SECTION 895
HIGHWAY LIGHTING

895.01 GENERAL.

All material furnished shall be new and meet the respective Specifications and standards of the American Institute of Electrical Engineers, Underwriters Laboratories, and the Institute of Traffic Engineers. All electrical parts shall have capacity to carry the required current without heating or causing an excessive drop in potential.

These Specifications shall not be considered as requiring one manufacturer's equipment over any other, provided suitable interchangeability is preserved for maintenance purposes; and equal quality, reliability, and durability can be expected in performance.

The Contractor shall furnish the specified material unless substitute materials are approved in writing by the Engineer.

895.02 RIGID CONDUIT.

A. **Steel Conduit.** Steel conduit shall be of corrosive-resistant material meeting UL 6. Aluminum conduit shall not be used.

B. **Polyvinyl Chloride Conduit.** Rigid nonmetallic conduit shall be polyvinyl chloride (heavy wall) conduit meeting UL 651 suitable for direct burial applications.

895.03 CONDUCTORS.

A. **Feeders.** Conductors used as feeders shall be one of 2 types: a single conductor or multiple stranded conductors formed into a cable. The underground phase and neutral conductors shall be insulated to meet the requirements for direct burial cable carrying currents of up to 600 volts, and shall meet ASTM B-3 and B-8. Aluminum conductor shall not be used.

1. **Single Conductor.** Single conductor shall be marked Style "RHW-USE" with the required AWG size on the sheath. The grounding conductor (not a neutral) shall be stranded No. 6-AWG-Type THW. Rubber insulation specifically listed for that purpose by the Underwriter Laboratories does not require an outer cover.

2. **Multiple Conductor.** Multiple conductor shall be Style USE and meet NEMA Standards Publications WC-3, WC-5, WC-7, rated at 0 through 600 volts, modified as follows:

   Multiple conductors shall be of the specified sizes, insulated with either cross-linked thermosetting polyethylene (XLP), or butyl. The multiple

conductors of either insulation type shall have circuit identification. They shall be assembled into a cable of circular cross section with filler, binder, armor, and an overall outer cover. The armor shall be a bronze tape meeting ASTM B-130 with a minimum thickness of 10 mils and a spiral overlap of not less than 1/4-inch. The outer cover on the polyethylene insulated type shall be a polyvinyl chloride material, and the outer cover on the butyl insulated type shall be a neoprene rubber material.

Circuit identification, conductors, cables, fillers, and binders shall meet Part 5 of NEMA WC-3 except that the identification shall be obtained by colored tapes, colored compounds, or colored coatings only, and fillers shall be rubber or rubber-like materials.

B. **Internal Conductor.**

1. **Light Standard and Sign Lighting.** The conductor connecting the fuse kit in the base of the light standard to the luminaire ballast, or connecting the sign lighting load center to the sign lighting ballast, or connecting the fuse kit in the pull boxes to lighting luminaire ballast shall be copper No. 12 AWG, stranded, Type THWN/THHN, and shall meet ASTM B-3 and B-8. Aluminum conductors shall not be used.

   Rubber insulation which has been specifically listed for that purpose by Underwriters Laboratories will not require an outer covering.

2. **High Mast Lighting Assembly.**

   a. **Luminaire Wiring.** The individual luminaire wiring conductor shall be No. 14 AWG stranded, Style THW or RHW-USE, meeting the requirements for carrying currents up to 600 volts. Each luminaire shall be fused within the ballast housing. The fuse shall be rated at 15 ampere and shall be replaceable without tools.

   b. **Power Cables.** The power cable shall be a 4 conductor No. 8 flexible power cord. This cable shall provide a 240/480 volt service. The fourth conductor shall be used as an equipment ground. The end fitting shall be as shown in the Contract.

   c. **Power Cable Protection.** The free hanging static conditions of the cable shall not affect its satisfactory performance and flexibility for a temperature range of –40°F. to 120°F. A bushing or other approved method shall be used to protect the cable from abrasion whenever cable passes through any metal device.

895.04 PULL BOX.

Pull Boxes shall be instaled as shown in the Plans.

Concrete pull boxes shall be constructed of Class AE concrete as specified in Section 802.

The pull boxes shall be provided with at least one knockout per side.

895.05 FEED POINT.

The cabinet shall contain a photoelectric cell installed near the top of the cabinets. The cabinet shall have a NEMA 12 rating and be pad or pole mounted. The photoelectric cell shall control the on and off switching of the light circuits and have a 3 to 5 minute delay switch. A pilot relay shall be installed between the photo control and the lighting circuit relays. The lighting circuit relays shall be enclosed and shall normally be in the open position. The cabinet shall have circuit breakers enclosed in a load center type panel board of a type approved for service equipment. The feed point shall have a test switch that bypasses the photoelectric cell.

895.06 LIGHTING STANDARDS.

A. **Design.** Lighting poles shall meet the requirements of AASHTO publication, *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* (1994). A wind velocity of 85 mph with the necessary coefficient of height correction factor shall be used in the calculations. Different wind pressures shall be applied to the structure at different heights rather than using an average wind pressure for the entire height of the structure. All the necessary calculations and drawings used in the design of these poles shall be furnished with the shop drawing submittal.

B. **Material.** The light standard shall be fabricated from steel and may be of one or 2 piece construction. All welds shall develop the full strength of the adjacent shaft section. The light standard shall be either galvanized or stainless steel. Galvanized standards, including the mast arm, shaft, and base shall be galvanized according to AASHTO M-111. The round or multi-sided shaft for galvanized steel poles shall have a minimum yield strength of 48,000 psi after fabrication. The multi-sided shaft for stainless steel poles shall have a minimum yield strength of 60,000 psi. The stainless steel shall meet the requirements of ASTM A 666, Type 201 for mast arm, shaft, and base. The shaft shall have no more than one longitudinal weld.

C. **Mast Arm.**

1. **Davit-Type.** The davit-type mast arm shall be made of the same material as the shaft and shall have a tenon adapter for receiving the luminaire.

2. **Truss.** The truss mast arm assembly shall consist of an upper and lower member securely joined by means of a vertical strut or struts. The upper and lower members shall be steel pipe of 2 inch inside diameter or larger. The pole end of the arm of both members shall have a welded steel fitting for attachment to the pole by cap screws. An opening shall be furnished near the top of the shaft to provide a cable entrance from the shaft into the mast arm. A steel adapter shall be welded into this opening providing a smooth cable guide for wiring and a support for the attachment plate which is welded to the mast arm.

D. **Base.**

1. **Anchor Base.** The anchor base shall be a one-piece steel casting or hot-rolled carbon steel plate. The steel casting shall meet ASTM A-27, Grade 65-35 and the hot-rolled carbon steel shall meet AASHTO 270 Grade 36. The anchor base shall be secured to the lower end of the shaft by 2 continuous welds. The

welds shall be inside the base at the bottom of the shaft and at the top of the anchor base. The welded connections shall develop the full strength of the adjacent shaft section. The anchor base shall be provided with 4 bolt covers and cap screws for securing the covers to the base. A grounding lug shall be provided if no transformer base is provided.

2. **Slip Base.** The multi-direction slip base shall be of the style and type indicated in the Contract. The plates shall meet AASHTO 270 Grade 36 steel galvanized according to AASHTO M-111. The bolts shall meet ASTM A-325 galvanized according to AASHTO M-232. The keeper plate shall meet ASTM A-466, Grade A and shall be galvanized according to AASHTO M-111.

   The manufacturer shall certify that the slip base meets the AASHTO requirements for both breakaway and structural adequacy.

3. **Steel Transformer Base.** The steel transformer base shall be fabricated from not less than No. 7 gauge steel, with the top and bottom plate made of not less than 3/4-inch steel plate. The door opening in the base shall have a tamperproof lock. Each base shall be provided with 4 loose steel plate anchor clips to fasten the base down to the anchor bolts or a base plate fabricated so that leveling nuts and hold down nuts placed on the anchor bolts secures the transformer base to the foundation. After complete assembly, the base shall be galvanized according to AASHTO M-111. The transformer base shall fasten to the shaft anchor base by 4 galvanized hex head steel machine bolts and nuts meeting ASTM A-325, and galvanized according to AASHTO M-232. A grounding lug shall be provided inside the base.

4. **Aluminum Transformer Base.** The aluminum transformer base shall be of the style and type indicated in the Contract. The casting shall meet ASTM B-26 or B-108 Alloy 356-T6. The casting shall be smooth with all details well defined and true to pattern. A grounding lug shall be provided inside the base.

   The manufacturer shall certify that the aluminum transformer base meets the AASHTO requirements for both breakaway and structural adequacy.

5. **Certification.** The manufacturer of the stainless steel light standard shall certify that the light standard base meets the AASHTO requirements for both breakaway and structural adequacy when breakaway is called for on the Plans.

E. **Hand Holes.** Where transformer bases are not to be installed, each shaft shall have a minimum 4-inch by 6-inch hand hole located opposite the road side of the pole. Hand holes shall have reinforcing frames and a secured removable cover.

F. **Convenience Circuits.** Convenience or Festoon Circuits shall have electrical outlets 15 to 20 feet above ground level. All the material and wiring required for these convenience circuit outlets shall be provided. The outlets shall be wired for 120 volts, 60 Hz., A.C. The outlet box shall be welded inside of the pole, and the outlet cover shall be watertight.

G. Welding applications as specified in Section 105.06 D.

895.07 STREET LIGHT LUMINAIRE.

A. **General.** The luminaire shall consist of a die-cast aluminum housing, optical system door, and a door-mounted ballast, and if specified, an internal photoelectric control, finished in backed-on gray enamel.

B. **Slip Fitter.** The luminaire shall have an adjustable slip fitter containing 2 or 4 bolts, suitable for tightening both internally and externally. The slip fitter shall be capable of adapting to 1 1/4-inch through 2-inch pipe and be adjustable ± 5° from horizontal.

C. **Optical Assembly.** The optical assembly shall consist of an anodized aluminum reflector, an adjustable socket assembly, filtered optical system of polyester fiber, a gasket for sealing between the reflector and refractor, and a borosilicate or acrylic polycarbonate prismatic refractor. The light distribution shall be ANSI/IES Type as specified.

D. **Ballast.** The door-mounted integral ballast shall be quickly and easily removable and replaceable through the use of quick disconnect plugs. The ballast shall be prewired to the lamp socket and terminal board, requiring only connection of the power supply leads to the terminal board. In lieu of door-mounted ballasts, a power pad with easy removal allowing complete ballast assembly replacement by a simple quick-disconnect may be used.

   The ballast shall operate one lamp from a nominal (120, 240) volt, 60 Hz. power source and be capable of starting and operating the specified lamp.

895.08 FUSING.

The fusing of the luminaire ballasts shall be accomplished as follows:

A. Each light ballast shall be fused in the base of each light standard. Connection to power distribution circuits shall be made with field-applied waterproof kits.

B. Each fused connector kit shall contain a pair of spring-loaded, 90% maximum conductivity contacts suitable for gripping a 15 ampere cartridge fuse. These contacts shall be fully annealed and constructed to be crimped to the cable. They shall be constructed to be retained securely in the proper position within the rubber or molded plastic housing.

C. Each fused connector kit shall contain a line side and a load side housing, each made of water-resistant synthetic rubber or molded plastic, suitable for burial in the ground or installation in the sunlight. Each housing shall provide a section to form a water seal around the cable; have an interior arrangement to suitably and complementarily receive and retain the copper fuse contacts; and a section to provide a water seal between the 2 housings at the point of disconnection. The load side housing shall be constructed to retain the fuse when disconnected. Each housing shall be permanently marked “loadside” and “line side.” Each kit shall be supplied with sufficient silicone compound to lubricate the metal parts and the rubber or molded plastic housing for easy assembly.

D. Each kit shall be sized for the conductors installed and fused to protect the ballast.

895.09 SIGN LIGHTING LOAD CENTER.

The load center cabinet shall be weather-proof and constructed to receive a padlock. A grounding lug shall be provided inside the cabinet.

895.10 SIGN LIGHTING LUMINAIRES.

A. **General.** The sign lighting luminaire shall consist of an aluminum main casting containing a clamp mechanism, terminal block, socket assembly, reflector, and a refractor door assembly. The luminaire shall be effectively shielded to oncoming traffic so no direct light is seen by the motorists.

B. **Clamping Mechanism.** The clamping mechanism shall be designed for a 1 1/4-inch nominal pipe bracket using two 3/8-16 hex-head bolts and serrated, positive gripping, cast aluminum clamps. A vertical adjustment range of ± 5° shall be designed into the clamping mechanism. Leveling pads shall be provided on the bottom and inside of the luminaire casting.

C. **Lighting Lamps.** The 250-watt deluxe white mercury vapor sign lighting lamps shall operate on 240 volts A.C. A footcandle uniformity ratio as shown in the Contract, maximum to minimum, shall be obtained on the sign face with the number of sign lighting units per sign as specified. The manufacturer shall certify, through photometric data, that the ratio is obtained.

D. **Terminal Block.** A terminal block shall be provided under the reflector at the wire entry location. The terminal screws shall be captive to the terminal block. Terminal plates shall be provided for a positive hold action.

E. **Reflector.** The reflector shall be held in place by 4 screws. Key hole slots shall be provided in the reflector to permit removal without removing the mounting screws.

F. **Refractor Door.** The refractor-door assembly shall be attached to the main casting by separate hinges at the front of the luminaire and by 2 stainless steel, spring-tempered tension latches at the rear. The spring latches shall provide sealing pressure for the gasketed assembly. The assembly shall consist of an anodized extruded aluminum channel form fitted with captive gasket to the prismatic refractor. The gasket shall be a single piece of high thermal-resistant material, incorporating a sealing pad. The refractor assembly shall be readily removable and capable of being completely immersed for cleaning. The glass refractor shall be protected by a rubber bumper mounted on the pipe bracket.

G. **Ballast.** The ballast shall be enclosed in a cast aluminum, weather-proof enclosure. The ballast enclosure shall mount directly to the ballast support by four 3/8-inch bolts. The electrical conductor shall enter the ballast by 3/4-inch conduit openings located on each side of the ballast enclosure. The gasketed cover plate shall be attached to the bottom casting by 4 hex head bolts. A 1-1/4-inch threaded pipe shall be provided at the end of the ballast enclosure to support the luminaire.

895.11 HIGH MAST SODIUM VAPOR LUMINAIRES.

A. **Ballast.** The auto-regulator ballast shall be used with a 1,000 watt sodium vapor lamp. The ballast shall operate at a voltage of 240 volts and it shall be enclosed in a

weather-proof cast aluminum housing fully serviceable without removing the luminaire from its bracket.

B. **Slipfitter.** The cast aluminum slipfitter housing shall accommodate a 2-inch horizontal pipe bracket and shall be adjustable 3° above and below the bracket axis for leveling. Means shall be provided to prevent the twisting of the luminaire about the bracket. Terminal boards shall be included in the housing.

C. **Lamp Socket.** The lamp socket shall be a heavy-duty, mogul multiple type, porcelain-enclosed, with an integral lamp grip to assure electrical contact under conditions of normal vibration. Additional lamp clamps shall be provided to help prevent vibrational damage to the lamp and socket. The lamp socket shall be adjustable to provide for different light distributions and maximum candlepower angles.

D. **Optical Assembly.** The optical assembly may be either an open ventilated unit permitting free flow of air upward by chimney action or an enclosed globe unit. Both symmetrical and asymmetrical distributions may be required. The symmetrical luminaire shall have a maximum beam angle of between 55° and 60°. The asymmetrical luminaires shall have an I.E.S. short, semi-cutoff, Type III distribution.

1. **Open Ventilate.** The open ventilated unit shall be a fully-detachable optical assembly consisting of an annealed borosilicate glass reflector with a sealed metal cover and an open borosilicate glass refractor. The lamps shall have a light center of 8-3/4 inches below the top of the reflector. The effective projected area of a ballasted luminaire shall be approximately 2.7 square feet. The ballast and luminaire shall have a maximum weight of 62 pounds. These specifications shall apply to both the symmetrical and asymmetrical type units.

2. **Enclosed Globe.** The enclosed globe unit reflector assembly shall be of spun aluminum finished with the anodize process. The upper portion shall redirect the reflected light away from the arc tube of the lamp. The assembly shall be enclosed and gasketed and shall contain an activated charcoal filter to allow “breathing.” The globe shall be made of heat and shock-resistant tempered borosilicate glass. The globe shall be attached to the reflector housing by a hinged gasketed door with stainless steel latches. The unit shall be constructed to allow the attachment of external shields. The effective projected area of the ballasted symmetrical luminaire shall have approximately 3.2 square feet. The ballasted luminaire shall be a maximum weight of 65 pounds. The effective projected area of the ballasted asymmetrical luminaire shall be approximately 3.4 square feet. The ballasted luminare shall have a maximum weight of 80 pounds.

E. **Symmetrical Luminaires.** The symmetrical luminaires shall be Holophane Symmetrical Luminaire, Catalog No. 1171-240 SYM; General Electric Asymmetrical Type X209 High Mast, Catalog No. X209Cl. OL360. Quality Symmetrical Luminaire, Catalog No. 5527-240 or equal.

F. **Asymmetrical Luminaires.** The asymmetrical luminaires shall be Holophane Asymmetrical Luminaire, Catalog No. 1171-240 ASY; General Electric Asymmetrical Type X209 High Mast, Catalog No. X209Cl. OL3B4 or equal.

895.12 SODIUM VAPOR WALL-MOUNTED LUMINAIRE.

A. **General.** The luminaire shall consist of a cast aluminum housing containing the ballast, terminal board, and anodized aluminum reflector as well as a cast aluminum door with a heat and impact resistant prismatic refractor sealed to it. The reflector shall have anodized aluminum finish. The refractor shall be a prismatic type of thermal and shock-resistant material. The ballast shall be an integral part of the housing and completely prewired. The socket shall be a mogul base porcelain-grip type with 2 positions for beam control.

B. **Housing.** The luminaire housing shall be die-cast corrosion-resistant aluminum, completely gasketed to keep out dust, insects, and other contaminants. The ballast area shall have a neoprene gasket and a polyester fiber gasket in the optical assembly for maximum weather-resistant protection. The door assembly shall be hinged to the housing at the bottom, protected by a safety chain and secured by stainless steel latches. The housing shall be constructed to allow installation on any flat surface and shall have wiring holes including a threaded 3/4-inch side entry for exposed conduit.

895.13 SODIUM VAPOR UNDERPASS CEILING-MOUNTED LUMINAIRE.

The mounting system shall protect the enclosed lamp from shock or breakage. The fixture shall be indestructible and guaranteed to withstand vandalism. The fixture shall be for ceiling mounting complete with 100 watt high-pressure sodium lamp, 240 volt high power factor ballast, and neoprene gaskets for outdoor use. The fixture shall also have an unbreakable hercalex opalescent lens diffuser, ultraviolet stabilized for outdoor application, and 14-gauge steel backplates, of baked enamel finish, with stainless steel tamperproof screws.

895.14 HIGH-MAST LIGHTING ASSEMBLY.

A. **Design.** The design of the high-mast lighting poles shall meet Section 895.06 A.

B. **Shaft.** The shaft shall be circular or multi-sided and shall be constructed of steel meeting either AASHTO 270 Grade 50, or AASHTO 270 Grade 50 W. The shaft shall have a minimum yield strength of 50,000 psi. The reinforcing material, backup bars (if required) etc., shall meet the same AASHTO steel requirements as the steel in the shaft. The AASHTO 270 Grade 50 steel shaft shall be galvanized according to AASHTO M-111. The AASHTO 270 Grade 50 W steel shaft shall be shot blasted to obtain a uniform finish and allow fast, even oxidation. All exposed surfaces on the AASHTO 270 Grade 50 W steel shall be cleaned of welding slag, loose scale, paint, and grease.

The shaft may be furnished in a single unit or in telescoping sections. If a sectional shaft is furnished, the number of sections shall not exceed 5. Each section shall be fabricated so that each may be telescoped over the next section without the use of welds. The sections shall lap a minimum of 1-1/2 times the outside diameter of the bottom shaft at the location of the lap joint. Telescoping points shall be marked and sections match marked.

The telescoping sections of the shaft, fabricated of AASHTO 270 50 W (Weathering Steel) material, shall be metallized in the overlap areas on both inner and outer

tubes. The metallizing shall meet Section 894.08 A.1.a(2) or (3). The outer joint shall receive a sealant to prevent the intrusion of moisture. The sealant shall be as recommended by the pole manufacturer.

The shaft shall be uniformly tapered from top to bottom.

Each shaft shall be grounded. A grounding nut shall be located within the base.

The internal portion of the shaft shall satisfactorily accommodate the necessary lowering device equipment and shall be free of any obstructions, sharp projections, or protrusions that would interfere with or damage any part of the lowering device.

C. **Base Plate.** The base plate material shall meet AASHTO 270 Grade 50 or AASHTO 270 Grade 50 W and shall be designed to withstand the full bending moment of the shaft. AASHTO 270 Grade 50 W steel shall be shot blasted to allow fast, even oxidation.

The enlarging of anchor bolt holes to provide for the possible shifting of the anchor bolts will not be allowed.

D. **Anchor Bolts.** Anchor bolts shall meet the mechanical requirements of AASHTO M-31, Grade 75 or ASTM A-576, Grade 1541 modified or equal. The exposed portion of the bolt above the foundation shall be galvanized according to AASHTO M-232. Precaution shall be taken against embrittlement, warpage, and distortion according to ASTM A-143.

Each anchor bolt shall have 2 extra-heavy, high-strength hex nuts, one for leveling and one for hold down. The hex nuts shall be galvanized according to AASHTO M-232 and meet ASTM A-143 for prevention of embrittlement. The nuts shall make full contact with the base plate.

Anchor bolts shall be shipped before the rest of the equipment and shall be preclustered, or clustered by mechanical rings which can be field-assembled. A removable template shall be supplied to ensure proper fit of the pole base on the anchor bolts.

The manufacturer shall certify that the anchor bolts are of adequate strength to resist the required loading. They shall be of sufficient length to develop the required loading of the bolt. Adequate thread length shall be provided. Anchor bolts shall not be welded to meet the required lengths.

E. **Access Opening.** Access openings of ample size allowing for service and maintenance of internal apparatus shall be provided near the base of the shaft. The opening shall not interfere with the operation of the lowering device.

Openings shall be externally reinforced to provide 150% of the unaltered shaft section modulus beginning and ending at a distance of 1/4 shaft diameter above the top and 1/4 shaft diameter minimum below the bottom of the access openings or internally reinforced to return the shaft to its full strength.

Covers with stainless steel cap screws and a hand grip shall be furnished to secure the opening. The cover shall be furnished with gaskets that will seal out dust, rain, and snow.

F. **Welding.** All welding shall meet AASHTO, Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, and Section 616.03 D.

Each shaft section shall have a maximum of 2 longitudinal seam welds, except that the bottom 2 sections shall have a maximum of 3 longitudinal seam welds. Shafts with 2 or 3 seam welds shall have a minimum of 80% penetration, while shafts with only one longitudinal seam weld shall have a minimum of 60% penetration. Longitudinal welds at slip joints shall have 100% penetration. No circumferential welds will be allowed.

Full penetration-type welds shall be made for the shaft to base plate welds. Backup bars are permitted; however, they shall be contoured for full contact with the shaft, be continuous, and be of the same material as the shaft. Backup bars shall not be tacked to the shaft. All spaces between the backup bars and the shaft shall be filled with molten lead.

All attachment welds shall be full penetration fillets. Field welds will not be permitted.

All welds shall be visually inspected to check that there are no cracks, undercutting, or surface blow holes. In addition, all welds shall be ultrasonically and/or magnetic particle tested. Records of welding procedure and all test results shall be submitted to the Engineer.

Full penetration-type welds shall be made in the overlap area. These welds shall be radiographically examined in an area consisting of the overlap plus an additional 6 inches of tube length. Any deficient welds shall be repaired and then retested after repairs are made.

G. **Certification.** The manufacturer shall certify that all joints and welds of the assembled structure, when loaded as specified in these Specifications, will develop the full strength of the shaft.

Certification shall also be submitted that deviation of the shaft alignment or “canting” will not occur at any of the joints when erected.

H. **Lowering Device.**

1. **General.** The lowering device shall lower the luminaire ring to within approximately 4 feet (vertical) of the base plate. The luminaire ring assembly shall be capable of being raised or lowered at a minimum rate of 10 feet per minute. All cables, both electrical and hoisting, shall be able to be inspected from ground level. The complete lowering system shall consist of a head frame assembly which is rigidly attached to the top of the pole shaft, a luminaire ring assembly on which the luminaires are mounted, and a winch and hoisting assembly which is located in the base of the pole shaft.

2. **Head Frame Assembly.** The head frame assembly shall include a minimum of 4 hoist cable sheaves grooved to exact cable diameter for 180° cable bearing surface and 1 or 2 grooved power cable sheaves. The sheaves shall have oil impregnated, sintered bronze bushings over the stainless steel shaft. Sheaves shall be the only moving components of this assembly. Sheave pins

shall not be welded but shall be secured by washers and cotter keys or pins. The sheaves shall have a minimum diameter of 25 wire rope diameters for the positive locking load cable system; except when 2-point suspension and 2 winches are used, the sheaves minimum diameter shall be 24 wire rope diameters. For nylon-jacketed wire rope, the wire rope diameter used shall be the core or unjacketed wire rope diameter.

The electrical and support cables and sheaves shall be arranged to minimize their exposure. Openings into the shaft shall be minimized by a cover plate or other suitable means to reduce water intake, yet permit adequate shaft ventilation.

The assembly shall provide for a 2- or 3-point suspension of the luminaire ring. Structural members shall be of stainless steel, or galvanized steel according to AASHTO M-111.

Where the structural members have been welded together to form a reasonably weather-tight head frame assembly, the only openings shall be the holes through which the hoisting cables and the power cables pass.

The head frame shall be securely fastened to the shaft in an approved manner.

Should the Contractor use the option of holding the luminaire ring in place by latching devices, the head frame assembly shall include 2 or 3 latching devices to support the raised luminaire ring. All moving parts of the latch mechanism shall be attached to the luminaire ring assembly and shall be serviceable from the ground. The latching mechanism shall not be impaired by the formation of ice. All tension and weight shall be removed from the hoisting cables when the luminaire ring is latched to the head frame assembly. Means shall be provided to indicate the luminaire ring is latched to the head frame.

3. **Luminaire Ring Assembly.**

   a. **Slipfitters.** The slipfitters for the mounting of the luminaires shall be of 2-inch steel pipe. The slipfitters shall be attached to the luminaire ring either by being threaded into welded hubs or by bolts. A suitable smooth wire entrance shall be provided in each slipfitter when the slipfitter is attached by U-bolts.

   b. **Ring.** The ring shall serve as a fully-enclosed wire raceway for all electrical connections to the luminaires. The ring may be factory prewired or field wired.

   c. **Assembly.** The assembly, except where noted, shall be hot-dipped, galvanized according to AASHTO M-111.

   d. **Power Receptacle.** A weather-tight, twist-type lock, power receptacle shall be provided on the ring to allow for the testing of lamps and ballasts while the ring is in a lowered position. Two 10-foot sections of pole power cable shall be provided for the testing. Each section shall be provided with electrical connections to connect the power source to the ring.

   e. **Roller Arms.** A minimum of 3 steel spring-loaded centering roller arms shall guide the luminaire ring when it is raised or lowered. The arms shall

be stainless steel or aluminum. The springs shall be stainless steel. Rollers shall be made of a water-resistant nonmarking material. A PVC bumper ring may be utilized in lieu of roller arms.

f. **Luminaire Ring.** The luminaire ring shall be of adequate size, strength, and shape to accommodate the number of luminaires per pole as specified.

When in a raised position, the luminaire ring shall have no free movement. When in a raised position, the luminaire ring assembly may be held in place by the constant load cable system or by a positive latching device which shall not be impaired by accumulation of snow or ice.

If a constant loading cable system is used, a backup cable and grip system shall be provided to prevent free fall of the luminaire ring if a winch cable failure occurs. Minimum 1/4-inch diameter stainless steel aircraft cable shall be provided.

The luminaire ring assembly shall be equipped with an approved lightning arrester and shall be installed in an approved electrical manner. The line leads of the arrester shall be spliced to the hot power cable conductors within a junction box. The ground lead of the arrester shall be connected to the ground conductor of the power cable at which point a positive ground connection is made with the luminaire ring. This positive ground may be accomplished by a grounding lug attached to the luminaire ring but not to the junction box. All splices and connections shall be internal to the system and not exposed to the elements. The arrester furnished shall be securely attached to the junction box or the ring.

The junction box shall contain all splices required for connecting the power cable to the individual luminaire wiring.

4. **Winch and Hoisting Assembly.**

a. **Lowering Device.** The 3-cable lowering device shall be a self-locking, worm-gear type with a permanently lubricated gear box. The 2-cable lowering device winch assembly shall consist of a worm-gear speed reducer with a double output shaft and with stainless steel drums with calibrated spring-loaded clutches which compensate for possible hoist cable overrun. The minimum drum diameter of the winch shall be 16-wire rope diameter for the positive locking system and 20-wire rope diameter for the cable system, except when 2 winches are used, the minimum drum diameter shall be 14-wire rope diameters.

The maximum allowable stress in the sheaves, pins, drums, brackets, and other associated structural members of the lowering device shall not exceed 1/2 of the nominal yield stress of the material. The winch drum shall contain at least 3 full wraps of wire rope when the luminaire assembly is in the fully-lowered position. The starting end of the wire rope shall be securely attached to the wind drum through use of a suitable clamp or “keyhole and stop” arrangement. Drum flanges shall be large enough to contain the winch cable and provisions made so the winch cable does not build up on the end of the drum and run off.

On “Positive Locking System,” when the load is removed from the cable after the luminaire assembly is locked in place, provisions shall be made to prevent the winch cable from loosening on the drum to an extent that cables cross each other.

All bolts and machine screws shall be secured to preclude their becoming loosened by vibration. Star washers, jam nuts, self-locking nuts, locking compound, etc., may be used to secure nuts and machine screws.

b. **Winch.** The permanent winch assembly shall be internally mounted in the pole base. The winch shall normally be operated by an electric drill; however, the winch shall be adaptable to manual operation.

The winch shall be capable of being removed from the pole without having to make electrical disconnects or mechanical manipulations.

c. **Circuit Breaker.** A circuit breaking switch and a twistlock disconnect shall be provided in the pole base. There shall be no electro-mechanical disconnect at the pole top. The switch shall be used to switch power on and off to the main power cable for the lowering device and the portable power cable. There shall be facilities to energize the luminaires and ballasts while the luminaire ring is in a lowered position. The circuit breakers shall be 30 amps, single throw, double pole mounted in a 100 amp frame.

d. **Torque Limiter.** A current or torque limiter shall be provided to shut down the drill whenever the luminaire ring is seated in the head frame assembly.

5. **Cable.**

a. **Hoisting Cable.** The hoisting cables shall be a minimum 3/16 inch diameter, 7 x 19 stainless steel cable. When hoist cables are used as winch cable, they shall be 1/4 inch diameter 7 x 19 stainless steel cable.

The 2 or 3 cables attached to the luminaire ring shall be equally spread.

Hoisting cables utilized in the constant load cable system shall be nylon jacketed, unless they are used, as winch cables.

b. **Winch Cable.** The winch cable shall be a minimum 1/4 inch diameter, 7 x 19 stainless steel cable. When the luminaire ring is in a raised position, this cable shall be wound on the winch drum.

c. **Materials.**

(1) **Stainless Steel.** Material for stainless steel cables shall meet the following composition:

Carbon	0.15% max.	Sulfur	0.030% max.
Manganese	2.00% max.	Chromium	17.0% – 20.0%
Silicon	1.00% max.	Nickel	8.0% – 12.0%
Phosphorous	0.045% max.		

(2) **Nylon-Jacketed Cables.**

The nylon jacketing material shall be extruded over the rope. Only virgin nylon material shall be used to coat wire ropes. The nylon used on the wire rope shall meet the following requirements of Federal Specification MIL-2-83420:

Property	**Test Value**
Ultimate Tensile Strength	5000 psi min.
Elongation	250% min.
Specific Gravity	1.02 to 1.14 psi min.
Stiffness	35,000 psi min.
Water Absorption	1.5% max.
Brittleness	–65°F. (–54°C.) max.
Heat Deflection	110/45°C. at 66/264 psi min.
Melting Range	320°F. to 374°F.
Burn Resistance	4-inch/min.

(3) **Lubricant.** A suitable type of friction-preventive compound having non-corrosive properties shall be impregnated into the wire rope.

(4) **Wire.** The wire used in steel cable shall be cylindrical and smooth and of uniformly high quality. It shall be free from splits, cold shuts, and other defects.

Tensile strengths of wire and wire sizes shall be such that wire rope will be capable of meeting the requirements of this Specification.

The individual wires and strands composing the wire rope shall be shaped into the exact helical position they will have in the finished wire rope. If the wire rope is cut or severed, the measured diameter of the wire rope at the unseized cut ends shall not increase by more than the amount specified in Table IA.

All wire splices or joints shall be brazed or welded. Any joints in individual wires in any layer of a strand shall not be closer than 20 feet.

The type of construction for the respective diameters, the dimensional tolerances, and the physical properties shall be as specified in Table IA.

(5) **7 by 19 Construction.** Wire ropes of this construction shall consist of 6 outer strands of 19 wires each laid around a core strand of 19 wires. The 6 outer strands shall each consist of a layer of 6 wires laid around a center wire in a left-hand direction and a layer of 12 wires laid over the 7-wire strand in a left-hand direction. The core strand shall consist of a layer of 6 wires laid around a center wire in a right-hand direction and a layer of 12 wires laid around the 7-wire strand in the right-hand direction. The 6 outer strands shall be laid around the core in a right-hand direction. The length of lay of the inside layer of 6 wires in each of the 6 outer strands and the one core strand shall not exceed 60% of the lay of the outside layer of 12 wires in each strand. The length of the lay of the outside layer of 12 wires in each of the 6 outside strands and the core strand shall not exceed 50% of the lay of the finished wire rope. The length of the lay of the finished wire rope shall be not more than 8 times nor less than 6 times the nominal wire rope diameter.

Other wire rope construction may be used to improve the operation of the Hi-Mast Lighting Unit if the other conditions of the Specifications are met, i.e., design factor, stretch limits, sheave and drum ratios. In such cases, the manufacturer of the wire rope shall certify it meets the specific design application.

(6) **Wire Quality Testing.** Quality conformance testing shall consist of all the inspections such as workmanship and physical appearance specified. The sample wire rope shall pass the breaking strength test and all samples shall be subjected to the stretch tests.

(a) **Sampling.** When conducting the tests herein, one sample shall be taken after any discard has been removed from the head or starting end of the first manufacturing reel for each lot of wire rope. A lot shall consist of not more than 20,000 feet of wire rope of the same construction and diameter produced continuously by one machine or by one series of progressive processing machines.

(b) **Workmanship.** The finished cable shall be uniform in construction and securely laid, free from kinks, loose wires, loose strands, or other defects.

(c) **Nylon-Jacketed Cables.** The nylon coating shall be a uniform thickness as specified in Table IB and shall be uniform in appearance. The nylon coating shall be transparent and shall be homogeneous and uniform in consistency. The jacketed wire rope shall have no cracks or seams, or extrusion die marks on the surface which affect wire rope performance. Any deleterious effects, such as cracking or separating from the wire rope, shall be cause for rejection.

(d) **Breaking Strength.** The wire rope specimen shall be selected from the sample from each lot. The specimen shall be no less than 24 inches in length, and where necessary, swaged terminals meeting Federal Specification MIL-T-781 (do not use

ball-end fittings) and accompanying hardware may be used to facilitate installation of the specimen in the jaws of the testing machine. The distance between the jaws of the testing machine with the sample shall be no less than 10 inches. The breaking strength shall be determined by use of a tensile testing machine according to ASTM E-8. The breaking strength shall meet the requirements of Table IA for qualification.

(e) **Stretch Test.** One specimen from each sample of wire rope selected as specified shall be tested to determine the percent stretch. The total length of the wire rope specimen to be tested shall not be less than 24 inches. Where necessary, swaged terminals and accompanying hardware may be used to facilitate installation of the specimen in the jaws of the test machine. The amount of stretch shall be determined on a tension-testing machine according to ASTM E-8. The specimen shall be loaded to 1% nominal breaking strength shown in Table IA to straighten the wire rope. While the specimen is under tension, an adequate gauge length shall be marked off the wire rope between the jaws of the testing machine. The specimen shall then be loaded to 60% of minimum breaking strength and measured to elongation under load. The specimen so tested shall not exceed a stretch of 1.5%.

(f) **Responsibility for Inspection.** The supplier shall perform all inspection requirements. The supplier may use its own or any other suitable facilities for the performance of the inspection requirements, if approved by the Engineer.

(g) **Certification.** The wire rope manufacturer shall furnish a certified test report showing that the wire rope meets this Specification. The test report shall include actual results of the tests.

The nylon certification and test report shall be furnished by the manufacturer.

6. **Cable Attachments.** Wire rope attachments which are not readily accessible for inspections shall be permanently swaged onto the cables by the wire rope manufacturer in accordance with the recommended practice of the fitting manufacturer. These end attachments will generate the full nominal break strength of the cable.

   Adjustable or semi-permanent end attachments such as wire rope clips shall be attached in a manner and of a number recommended by the fitting manufacturer. No less than 2 clips of correct size shall be used on each termination, and clips shall be inspected and retightened as necessary. The “saddle” portion of the clips shall bear on the live or long end of the cable and the U-bolt shall bear on the dead or short end of the cable.

   All eyes (loops) shall be thimbled to protect the wire rope from abrasions.

   No wire rope attachments shall be applied over nylon jackets of cables.

7. **Portable Power Unit.** The portable power unit shall supply all necessary driving power to the winch.

The minimum 1/2-inch heavy-duty, reversible electric drill with a torque limiter shall operate on 240 volts. A means of checking the restraint offered by the torque limiter shall be provided.

The drill shall be provided with overload protection and be UL approved. The drill shall be arranged for remote control operation. A drill mounting assembly shall be easily attached to the base of the pole with a quick-connect securing mechanism that can accommodate any size or shape pole. A pendant control switch with a 20 foot cord shall be provided to allow the operator to stand clear of the service area while the luminaire ring is either raised or lowered. Two drills shall be provided.

8.

TABLE IA
Construction, Physical Properties of Galvanized Carbon Steel and Stainless Steel Wire Rope

Nominal Dia. of Wire Rope (In.)	* Const.	Tolerance on Dia. (Plus only) (In.)	Allowable Inc. of Dia. (In.)	Nominal Break Strength Galv. Carbon Steel (Lbs.)	Nominal Break Strength Stainless Steel (Lbs.)	Approx. Wt. per 100 ft. (Lbs.)
5/32	7 x 19	.016	.017	2,800	2,400	4.50
3/16	7 x 19	.018	.019	4,200	3,700	6.50
7/32	7 x 19	.018	.020	5,600	5,000	8.60
1/4	7 x 19	.018	.021	7,000	6,400	11.00
5/16	7 x 19	.022	.024	9,800	9,000	17.30
3/8	7 x 19	.026	.027	14,000	12,000	24.30

*See Section 895.14 H.5.c.(5)

9.

TABLE IB
Construction and Dimensional Properties of Nylon Jacketed Wire/Rope Jacket Tolerances

Nominal Dia. of Wire Rope (In.)	* Const.	Tolerance on Jacket O.D. (Plus only) (In.)	Outside Dia. of Jacket (In.)	Jacket Wall Thickness (Reference) (Lbs.)	Approx. Wt. per 100 ft. (Lbs.)
3/16	7 x 19	.022	5/16	.063	9.20
7/32	7 x 19	.020	9/32	.031	9.76

*See Section 895.14 H.5.c.(6)(c)

SECTION 896
HIGHWAY TRAFFIC SIGNALS

896.01 GENERAL.

The word and phrase definitions shall be as defined in Section 1 “Definitions” of NEMA Standards Publication TS 2 latest edition *Traffic Control Assemblies with NTCIP Requirements.*