shall be clear and complete. Pay Items are not to be referenced on the form. Incomplete or inaccurate submittals will be returned to the Contractor for revision and resubmittal. Partial lists may be considered if prior approval for the submittal of a partial list is approved in writing by the Engineer.

Materials shall not be installed prior to approval. The Department will not be liable for materials purchased, work performed, or any delay incurred due to the failure of the Contractor to secure prior approval.

Failure of the Engineer to note unsatisfactory material as received at the job site will not relieve the Contractor of the responsibility of furnishing the required material.

750.03 Construction Requirements.

(a) CODE.

All work shall be done in accordance with the requirements given in the current edition of the National Fire Protection Association "NFPA 70, "National Electrical Code" (NEC) and the regulations and standards of the power company providing service.

(b) LICENSE.

The Contractor responsible for the performance of the work shall be licensed as a General Contractor authorized to perform electrical work by the Alabama State Licensing Board for General Contractors

At least one out of every three persons in each work crew shall be a Journeyman licensed by the Alabama Electrical Contractors Board. Journeymen shall be present and shall have direct

involvement with all work required for the installation and operational testing of electrical materials and equipment. The Journeymen shall also possess an IMSA (International Municipal Signal Association) Roadway Lighting Level 1 Certification.

The Contractor shall submit copies of the General Contractor license, Journeyman licenses and IMSA certifications to the Engineer as a part of the submittal of the list of materials proposed for installation. Work shall not begin on the installation of electrical materials or equipment until copies of the licenses and certifications have been approved by the Engineer.

(c) ELECTRICAL POWER.

The entity (City, County, State, etc.) that will be responsible for the eventual operation and maintenance of the roadway lighting system will make application for electrical service upon notification that power service will be required. The Contractor shall inform the Engineer when power service is required at least 30 calendar days prior to the need of the power service. This same entity will be responsible for the cost of the service connection and the monthly service billings thereafter.

Electrical power shall be the power system shown on the plans which will usually be a single phase, 3-wire, 480 Volt-AC system. Power shall be provided by a transformer that does not provide power to any other equipment.

(d) GENERAL CONDUIT SYSTEM INSTALLATION REQUIREMENTS.

Conduit shall be installed in accordance with the details shown on the plans or as directed by the Engineer. Rigid Nonmetallic Conduit (RNC) may be installed as a substitute for Nonmetallic Underground Conduit and Cable (NUCC) if it is the same size and schedule as the NUCC. Conduit routing shown on the plans is diagrammatic only. Actual routing shall be in the most prudent manner as approved by the Engineer.

Underground conduit depth shall be 24 inches {600 mm}, minimum, unless shown otherwise on the plans.

All conduit ends (except NUCC and HDPE) shall be put together in couplings to form a smooth raceway for cables. Bushings and duct sealant shall be installed at all conduit terminations to protect the insulation of the conductors and to prevent debris from entering the conduit. Conduits shall be joined by approved methods prescribed by the manufacturer of the conduit. When conduit is installed for future use, the ends of the conduit shall be capped with a fitting listed for this purpose to prevent water and other foreign matter from entering the conduit system.

The Contractor shall seed and mulch disturbed areas as directed by the Engineer. The seeding and mulching of disturbed areas shall be a subsidiary obligation of the conduit installation.

Before beginning excavation, the Contractor shall determine the location of all utilities in the vicinity. Utilities shall not be damaged during construction.

Conduit shall be located to avoid potential conflict with the future installation of guardrail, signposts, and other equipment and devices. A minimum of 12 inches {300 mm} clearance shall be provided between the finished lines of conduit runs and existing underground utilities. Where the underground conduit run is adjacent to concrete walls, piers, footings, etc., a minimum of 4 inches {100 mm} of undisturbed earth or firmly compacted soil shall be maintained between the conduit and the adjacent concrete.

Unless shown otherwise on the plans, trenches shall not be excavated in existing pavement or paved shoulders to install conduit. When it is necessary to place conduit under an existing pavement, the conduit shall be installed in accordance with the requirements given in Section 756. Unless approved otherwise by the Engineer, trenches shall not remain open after normal work hours each day.

Liquid Tight Flexible Metal Conduit (LFMC) or Liquid Tight Flexible Non-metallic Conduit (LFNC) as shown on the plans or directed by the Engineer shall be installed where conduits cross an expansion or open joint on bridges, barrier rails or structure. The LFMC or LFNC shall be 36 inches {900 mm} in length and shall have a sag of not more than 3 inches {75 mm} between the fixed ends of the rigid conduit.

(e) JUNCTION BOXES.

The types of junction box shall be:

TYPE	INSTALLATION LOCATION	BOX MATERIAL
Type 1	Installed flush with grade.	Non-Metallic
Type 2	Installed on the surface of a structure.	Metal
Type 3	Installed flush with surface of a structure.	Non-Metallic
Type 4	As Shown on the Plans	As Shown on the Plans

(f) NONMETALLIC UNDERGROUND CONDUIT AND CABLE.

Nonmetallic Underground Conduit and Cable (NUCC) shall be installed in accordance with the manufacturer's recommendations.

If plowing is proposed for the installation of the NUCC, the manufacturer's recommended installation practices shall be submitted to the Engineer prior to beginning the installation. If the Engineer is not satisfied with the Contractor's performance and knowledge once installation begins, the Contractor shall arrange for a manufacturer's representative experienced in plowing methods to be at the jobsite until the Engineer determines that the Contractor is capable of properly installing the NUCC. If rock or other obstructions hinder plowing operations, the Engineer may require that conductor routes be pre-ripped to locate rock or hidden obstructions. Obstructions may be removed or the conductors routed around them as approved by the Engineer.

If the "Plow Pulling" method is used, the plow operator shall have an acceptable method to insure that the manufacturer's recommended maximum tensile force on the NUCC is not exceeded.

If at any time the Engineer determines the installation is not in full compliance with the intent of the manufacturer's recommended practices, the operation shall stop until a manufacturer's representative can further instruct the Contractor's personnel in the deficient areas.

If the "Chute Plowing" method is used, special attention shall be given to the conductor feed chute dimensions.

(g) CONDUCTOR INSTALLATION.

1. SPLICES AND TAPS IN CONDUCTORS.

Splices and taps in conductors shall only be made in junction boxes and pole bases. They shall be made with solderless split bolt connectors.

Splices and taps shall be protected in sealed in silicone gel filled enclosures to provide a waterproof connection and to ensure the required electrical insulation.

Silicone gel filled enclosures shall be re-enterable; shall be UV resistant, listed for temperatures from -40 °C to 90 °C; and shall be impact and abrasion resistant. The enclosure shall be sized as shown in the following table:

Conductor Size	Gel Enclosure Size
#4 AWG and smaller	#2
#2 AWG	#2.5 or Miniwedge
Larger than #2 AWG	#3

2. PULLING CONDUCTORS INTO CONDUIT.

Conductors shall not be pulled into a conduit until the installation of the conduit is complete. Conductors in conduits shall be carefully pulled into place using approved methods so that the conductors will not be damaged. Powdered soapstone, talc, or other inert lubricant specifically designed for the purpose shall be used when pulling conductors through the conduit. All conductors within a single conduit shall be pulled at the same time and shall be handled and installed in such a manner as to prevent kinks, bends or other distortion which could damage the conductor and outer covering. When conductors are pulled through hand holes, pole shafts, etc., a pad of firm rubber or other suitable materials shall be placed between the conductors and the edges of the opening to prevent damage to the conductors.

(h) GROUNDING.

All metal poles and metal enclosures containing electric wires and/or equipment shall be grounded. Exothermic welds or other approved connectors shall be used to connect the grounding conductor to the ground rods.

A continuous grounding conductor, either bare or having a green colored insulation, shall be extended from the service ground to all equipment and shall be used for grounding purposes only.

(i) LIGHTNING PROTECTION.

Lightning protection shall be installed as shown on the plans at all poles greater than or equal to 75 feet {22.8 m} in height.

(j) FOUNDATIONS.

For bidding purposes, the size and configuration of reinforced concrete foundations will be shown on the plans for the designated ranges of pole heights

The Engineer will inform the Contractor if changes are required to the depth of concrete foundation required at each pole. Changes in the depth of foundations may be made based on a review of the Contractor's design submittal. The Contractor will be notified of any such changes upon completion of this review. If no changes are required, the Contractor shall install the as-bid sizes of foundations.

Care shall be taken to properly orient the anchor bolts of concrete foundations so that the luminaire assembly will be in proper alignment with the roadway.

Conduits shall be accurately placed, oriented in the proper direction to accommodate future extension, and securely held in place to prevent movement.

Concrete shall then be placed in the excavated area against undisturbed earth below the finished ground line. The concrete shall be placed in an approved form above ground line to the top of the foundation. All exposed edges of the concrete shall have a 3/4 inch {19 mm} chamfer.

The top of the foundation shall be level and shall be placed to properly orient the luminaire assembly with the roadway. For breakaway poles, the finished foundation shall have a maximum 4 inch {100 mm} "Breakaway Support Stub Height Measurement" as defined in the AASHTO Roadside Design Guide, Chapter 4.2.

(k) INSTALLATION OF LUMINAIRE POLES.

Luminaire poles shall be installed in a vertical position. Erection shall be accomplished carefully to prevent marring the finish or otherwise damaging the pole.

When lighting is to be installed on a bridge, the Contractor shall, before ordering the poles, examine the bridge plans or the completed bridge, whichever is applicable, to determine the exact nature of the proposed or existing details which will accommodate the luminaire poles. Any discrepancies between the plans and an existing bridge structure shall be immediately reported to the Engineer.

The Contractor shall verify that the pole anchor bolts, base plate bolt pattern, and pole assembly (including tenon mounting holes, multiple pole sections, and hand-hole orientation) are coordinated for proper orientation of lowering devices and luminaires to the roadway as shown on the plans.

A screen made from 1/4 inch {6.4 mm} mesh galvanized wire cloth shall be fabricated and inserted in the pole base to prevent rodents, etc. from entering the pole.

Backfill for direct burial fiberglass poles shall be as recommended by the pole manufacturer.

Care shall be taken to assure the bracket arm is properly aligned.

(l) INSTALLATION OF LUMINAIRES.

The light control surfaces and glassware shall be cleaned after installation. Cleaning shall be performed in accordance with the luminaire manufacturer's recommendations. Luminaires shall be leveled, plumbed, and installed as per the manufacturer's recommendations to achieve the most suitable light pattern.

The Contractor shall verify that the lamp socket is in the proper position to produce the optimum lighting pattern for each luminaire not to just meet minimum. Each luminaire shall be adjusted to provide the most effective light pattern as directed by the Engineer after installation.

(m) TESTING INSULATION.

The insulation of all lighting circuits will be tested by the Engineer at the load side of the contactors or circuit breakers. These tests shall be made with a 500-volt DC Megger Tester. Any reading of 250,000 ohms to ground or higher is satisfactory. Any reading of less than 250,000 ohms to ground is unacceptable and shall be corrected. The Engineer may conduct additional insulation testing after the completion of the operational testing.

(n) GROUND RESISTANCE TESTING.

The resistance to ground will be tested by the Engineer at each lighting control center . The test will be conducted using a null balance earth tester with auxiliary ground rods placed 50 feet {15.24 m} and 100 feet {30.48 m}, respectively, from the tested ground rod. A reading of 25 ohms or less is satisfactory. Any reading over 25 ohms will require the installation of additional ground rods to be placed in a pattern as directed by the Engineer. The Engineer may conduct additional ground resistance testing after the completion of the operational testing.

(o) TESTING LUMINAIRE LOWERING DEVICES.

The Contractor shall perform a functional test on all luminaire lowering devices. Tests shall be performed in the presence of the Engineer. The test shall be performed on the final completed lighting assembly with all luminaires and other components installed. The test shall be performed as follows:

- Start with the device in the latched position on top of the pole.
- Unlatch and lower the device support to ground level for inspection.
- Raise device to top and latch.
- Unlatch and lower the device 5 to 10 feet {1.53 to 3.05 m}.
- Raise the device and confirm that secure latching has occurred.
- Repeat unlatching, lowering, raising and latching three times.

If latching or unlatching failures occur, or if any other problems occur during the test, the Contractor shall make corrections and repeat the complete test in the presence of the Engineer.

(p) OPERATIONAL TESTING OF THE SYSTEM.

The Contractor shall perform full operational testing of the completed lighting system after the completion of the installation of all equipment and materials, including all miscellaneous items of work required for the complete lighting system. The operational testing will not begin until the testing of the insulation, resistance to ground, and luminaire lowering devices has been completed and accepted by the Engineer.

The Engineer will set the date that the operational testing will begin. The Contractor shall provide all installation and operational instructions for all lowering devices before the operational testing of the system will be allowed to begin.

An operational test shall be the full operation of all components of the lighting system for a period of 30 calendar days. During this test period the Contractor shall perform all necessary adjustments (including re-aiming of luminaires) and replace all malfunctioning parts of the equipment required to place the system in a fully operational condition. Extra compensation will not be given for adjustments, maintenance, repairs and replacements during the test period. The initial test period will be suspended as directed by the Engineer during the time that the entire lighting system is not in full operation. The 30 calendar day operational test period shall be restarted or repeated if required by the Engineer due to repeated failure of the lighting system.

The Engineer will perform a final inspection of the lighting system at the completion of the operational testing. If all items of work in the contract have been completed, the Engineer will suspend contract time charges during the operational testing.

Upon completion of the operational testing, field tests may be conducted by the Engineer to verify that the required lighting levels and uniformity ratios are being provided. Any adjustments to the lighting system necessary to meet the design criteria shall be done at the Contractor's expense.

(q) WARRANTIES, GUARANTEE AND MAINTENANCE.

The State shall be protected from any defect in the lighting system by the following:

- The Contractor shall provide the manufacturer's warranties to the State for all electrical and mechanical equipment and;
- The Contractor warrants equipment and guarantees workmanship for satisfactory in-service operation of the electrical and mechanical equipment and related components for a period of one year following the date of completion of the operational check period. ,
- Maintenance repair work may be required for long duration contracts. In the case of long duration contracts the Contractor shall perform maintenance repair work on the lighting system (equipment, devices, structures and hardware) from the end of the one year warranty period until the

end of contract time charges. Maintenance repair work during this time period will be paid for as "Extra Work" in accordance with the requirements given in Article 109.04.

The Department will not make the final payment for work under this Section until the warranties, guaranties and contact information are furnished to the Engineer.

(r) MODIFICATION OF ROADWAY LIGHTING.

The modification of roadway lighting shall consist of any amount of preparation, restoration, relocation, rehabilitation, demolition or salvage work designated on the plans for modification. New materials shall be furnished when required for the modification work unless noted otherwise on the plans.

(s) LUMP SUM ROADWAY LIGHTING.

The work of furnishing and installing "lump sum" Roadway Lighting shall consist of the construction of partial or complete roadway lighting as shown to be required on the plans. It may be work that is limited to no more than the installation of lamps or fuses for luminaires to a complete roadway lighting system with multiple lighting structures, luminaires and lighting control equipment.

750.04 Method of Measurement.

Pay Items 750-A, B, C, D, H, I, and L will be measured per each item.

Pay Items 750-E, F and G will be measured in linear feet {meters}.

Pay Items 750-J, K and Z will be measured as lump sum units.

750.05 Basis of Payment.

(a) UNIT PRICE COVERAGE.

The contract unit price for each Pay Item shall be full compensation for all materials, tools, labor, equipment and miscellaneous items required to compete the item of work. This will include excavation, foundations, conduits, conductors, pole assemblies, luminaires, junction boxes, lighting control centers, power service equipment and materials as designated for each pay item.

Pay Items are as follows:

Item 750-A: High Mast Luminaire Assembly. A high mast luminaire assembly shall be the pole, lowering device, electric motor, pole wiring system, luminaires, lamps, fuses, circuit breaker, surge arrester, lightning protection system, pole numbers, equipment grounding system, and miscellaneous hardware.

Item 750-B: Roadway Luminaire Assembly. A roadway luminaire assembly shall be the pole, pole numbers, pole wiring system (State furnished when applicable), surge arrester, lightning protection system, Type 1 junction box, equipment and pole grounding systems, fuses, luminaires, lamps, and miscellaneous hardware. A breakaway device and luminaire lowering device shall be a part of this pay item when shown to be required on the plans.

Item 750-C: Pole Foundation. A pole foundation shall be a reinforced concrete foundation including the excavation, disposal of excavated material, concrete, backfill, concrete pad, reinforcing steel, conduit and elbows, anchor bolts, and mulching and seeding the disturbed ground.

The compensation for a reinforced concrete foundation may be adjusted if the size of the foundation is required to be changed. Bid prices shall be given for the construction of a foundation to the depth and at the diameter shown on the plans. A deeper foundation may be required based on the results of the Department's review of the Contractor's submittal of the design of the pole structure.

The compensation for a foundation will be adjusted if changes are required to be made to the depth of the foundation. The adjustments shall be in accordance with the following requirements:

- 2'-0" {600 mm} Diameter: The compensation for 2'-0" {600 mm} diameter foundation shall be increased by \$50 for each foot {\$50.00 for each 300 mm} of depth that the foundation increases from what is shown on the plans.

- 2'-6" {760 mm} Diameter: The compensation for 2'-6" {760 mm} diameter foundation shall be increased by \$75 for each foot {\$75.00 for each 300 mm} of depth that the foundation increases from what is shown on the plans.

- 3'-0" {910 mm} Diameter: The compensation for 3'-0" {910 mm} diameter foundation shall be increased by \$100 for each foot {\$100.00 for each 300 mm} of depth that the foundation increases from what is shown on the plans.

- 4'-0" {1.22 m} Diameter: The compensation for 4'-0" {1.22 m} diameter foundation shall be increased by \$200 for each foot {\$200.00 for each 300 mm} of depth that the foundation increases from what is shown on the plans.

- Reinforcing Steel: The adjustments to compensation because of changes in foundation depth shall also cover compensation for providing the reinforcing steel shown on the plans for the deeper foundations. The number and size of longitudinal reinforcing steel and the size and spacing of hoops will be the same regardless of any change in depth.

Item 750-D: Electrical Junction Box. An electrical junction box shall be the junction box, concrete, and mounting hardware.

Item 750-E: Conduit. Conduit (RMC, LFMC, LFNC, or RNC) shall be the conduit tubing including fittings, trenching, backfilling, attachment to structure and miscellaneous hardware.

Item 750-F: Conductor. This shall be individual conductors and includes pulling, splicing, terminating, testing and miscellaneous hardware.

Item 750-G: Combined Duct and Cable: Combined duct and cable (NUCC) shall be the complete assembly of polyethylene duct and the size and number of required conductors. It shall include fittings, trenching, backfilling, splicing, terminating, testing and all miscellaneous hardware.

Item 750-H: Service Pole. A service pole shall consist of the pole, switch, fuses, ground rod, one-spool clevis, down guy and guy rod (if required) and miscellaneous hardware.

Item 750-I: Lighting Control Center. A lighting control center shall include switches, circuit breakers, contactors, fuses, enclosures, photocontrols, ground rods, incoming service conductors and conduit, concrete slab, anchor bolts, and miscellaneous hardware.

Item 750-J: Preparation Work for Utility Company Equipment. This work shall include the installation of concrete pads, pull boxes, conduit, grounding equipment, conductor vaults, and other equipment and materials as shown on the plans.

Item 750-K: Modification of Roadway Lighting. The modification of roadway lighting shall consist of the work shown on the plans to be included in this pay item. It may include any kind and amount of preparation, restoration, relocation, rehabilitation, demolition and salvage work detailed on the plans.

Item 750-L: Landscape Luminaire Assembly. Landscape luminaire assemblies shall be furnished and installed by the Contractor in accordance with the details shown on the plans. Each landscape luminaire shall be connected to the electrical power service to become a fully functional part of the required lighting system.

Item 750-Z: Roadway Lighting. Roadway Lighting (lump sum) shall include all equipment, materials, tools, labor, and miscellaneous items required for roadway lighting as shown to be required on the plans. This shall include all excavation, foundations, conduits, conductors, pole assemblies, luminaires, junction boxes, lighting control centers, power service equipment and materials, and all miscellaneous items required to complete the work shown on the plans that is included in this item of work.

(b) PAYMENT WILL BE MADE UNDER ITEM NO.:

750-A High Mast Luminaire Assembly with * - per each

750-B Roadway Luminaire Assembly with * - per each

750-C Pole Foundation, ** - per each

750-D Electrical Junction Box, Type ____ - per each

750-E Conduit, *** - per linear foot {meter}

750-F Conductor, **** - per linear foot {meter}

750-G Combined Duct and Cable, ***** - per linear foot {meter}

750-H Service Pole - per each

750-I Lighting Control Center - per each

750-J Preparation Work for Utility Company Equipment - per lump sum

750-K Modification of Roadway Lighting - per lump sum

750-L Landscape Luminaire Assembly, ***** - per each

- 750-Z Roadway Lighting - per lump sum
- * number, type, and wattage of luminaire(s) as required
 - ** either Roadway or High Mast
 - *** conduit size and type
 - **** size of conductors
 - ***** number and size of conductors
 - ***** either bollard, canopy, recessed light, up light or down light

SECTION 889

ROADWAY LIGHTING MATERIALS

889.01 General.

Electrical materials shall conform to the requirements given in the current edition of the NFPA 70, "National Electrical Code" (NEC). Electrical materials shall also conform to the standards of the American National Standards Institute (ANSI), the National Electrical Manufacturers Association (NEMA), and the Underwriters Laboratories, Inc. (UL), in every case where a standard has been established. All materials shall be "listed" by one or more of these organizations. The mark of the listing organization shall appear on electrical material and equipment.

Units of any one item (such as poles, luminaires, lamps, control devices, enclosures, circuit breakers, etc.) shall be made by the same manufacturer.

889.02 Conduit.

(a) RIGID METAL CONDUIT (RMC).

Rigid metal conduit, couplings, and fittings shall be galvanized steel, meeting the requirements given in UL 6. Couplings and fittings shall be threaded.

(b) LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC).

Liquidtight flexible metal conduit shall meet the requirements given in UL 360. The thermoplastic covering shall be oil resistant.

(c) LIQUIDTIGHT FLEXIBLE NON-METALLIC CONDUIT (LFNC).

Liquidtight flexible non-metallic conduit shall meet the requirements given in UL 1660.

(d) RIGID NONMETALLIC CONDUIT (RNC).

Rigid nonmetallic conduit shall be Schedule 40 PVC and shall meet the requirements given in UL 651.

(e) NONMETALLIC UNDERGROUND CONDUIT WITH CONDUCTORS (NUCC).

Nonmetallic Underground Conduit with Conductors (NUCC) shall meet the requirements given in UL 1990.

889.03 Lighting Circuit Conductors.

(a) GENERAL.

All conductors in the lighting circuits shall be stranded copper with 600 Volt-AC insulation rating. Insulated conductors shall be Type RHW, RHW-2, XHHW or XHHW-2 meeting the requirements given in UL 44. The size of the conductor, voltage rating, and insulation type shall all be clearly marked on the conductor in a color that contrasts with the insulation color.

(b) CONDUCTOR IDENTIFICATION COLOR.

Unless designated otherwise by the requirements given in the NEC, conductors shall be identified as follows. Equipment grounding conductors shall be bare or shall be identified by a continuous green color insulation. Grounded conductors (neutrals) shall be identified by continuous white or gray color insulation. Current carrying conductors may be identified by any color insulation other than white, gray or green and shall have a consistent color for each conductor.

(c) SPLICING AND TERMINATION OF CONDUCTORS.

Splices and terminations shall be made with materials which are listed for that purpose. Grounding conductors shall be connected to structures using materials specifically listed for grounding.

(d) CONDUCTORS IN LUMINAIRE POLES.

The Contractor shall furnish and install the conductors, connectors and fittings in the luminaire poles for supplying power to the luminaries. The required details of the conductors, connectors and fittings are shown on the plans.

889.04 Fuses and Fuse Holders At Breakaway Luminaire Supports.

(a) FUSES

Fuses for installation within fuse holders for the protection of lighting branch circuits shall be small-dimension cylindrical fuses designed for fast acting current limiting. The fuses shall be rated for 600 volts AC and shall have a UL listed interrupting rating of not less than 10,000 rms symmetrical amperes at rated voltage.

Fuses for luminaires shall be rated at 300% of the starting or operating current, whichever is greater, but in no case greater than the branch circuit conductor ampacity.

(b) FUSEHOLDERS.

The fuse holder shall be capable of disconnecting upon sufficient tension in the connected wires, as in a pole knockdown. The fuse shall remain enclosed in the de-energized portion of the fuse holder upon disconnection. The fuse shall not be utilized as the disconnection means; a separate plug and receptacle shall be utilized for the disconnection means.

The fuse holder assembly shall connect to the load-side quick disconnect receptacle.

889.05 Junction Boxes.

(a) NON-METALLIC BOX.

Non-metallic junction boxes shall be made from polymer concrete. With approval of the Engineer, slight deviations to a larger size box may be allowed to conform to a standard manufacturer's production size. The cover shall be attached with stainless steel hex-head bolts factory coated with anti-seize compound.

A box installed at grade shall be capable of withstanding an A16 loading in accordance with the requirements given in ASTM C 857. The box and lid shall be a light gray color to match the surrounding concrete. The box shall be constructed with an open bottom. The cover shall fit flush with the surface shown on the plans.

A box installed in a structure (such as concrete barrier rail) shall have the exposed face of the box flush with the surface of the structure. If the size of the box is not shown on the plans, the minimum size shall be 12 inches {300 mm} long by 10 inches {250 mm} wide by 5 inches {125 mm} deep. Conduit openings may be factory cut.

(b) METALLIC BOX.

Metallic junction boxes shall be aluminum or stainless steel NEMA Type 4 unless shown otherwise on the plans. A grounding lug shall be provided for the connection of the equipment grounding conductors. Metallic boxes shall be installed only above ground and shall be suitable for surface mounting.

889.06 Service Pole.

Service poles shall be treated in accordance with the requirements given in Section 833.

889.07 Lighting Control Center.

(a) CABINET.

An aluminum identification plate shall be permanently affixed to the outside of the cabinet door. The identification plate shall be sized to provide the message "Alabama Department of Transportation Lighting Control Center *" either etched or embossed in 1 inch {25 mm} high letters. The identification (A, B, C, etc.) of the lighting control center shown on the plans shall be placed on the identification plate where * is shown in the description of the wording required on the identification plate. The letters shall be delineated in black enamel.

The control cabinet shall be constructed of 0.125 inch {3.175 mm} thick Aluminum unless shown otherwise on the plans and shall be rated NEMA Type 4. Each cabinet shall be provided with a 12 gauge steel interior panel for mounting of components.

The cabinet shall not be smaller than the minimum dimensions shown on the plans. The cabinet shall be large enough to adequately house all required components with room for arrangement and termination of wiring and room for the inclusion of space for two future lighting circuits.

The cabinet door shall be mounted to the cabinet with a continuous hinge, located on either side of the cabinet (right-hand or left-hand door opening). The cabinet door shall also have a handle-operated three-point latching system located on the opposite side of the continuous door hinge. The door handle shall contain a "Corbin", or an approved equal, lock with two keys (keys shall match state keying system). The Contractor shall give the keys to the Engineer when the project has been completed, tested, and accepted.

(b) PHOTOCCELL CONTROL.

The photocell shall consist of a metal electrode, molecularly bonded to a ceramic wafer, and coated with cadmium-sulfide. The photo cell shall be highly corrosion resistant without "plastic dipping". Color response of the cell shall be such that a maximum sensitivity is in the blue-green portion of the color spectrum. The photocell shall be of a solid state design. In addition, the photocell shall meet the requirements of UL 773.

The "On-Off" switching operations shall be accomplished by a normally closed contact which will be operated by means of an electro-magnetic relay. The response time shall be less than one second time delay for turn-on and three to thirty seconds time delay to prevent the "Turn-off" due to lightning flashes. If the photocell fails, the luminaires shall remain on as a notification of needed maintenance.

Over voltage protection shall be provided for the control components and the load circuit by the means of an expulsion type surge arrester capable of passing the surge outlined in ANSI C136.10, except follow current is 10,000 A.

The base of the unit shall be manufactured on a 3 inch {75 mm} wide, solid thermoset phenolic base. The bottom of the base shall have an integral, locking type, brass 3 prong plug according to NEMA specification SH16-1962. The gasket shall be of a cross-linked polyethylene to assure moisture proof seal to the luminaire socket.

The control must be able to operate over the range of 105-130V, 60 Hz. AC (120 V Nominal). Its direct load rating shall be 1000 Watts incandescent load and 1800 VA Mercury Vapor, High Pressure Sodium or other H.I.D. load.

The control shall be stable and reliable over an operating temperature range of -65 °F {-55 °C} to 158 °F {70 °C}.

Each control furnished shall be calibrated for a "Turn-on" setting of 2.6 footcandles and the "Turn-off" setting shall not exceed 0.6 times the "Turn-on" setting.

(c) SURGE ARRESTOR.

The surge arrester shall be weatherproof. It shall be capable of withstanding a surge current of 50,000 Amps and a surge voltage of 550 Volts.

(d) CIRCUIT BREAKERS.

All feeders, branch circuits, and auxiliary and control circuits shall have overcurrent protection. The overcurrent protection shall be by means of circuit breakers. Circuit breakers shall be standard UL-listed, molded case, thermal-magnetic, bolt-on type, with trip-free indicating handles. Circuit breakers shall have a UL-listed interrupting rating of not less than 22,000 rms symmetrical amperes at rated circuit voltage for which the breaker is applied (unless otherwise noted on the drawings). Multi-pole circuit breakers larger than 100 ampere size shall have adjustable magnetic trip settings. The number of branch circuit breakers shall be as indicated on the Control Cabinet detail drawing or as indicated in the lighting system wiring diagram, whichever is greater, plus space for 2 spare circuit breakers. Circuit breakers shall be installed so that they will be in sequential order from left to right, top to bottom when the circuit breakers are viewed in the open cabinet. The sequential order shall be based on the identifying designation shown on the plans for each lighting circuit.

(e) CONTACTORS.

Contactors shall be electrically operated, mechanically held, as specified, with the number of poles required for the service and with operating coil voltage as indicated. Ampere rating of contactors shall be not less than required for the duty shown and shall otherwise be rated as indicated. Contactors shall be complete with a non-conducting inorganic, non-asbestos subpanel for mounting. Contactors

shall be mechanically held and shall be complete with coil-clearing contacts to interrupt current through the coil once the contactor is held in position. The main contactor contacts shall be the double break, silver to silver type. They shall be spring-loaded and provide a wiping action when opening and closing. The contacts shall be renewable from the front panel, self-aligning, and protected by auxiliary arcing contacts. The line and load terminals shall be pressure type terminals of copper construction and of the proper size for the ampere rating of the contactor. A lever for manual operation shall be incorporated in the contactor. Protection from accidental contact with current-carrying parts when operating the contactor manually shall be provided. The contactor operating coil shall operate at 120 V AC, single phase.

The number of lighting contactors shall be as indicated on the Control Cabinet detail drawing or as indicated in the lighting system wiring diagram, whichever is greater, plus space for 2 spare contactors.

All contactors shall be connected to the conductors with the line side on top of the contactor and the load side on bottom.

(f) GROUND AND NEUTRAL BUSS BARS.

Separate ground and neutral bus bars shall be provided. The ground bus bar shall be copper, mounted on the equipment panel, fitted with 22 connectors, minimum, of the type shown on the plans. The neutral bar shall be similar. The heads of connector screws shall be painted white for neutral bar connectors and green for ground bar connectors.

(g) INTERIOR POWER, LIGHTING AND RECEPTACLE.

The cabinet shall have an auxiliary device circuit at 120 V AC, single phase to supply a ground fault interrupting, duplex convenience receptacle, a fluorescent cabinet light and photocell for the lighting system. The 120 V, single phase AC power shall be provided by a NEMA 3R rated dry type, 480/120 Volt-AC step-down transformer, not less than 2 kVA, which shall be mounted on the 12 gauge steel interior panel in the cabinet. The auxiliary device circuit, including transformer primary and secondary, shall have overcurrent protection according to NEC requirements. The fluorescent light shall be a 17 W minimum surface mounted fixture with protected lamp cover and directly connected to a door actuated switch. The receptacle shall be a 20 A, ground fault interrupting, duplex receptacle, in a weatherproof box with appropriate cover.

(h) WIRING AND IDENTIFICATION.

Power wiring within the cabinet shall be of the size specified for the corresponding service conductors and branch circuits and shall be rated RHH/RHW, 600 Volts-AC. Control and auxiliary circuit wiring shall be rated RHH/RHW or MTW with jacket, 600 Volts-AC. All power and control wiring shall be stranded copper. When the contract drawings do not specifically indicate assigned wire designations, the manufacturer shall assign wire designations and indicate them on the shop drawings. All switches, controls and the like shall be identified both as to function and position (as applicable) by means of engraved 2-color nameplates attached with screws, or where nameplates are not possible in the judgment of the Engineer, by the use of cloth-backed adhesive labels as approved by the Engineer. The cabinet with all of its electrical components and parts shall be assembled in a neat orderly fashion. All of the electrical conductors shall be installed in a trim, neat, professional manner. The conductors shall be trained in straight horizontal and vertical directions and be parallel, and adjacent to other conductors. Conductors in common paths shall be tied together in a bundle to reduce the number of loose conductors.

(i) TEST SWITCH.

The test switch (selector switch) shall be a standard duty maintained contact control station and shall have double break contacts rated for use on 120 volt AC. The switch shall be labeled "Manual", "Off", and "Auto". Suitable accessories shall be provided for mounting the test switch in the lighting control cabinet.

(j) SCHEMATIC DIAGRAM.

The Contractor shall furnish and install a schematic diagram of the control center wiring for each lighting control cabinet. The schematic shall be overlaid with a 10 mil clear laminate and attached to the inside of the control cabinet door using double stick tape or other approved method. The maximum size of the schematic diagram shall be 11 inches by 17 inches.

889.08 Roadway Luminaire Assembly.

(a) LUMINAIRE.

1. GENERAL.

The bottom outside of each luminaire shall be marked as shown on the plans or as directed by the Engineer with a permanent marking to provide an identification of the wattage of the luminaire. This designation shall be large enough so that it can easily be seen from the ground after the luminaire is installed.

All luminaires shall have a die cast aluminum housing; a weather resistant gray finish coat applied to the housing unless otherwise stated and a precision formed aluminum reflector coated to prevent tarnish and corrosion. All hinges, bolts, nuts, washers, screws and miscellaneous hardware shall be stainless steel.

All conventional luminaires shall have a pressed borosilicate glass refractor to provide the IES lighting pattern indicated.

All luminaires shall have labels indicating it is suitable for use in wet locations, suitable for 40 °C ambient temperatures, and suitable for -40 °C starting.

Luminaires other than those shown on the plans may be proposed for use on this project. These luminaires shall produce the lighting levels and ratios shown on the Lighting Design Criteria table in the plans. If a table is not shown, the levels and ratios shall conform to the AASHTO requirements given in the booklet An Informational Guide for Roadway Lighting. Luminaire light distribution classifications are as described in the AASHTO Lighting Design Guide publication.

2. OFFSET LUMINAIRE.

The luminaire shall be an offset type roadway fixture specifically designed for roadway lighting. Support shall be by means of a nominal 2-inch {50.8 mm} knuckle fitter or trunion yoke that allows the luminaire to be easily aimed in both a vertical and horizontal direction.

The lamp socket shall be provided with a quick disconnect for removal of the reflector/socket assembly. All electrical control components shall be completely removable without tools. A terminal block shall be provided for connection to the power source. The luminaire shall be sunlight resistant, shall be provided with 600 V AC rated conductors, and shall be provided with seals and gaskets to prevent entry of contaminants.

3. SEGMENTED REFLECTOR LUMINAIRE.

The general requirements for a luminaire shall be modified as indicated herein for a segmented reflector luminaire only. The housing shall be square or round heavy gauge aluminum with a vinyl coating or equal means of corrosion protection. The tempered clear glass lens shall be gasketed and securely fastened. A gasketed cast aluminum slip fitter shall accept a 2.375 inch {60.33 mm} O.D. pipe for mounting. The housing and slip fitter shall be substantially made to withstand the anticipated wind loads. The entire unit shall be UL listed as suitable for wet locations and sealed sufficiently to prevent the entrance of insects especially into the lens area.

The luminaire optical assembly shall produce an asymmetrical, square, or rectangular pattern as required by its location. The pattern shall be field adjustable to provide maximum utilization. The HPS lamp shall mount in a vertical base position and produce a cutoff lighting pattern. The maximum candlepower at nadir for a 400 Watt HPS lamp shall be less than 1250. The angle of peak candlepower shall be between 63 and 68 degrees in the vertical plane. The ballast shall be easily removable for maintenance and all wiring shall terminate on a terminal strip.

The luminaire shall be mounted as shown on the plans.

The luminaire shall be designed for a high pressure sodium, clear lamp of the wattage specified in the plans.

4. LIGHT EMITTING DIODE LUMINAIRE.

The housing shall be die cast aluminum with a weather resistant gray finish coat applied to the housing. The luminaire shall be provided with a hinged door assembly underneath the fixture. The door shall contain all of the electronic components with quick disconnect connectors.

Input supply wires should not need to be bent or re-routed around components to make the electrical terminations. Only copper wire shall be used to connect electronics within the fixture. No wire nuts shall be used within the luminaire assembly.

The luminaire shall utilize heat sink fins that are integrally cast with the housing to maximize heat transfer and minimize thermal impacts of environmental conditions such as debris clogged fins. Thermal management must be passive with no fans or other mechanical devices. The luminaire shall have a minimum heat sink surface such that the LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature. All exposed hinges, bolts, nuts, washers, screws and miscellaneous hardware shall be stainless steel.

All luminaires shall have labels indicating it is suitable for use in wet locations, suitable for 40 °C ambient temperatures, and suitable for -40 °C starting.

The luminaire shall be designed for light-emitting diodes to be mounted on removable modular boards with quick disconnect connectors and mounted to heat sinks using screws. Thermal grease shall not be used. Each LED module shall be fitted with a non-removable lens or individual lenses may be used on each LED die. No additional lens shall be used for the luminaire. All LEDs shall provide the same optical pattern such that catastrophic failures of individual LEDs will not constitute a loss in the distribution pattern.

The luminaire shall be protected by an integral surge protection device tested in accordance with ANSI/IEEE standard C62.4 for standard and optional waveforms defined in ANSI/IEEE C62.41.2 location category C (High) for 10 KV Basic Impulse Level (BIL). Both common and differential mode protection shall be provided. The failure mode of the surge protector shall be to turn the luminaire off. The protector shall be field replaceable in the event of failure and shall automatically reset after operation with no manual intervention required.

Luminaires shall be provided with a 5-year manufacturer's warranty covering replacement and repair of LEDs, drivers and paint finish. The warranty shall not be affected by opening the power door and accessing the electrical cavity. The manufacturer must have tested the luminaire model in a suitable testing program incorporating high heat, high humidity, thermal shock and vibration testing to ensure reliability and substantiate lifetime claims.

Luminaire compliance and performance claims shall be independently certified by an approved U.S. Department of Energy National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory in accordance with Illuminating Engineering Society of North America (IESNA) LM-79 and LM-80. The luminaire will have long term lumen maintenance documented according to the most current version of Illuminating Engineering Society of North America (IESNA) TM-21.

(b) BALLAST.

The ballast shall be capable of starting and operating one lamp of the indicated size from a 60Hz source at the proper voltage. The ballast shall be in full compliance with the lamp/ballast specifications from the lamp manufacturer. The igniter shall be a "Protected Starter" designed to remove the ballast from the circuit three to ten minutes after lamp fails to ignite; or, the igniter may be a type which directs the voltage spike to the lamp without being circuited through the ballast windings. A cycling or extinguished lamp shall not adversely affect the igniter or ballast which shall have an expected life exceeding five years in normal use.

The ballast design center shall not vary more than $\pm 5\%$ from rated lamp watts for nominal line voltage and nominal lamp voltage.

The lamp wattage regulation spread at any lamp voltage, from nominal through end of rated life, shall not exceed 35% for $\pm 10\%$ line voltage variation. The ballast must reliably start and operate the lamp in ambient temperatures down to -40 °C for the rated life of the lamp. The ballast primary current during starting must not exceed normal operating current. The ballast shall be capable of sustaining lamp operation with a line voltage dip or sag of 35% for up to 4 seconds when operating a nominal voltage lamp with nominal line voltage applied to the ballast primary. The line power factor of the lamp/ballast system shall not drop below 70% for $\pm 10\%$ line voltage variations at any point in the lamp life.

(c) LIGHT EMITTING DIODE DRIVER.

The driver shall be capable of starting and operating the LED modules of the indicated size from a 60Hz ± 3 Hz source at the designed voltage $\pm 5\%$. The driver output shall not vary more than $\pm 5\%$ from rated output watts for nominal line voltage and nominal lamp voltage.

Driver shall have a minimum power factor of 90% and a maximum Total Harmonic Distortion (THD) of 20% at full power output. The operating frequency should be high enough to avoid visible

flicker in the light output. The driver shall be UL certified for use in dry or damp locations. Driver life expectancy shall be 50,000 hours at 80 °C and 100,000 hours at 70 °C. The driver will not be adversely affected by the cycling or failure of one or more LED modules during the life of the driver.

The driver must reliably start and operate the lamp in ambient temperatures from -40 °C to 40 °C for the rated life of the lamp. The driver shall be capable of sustaining LED operation with a line voltage dip or sag of 35% for up to 4 seconds.

(d) LAMP.

Each luminaire with a lamp shall have a clear high pressure sodium (HPS) lamp of the required wattage installed. Average lamp life shall be 24,000 hours. Initial lumen output shall be:

70 Watts - 5,800 lumens	400 Watts - 50,000 lumens
100 Watts - 9,500 lumens	600 Watts - 92,000 lumens
150 Watts - 16,000 lumens	250 Watts - 28,000 lumens

(e) LIGHT EMITTING DIODE.

Each LED should be rated for a minimum operational life of 50,000 hours at 40 °C and comply with IESNA L-85 standards at 20 °C ambient temperature. Photometry must be in compliance with IESNA LM-79 when operating at an ambient temperature of 25 °C. The LED module shall lose no more than 10% optical intensity when operating at 40 °C than its initial delivered lumens at 25 °C.

All LED modules shall be constructed so that the failure of one LED will not result in the loss of the entire luminaire and so that modules can be replaced without replacing the entire luminaire. Each LED die or the LED module should be enclosed in a non-removable transparent lens of either glass or acrylic. The LED module shall produce a nominal correlated color temperature of 4000K \pm 275K with a color rendering index of at least 70 and a minimum output of 80 lumens per watt efficacy.

(f) ROADWAY LUMINAIRE LOWERING DEVICE.

1. RELIABILITY OF LOWERING DEVICE.

Any lowering device proposed for use shall have been proven reliable through previous acceptable performance. Lowering devices that are unreliable and have excessive maintenance costs in previous installations will not be approved for installation. Upon request by the Engineer, the Contractor shall furnish a list of at least ten installations, locations, and telephone numbers of persons to contact to verify the performance of the lowering device. Any delays in the progress of construction due to the Contractor's failure to furnish the requested information concerning the proposed lowering device shall be the responsibility of the Contractor.

2. REQUIRED CONFIGURATION OF LOWERING DEVICE.

The lowering device for a roadway luminaire assembly shall be configured to simultaneously raise or lower two or more luminaires that are attached to a single rigid assembly.

All exterior metal components of the lowering device shall be of corrosive resistant materials including stainless steel, aluminum, or galvanized steel unless otherwise specified. Other metal parts of the lowering device shall be of the quality recommended by the manufacturer for the proper functioning of the device.

The lowering device shall be capable of being latched at the top of the luminaire assembly to take the load of the luminaires and mounting hardware off of the cables at the final mounting height. The latching system shall be designed to impart no more than one G of force to any component of the roadway luminaire assembly.

The lowering device shall have a centering mechanism that will reliably keep the orientation of the luminaires in the proper position at all times until final latching is complete.

The raising and lowering shall be accomplished by the use of a portable winch and motor assembly that is connected by cord and plug to the electrical power for luminaires. The winch shall have a gear reduction assembly to allow a smooth, slow raising and lowering operation. The raising and lowering shall be accomplished by the use of stainless steel aircraft cable(s). The number of required cables shall be determined by the lowering device manufacturer. Each cable shall have at least 7 strands of 19 wires.

The Contractor shall provide one portable winch and motor assembly for State retention.

The safety factor for the winch, motor, cables, raising and lowering assembly, and mounting hardware shall have a loading capacity of at least five times the weight that is carried by the cables.

(g) LUMINAIRE POLES AND POLE FOUNDATIONS.

The details of the luminaire poles and foundations are shown on the plans. Additional requirements are given in Sections 718 and 891.

(h) BREAKAWAY SUPPORTS.

A frangible base that meets the requirements given in NCHRP 350 shall be installed on each luminaire assembly when shown on the plans. Breakaway Couplings will be allowed if shown on the plans. The Contractor shall assure the compatibility of the pole base, breakaway support, and foundation.

889.09 High Mast Luminaire Assembly.

(a) HIGH MAST LUMINAIRE.

The lighting distribution requirements for a high mast luminaire shall be the same as those given for a roadway luminaire.

Each high mast luminaire shall consist of cast aluminum housing, built in ballast and a one piece reflector assembly. The housing shall contain a slip fitter for a 2-inch {50.8 mm} horizontal pipe tenon which allows adjustment for leveling. All ballast components shall be accessible from the top with the luminaire mounted and aimed. The ballast shall be pre-wired to a terminal block using quick disconnect fittings. The luminaire and ballast shall be from the same manufacturer.

The optical assembly reflector shall be borosilicate glass encased within a spun on, sealed aluminum cover or a formed aluminum reflector with a chemically bonded lightweight non-breakable 95% silica glass finish. The reflector shall be designed to direct light away from the lamp arc tube. The lamp shall operate in the vertical base up position. If an enclosed and filtered optical assembly is shown to be required on the plans it shall include a hinged lens ring and a heat/impact-resistant flat glass lens held in place by four spring clamps.

The luminaire shall provide the ANSI/IES type distribution as required by the plans and have a minimum efficiency of 69% of base lamp lumens in the 0-90 degree zone.

Lamps shall be the same as those required for a Roadway Luminaire Assembly.

The performance requirements for ballast shall be those given for a Roadway Luminaire Assembly.

(b) LIGHT EMITTING DIODE HIGH MAST LUMINAIRE.

The requirements for a light emitting diode high mast luminaire shall be the same as those for a light emitting diode roadway luminaires. The housing shall contain a slip fitter for a 2-inch {50.8 mm} horizontal pipe tenon which allows adjustment for leveling. All drivers and internal components shall be accessible from the top with the luminaire mounted and aimed. The driver shall be pre-wired to a terminal block using quick disconnect fittings. The luminaire and driver shall be from the same manufacturer.

The requirements for high mast light emitting diodes shall be the same as those required for roadway light emitting diodes. The requirements for light emitting diode high mast drivers shall be the same as those given for a light emitting diode driver.

(c) HIGH MAST LUMINAIRE LOWERING DEVICE.

1. RELIABILITY OF LOWERING DEVICE.

Any lowering device proposed for use shall have been proven reliable by satisfactorily performing its function. Failure to operate properly or undue maintenance costs history in previous installations shall be grounds for disqualification of a particular product. Upon request, a list of up to ten installations, locations, and telephone numbers of persons to contact to verify this shall be provided. Any delays in the project schedule due to meeting these requirements shall be the responsibility of the Contractor.

2. REQUIRED CONFIGURATION OF LOWERING DEVICE.

Each high mast luminaire assembly shall be furnished with a lowering device, suitable for lowering a luminaire mounting ring, which will allow the complete luminaire and associated electrical

and mechanical apparatus to be serviced from not more than 5 feet {1.52 m} above the base plate. The luminaire mounting ring shall be raised and lowered by multiple stainless steel wire rope cables each of which shall be capable of supporting the entire mounting ring assembly under design wind loading conditions. The wire rope cables shall be stainless steel with each cable having at least 7 strands of 19 wires.

The power feed conductors shall be terminated in an aluminum or stainless steel NEMA 4 junction box using strain relief conductor clamps. "Kellums" type grips are not acceptable. The luminaire ring shall provide a totally enclosed wireway in which to route the conductors to each luminaire mount. An approved means shall be provided to insure smooth and non-damaging travel up and down the pole. The ring shall be securely positioned in its final location at the top of the pole.

The drive assembly for each high mast luminaire assembly shall consist of a single or twin drum at least 20 nominal wire rope diameters in size. It shall have an AGMA rated winch assembly with sufficient reduction to obtain self-locking when traveling in either direction. The use of sprockets and chains will not be accepted. The winch shall be driven by a drill motor or other motor equipped with a torque limiting safety clutch and a remote operator on a minimum 15 foot {4.57 m} long cord. Power for the motor shall be obtained through the circuit breaker conductors using an appropriate step-down transformer with a matching connector. The drive unit and complete lowering assembly shall be designed for the operator to raise the ring to the point the safety clutch begins to slip without damage to the mounting ring, the wire rope cables, or the pole top assembly.

The Contractor shall provide one electric motor and lowering apparatus for State retention.

Minimum thread diameters of the sheaves over which run the lowering cables shall be at least 25 times the nominal rope diameter. The nominal rope diameter of nylon jacketed wire rope shall be the core or unjacketed rope nominal diameter. The sheave grooves shall be semi-circular in cross section. The radius of the groove shall be one-half the nominal diameter of the rope plus 1/64th of an inch {0.397 of a mm}. Provisions shall be made to prevent the lowering cables from leaving the sheave grooves.

All components and hardware shall be galvanized or stainless steel.

3. LATCH DEVICE.

All latching devices shall be at the top of the pole. The pole top latch shall hold the lowering ring securely in position at the top of the pole by means of three symmetrically placed latches located on the head assembly with flags to indicate the locked or unlocked position. Each of the three latches shall latch and unlatch independently of the other two latches.

4. HIGH MAST POLES AND FOUNDATIONS.

The details of the high mast poles and foundations are shown on the plans. Additional requirements are given in Sections 718 and 891.