807-T-087 HIGHWAY ILLUMINATION MAINTENANCE AND REPAIR

(Revised 05-23-11)

Description

This work shall consist of the performance of routine maintenance, emergency maintenance, and major repair of highway lighting systems at various locations as indicated and further described in the Summary of Systems shown on the plans.

The Department, at its option, may elect to add new highway lighting system location sites to this contract upon written notification to the Contractor from the District.

Highway lighting shall include lights installed on main line routes, ramps and crossroads of interchanges with main line routes, bridges, underpasses, overhead sign structures, rest area ramp and parking lot lights, rest area post top pedestrian lights and weigh station ramp lights at the systems listed in the Summary of Systems.

The Contractor shall maintain and keep in good operating condition all roadway, underpass, and sign lighting fixtures; Department owned service points and their components; electrical distribution cables and connections located on the routes shown on the plans. This maintenance shall consist of routine maintenance, emergency maintenance, and major repair, which shall be as defined herein.

The Contractor’s responsibility for maintenance, repair, and installation shall start from the utility’s last connection at the service location relay switch and shall continue and embrace the entire highway lighting installation. The maintenance of lighting at rest areas and weigh stations shall include only outdoor lighting not attached to a building and the outdoor lighting circuitry into the building up to and including the breaker panel. No work shall be done on light fixtures on or inside the building.

The Contractor shall safely secure all exposed bare or broken electrical conductors which are accessible to laborers or to the public. This stipulation will also hold true when roadway luminaires supports are knocked down and the poles circuitry wires are exposed.

The Contractor shall commence work on the date directed and shall continue for a period of 1 year. The contract may be extended for an additional year at the same unit prices, if mutually agreed upon by the Department and the Contractor.

The Contractor shall make necessary repairs to all parts of the highway lighting systems which are malfunctioning, inoperable, or in need of repair at the time the notice to proceed is issued. The Contractor shall use the pay items shown in the Schedule of Pay Items and as specified herein to accomplish such repairs.

General Requirements

All materials used shall be of identical make and model number to that being replaced, except as specified herein or as approved.

If the original make of material is no longer available, requests for exceptions shall be made in writing.

Working drawings and specifications will be furnished to the Contractor upon request for existing structures, if they are available, from the Central Office Division of Highway Design & Technical Support. These drawings are for information only and will not be substituted for working drawings to be submitted by the Contractor.

The Contractor shall keep, maintain, and make readily available for inspection, all work records and all record keeping which demonstrates relevant costs.

Plan sheets for the lighting systems included in this work will be provided to the Contractor at the preconstruction conference.

With the exception of emergency maintenance, the Contractor shall perform operations only during daylight hours, Monday through Friday. The Engineer shall be notified 24 h prior to all planned activities.

All work shall be in accordance with the National Electrical Code, the National Safety Code, and local and State codes.

Materials

All luminaires, lamps, fuse kits, wire, cable, and major equipment proposed to be furnished shall be subject to approval by the Department and shall be new and shall bear the UL seal of approval. Otherwise such material shall be in accordance with UL Standards where such standards have been set for the material apparatus or supplies in question.

Material records in accordance with 106.01 will not be required since some materials will be supplied by the Department. Other materials are anticipated to be relatively small in quantity or acquired over the counter in bulk purchases. The Contractor shall still use quality materials which shall be in accordance with the specifications and normally accepted industry standards. Materials may be checked by the Department and will be rejected if determined to be unsatisfactory.

The "or approved equal" statement indicates that the material or equipment shall have durability and performance equal in every respect to the material specified.

Descriptive and technical literature pertaining to the materials, which the Contractor proposes to use, shall be submitted to the Engineer for approval prior to purchase and starting work.

Routine Maintenance

Routine Maintenance shall be performed upon all existing roadway underpass lighting, sign lighting, and other lighting which may be installed or taken over by the Department during the effective period of the contract.

Routine maintenance shall consist of the following:

(a) Replacement of burned out lamps within 7 calendar days of report or discovery

(b) The Contractor shall establish and pursue a method of disposal of replaced lamps such that re-use of old lamps shall not occur.

(c) Replacement of broken or damaged refractors within 7 calendar days of report or discovery

(d) Replacement of burned out starter panels within 7 calendar days of report or discover

(e) Replacement of blown fuses in fused through connector dits within 7 calendar days of report or discovery

(f) Removal of accumulated debris such as dead insects from luminaire housing by means of brushing or other suitable methods

(g) Checking of all electrical connections for firmness and tightening or repair where required

(h) Checking of luminaire position and adjusting slipfitter attachment as required. This shall include leveling the fixture horizontally in both planes and checking of the lamp socket position.

(i) The Contractor shall inspect the mast arm, arm pole connections, and pole for cracks and weld damage at the time of annual refractor washing. All structures with cracks or weld damage shall be reported to the Engineer immediately.

(j) Removal and replacement of all non-functioning ballasts within 7 calendar days of report or discovery

(k) Replacement of faulty capacitors within 7 calendar days of report or discovery

(l) Annual washing of refractors by means of removal from the luminaire and washing as described below and replacing after drying. The reflector shall not be disturbed. If the gasket is damaged by the refractor cleaning operation, the gasket shall be replaced.

(m) Replacement or repair of luminaire reflectors and light sockets, within 7 calendar days

(n) Replacement of faulty photo cells within 24 h of report or discovery

Luminaire refractors shall be cleaned in a soap, detergent, or cleaner solution using a soft brush which does not scratch the glass, then cleaned with a soft cloth. The solution shall be made in accordance with the soap, detergent, or cleaner manufacturer’s recommendations. The solution shall also be essentially neutral, with pH approximately 6 to 8, non-abrasive, and shall contain no chlorinated or aromatic hydro-carbons. The refractors shall be thoroughly washed in this solution then rinsed in clean water, drained, and wiped dry. The Engineer will determine when the washing solution and rinse water is no longer usable and when it shall be changed due to being dirty. The frequency of using new clean solution and rinse water will vary due to the size of the container used to hold the solution and water and the number of luminaires being cleaned.

The use of a sonic bath will be an acceptable alternate method for washing the refractors.

The annual washing of the luminaires shall be completed during the months of May or June. Failure to complete the annual cleaning of the luminaires by the end of June will result in the monthly routine maintenance payment being forfeited for each light that has not been washed until the first full month following the month when the luminaire has been cleaned. This will not, however, relieve the Contractor of responsibilities to provide all other services included in routine maintenance.

Emergency Maintenance

The Contractor shall perform emergency maintenance as defined below when required. Emergency maintenance shall consist of the work required to clear highway lighting system debris which has fallen onto the traveled roadway and to safely secure the system. This shall include roadway lighting standards, luminaires, refractors, conduit, or other components of the highway lighting system. The Contractor shall be expected to arrive at the site, day or night, all days of the week to perform emergency maintenance within 2 h of notification of a hazard by a police agency, city official, or State official.

The Contractor shall clean the site of all equipment and material not necessary for the operation of the lighting system. Such equipment and material shall be transported to the Contractor’s site within 2 h after emergency maintenance is performed. The Contractor will be assessed liquidated damages of $50.00 if the site is not clean after the 2 h period and an additional $50.00 for each 2 h period until clean-up is completed.

Major Repair

Major repair shall consist of all maintenance, repair, and installation which affects maintenance, operation, or continuity of the lighting system which is not previously described as routine maintenance or emergency maintenance. The Contractor shall perform this maintenance within 2 weeks of discovery or notification of all malfunctioning or non-functioning lights unless otherwise directed.

The Contractor shall diagnose the reason for lighting system outages which shall be repaired as required as major repair. This shall not include blown fuses, lamp outages, burned out starter boards, capacitors, or ballasts included in routine maintenance. After determining the problem with the system, the Contractor shall report it for approval to be repaired.

If a pay item is required which is not provided for in the Itemized Proposal, a new unit price for such pay item shall be established as specified in 109.04(c). The actual costs incurred shall be verified by receipted invoices.

Surveillance

The Department will perform a surveillance of the condition and operation of the highway lighting systems included in this contract. This surveillance will be by means of periodic inspections in all directions of travel, including all ramps during hours of full darkness, to ascertain that all lights are functioning in a proper manner. The Department will notify the Contractor in writing, during

the week of the inspection, of nonfunctioning or malfunctioning lights. The Contractor will then have 7 calendar days to repair all lights which may be placed in operation by routine maintenance, from date of receipt.

If the Department's periodic surveillance reveals that a luminaire is out of service beyond the time limits defined in Routine Maintenance and Major Repair, the Contractor will not be paid for routine maintenance for that luminaire for that month.

The Contractor will be assessed liquidated damages in the amount of $100.00 for each calendar day beyond the time limits defined in Routine Maintenance and Major Repair that such luminaire is out.

Contractor's Monthly Reports

The Contractor shall submit a monthly outage report to the Engineer. This report shall list all outages or damages reported to the Contractor through the Department's surveillance report, those which have been reported by other agencies or individuals to the Contractor, and those which have been discovered by the Contractor during normal operations. The outage report shall also include the date of discovery of reported outages or damages and the location of the units in question.

The Contractor shall also submit a monthly repair report to the Engineer. This report shall contain the location of the unit or units repaired, the type of repairs made, the date the repairs were completed, the time started and completed, and a list of materials used.

Liaison with Local Utilities

The Engineer will initiate and maintain liaison with the utility providing service for each lighting system for the purpose of relaying information to the Contractor on light pole knockdowns and non-functioning or malfunctioning luminaires which are not repairable by the utility's routine maintenance if the utility is providing glassware, fuse, and lamp replacement. This will also include relaying utility information concerning non-functioning and malfunctioning luminaires discovered by the Department's surveillance and which may be repairable with the utility's routine maintenance if they provide such a service as a part of their rate.

Liaison with Police Agencies

The Contractor shall initiate and maintain liaison with all police agencies for the area involved for the purposes of discovering light pole knockdowns as well as other non-functions or malfunctions which occur at times other than would be discovered by the Department's inspection.

The Contractor shall promptly furnish to the Engineer, police accident reports of incidents causing damage to the highway and sign lighting system, which become available to the Contractor through liaison with police agencies. The Contractor shall promptly report all charges related to such repairs to the Engineer.

Electrician

The Contractor shall provide 1 electrician, 1 assistant for the electrician, 1 boom and bucket truck or pickup truck and all other miscellaneous equipment which may be required to complete the repair.

This work has been included in order to pay for labor and equipment required to perform maintenance or repair functions which are not shown in the Schedule of Pay Items. This work shall be used only after prior approval from the Engineer and only if it is determined that the work to be done is not included in other pay items. This work shall only be used after the Contractor and Engineer have agreed on the maximum amount of hours the Contractor will be paid to perform the given work. If the Contractor uses less time, payment will only be made for the time actually spent on the site making the repair or performing the maintenance. The Contractor will not be paid for time spent traveling from the point of origin to the highway lighting system site. No payment will be made for time spent returning to the point of origin. The Contractor shall submit an itemized statement for this work with the monthly repair report listing the notice of repair, location, date, time started, time completed and personnel and equipment used.

Highway Lighting Supports

The Contractor may supply supports from another fabricator than the original supplier. However, written permission and approval of the supports will first be required. The structure shall be designed such that all component parts with necessary approved adaptor features are compatible and interchangeable with existing supports, bases and arms. The structures shall be similar in appearance to those in place.

The roadway lighting supports which are presently installed on transformer bases shall be replaced on transformer bases if a knockdown occurs. The roadway lighting supports which are presently installed on breakaway couplings shall be replaced on breakaway couplings if a knockdown occurs.

There are Praff and Kendall roadway luminaire structures presently in place. If the Contractor wishes to supply Praff and Kendall structures at given locations to replace poles which have been damaged, working drawings and calculations shall be submitted in accordance with the design requirements. The present Praff and Kendall structures are not in accordance with the standards for deflection and breakaway devices.

The stub type breakaway base which consists of a short T-base with a tube extension which fits inside of the main tube will not be acceptable. All existing stub type breakaway bases shall be replaced with shafts with anchor bases and breakaway couplings, if a knockdown occurs.

All replacement shaft bases shall be designed to match existing bolt circles. The Contractor shall measure existing bolt circles prior to ordering shafts from the manufacturer, to determine if a variation exists from the 11 1/2 in. to 14 1/2 in. (290 mm to 370 mm) bolt circle as stated herein. The Contractor may contact the Division of Highway Design & Technical Support for consultation and verification of these bolt circles.

The Contractor shall provide an installation summary sheet of all existing poles and mast arms prior to the completion of the contract.

Anchor Base Adapter Plate

Where an existing light standard with a shoe anchor base shall be replaced, the foundation and anchor bolts have not been damaged, and

the existing anchor bolt circle is not a standardized 11 1/2 in. (290 mm), the Contractor may request permission from the Engineer to use an anchor base adapter plate if it is not possible to purchase a pole that fits the existing bolt pattern. This adapter plate shall be used only with a shoe anchor base and shall not be used with, or replace, a transformer base or breakaway couplings. This adapter plate shall be capable of fitting an anchor bolt circle of 13 in. to 17 in. (330 mm to 430 mm) and shall fit only an 11 1/2 in. (290 mm) pole base bolt circle.

Repair of Highway Lighting Supports

Roadway luminaire supports which have been knocked down and damaged may be repaired by cutting the damaged sections of the support away and welding approved sections from another identical support to the damaged support. The weld shall be free from flaws and cracks, and shall be performed by a certified welder. This type of repair shall be subject to approval.

Shaft for Post Top Luminaire

The support for the post top luminaire shall be a round one-piece tapered 5 in. (127 mm) support of aluminum alloy 6063-T6 with satin finish or galvanized steel fabricated from quality hot rolled carbon steel with a minimum yield strength of 48,000 psi (331 MPa). The support shall be made to provide a 16 ft (5.9 m) mounting height.

The support shall be designed to support a 50 lb (110 kg) luminaire with an effective projected area of 2.6 sq ft (0.25 m^2) when subjected to an isotach value of 80 mph (128 km/h) and a gust velocity of 104 mph (167 km/h). The support shall be furnished with a 3 in. (75 mm) outside diameter tendon for mounting and luminaire, a 3 in. by 5 in. (75 mm by 125 mm) handhole with cover and stainless steel hexagonal screws, a 1/2 in. (13 mm) ground nut, and a spun-cover with stainless steel crews for the base. The support shall be designed for mounting on a 8 in. (200 mm) diameter bolt circle.

Breakaway Couplings

The pay unit for this pay item will be Set. The pay unit of set for breakaway couplings shall consist of 4 breakaway couplings and covers to be furnished.

Fabreeka Pads

Fabreeka pads shall be furnished and installed on all lighting structures between the base plate and the foundation as directed. These shall be supplied in die cut quarter sections, slotted such that installation may be accomplished without totally removing the pole.

One fabreeka washer shall be installed between the nut and base at each anchor bolt. The washer shall be 11/32 in. (9 mm) thick. The pad shall be 1/2 in. (13 mm) thick.

Repair of Anchor Bolt

Anchor bolts in foundations shall be repaired by one of the directed means as follows:

(a) This means shall consist of straightening a bent-over anchor bolt by applying heat to the affected area. After air cooling, the area shall be inspected for fractures which shall then be repaired by welding. Only enough heat

shall be applied to straighten the bolt without destroying the structural properties of the bolt.

(b) If a bolt is damaged beyond being able to repair it by straightening, the bolt shall then be repaired by one of the following means.

1. The foundation shall chipped down. A coupling shall be installed onto the remaining acceptable threaded portion of the anchor bolt that is left in the foundation. A stub bolt of the proper length shall be placed into the coupling.

2. The foundation shall be chipped down to a point to where a stub anchor bolt of the proper length may be welded onto the existing broken off anchor bolt with a full penetration weld.

All parts of the exposed metal shall be wire brushed then painted with 2 coats of an aluminum type rust inhibitive paint after straightening an existing anchor bolt or installing a new stub anchor bolt. After the paint has thoroughly dried, all loose or broken pieces of concrete shall be removed from the foundation. The concrete shall be repoured to bring the foundation back to its original shape and elevation. The paint shall not be applied to old concrete where new concrete shall adhere to it.

Completed repairs shall result in a complete foundation with anchor bolts in accordance with all strength requirements of the original foundation, and dimensionally correct for the proper installation of the new breakaway devices and poles.

All welding shall be performed by a certified welder.

Changes from the above procedures shall be subject to approval.

Numbering of Poles

If a new pole shall be installed due to an accident, wind damage, or act of God, the pole shall be numbered.

Light Pole Handhole Covers

New light pole covers or sign pole handhole covers shall be furnished and installed on existing structures where the original cover has been stolen or damaged. Payment will not be made for replacing covers which have been lost or have fallen off due to negligence in reinstalling the cover after performing maintenance or repairs in the handhole. The new cover shall have the same outside appearance and shall be made of the same metal as the original handhole cover. This work shall also include new bolts, drilling, and tapping required to install the new cover.

High Mast Luminaires

The luminaire shall be an integrally ballasted unit for 240 volts operation with a regular type ballast and complete with a 1,000 watt high pressure sodium lamp. The lamp shall be supported at both ends with mechanical spring grips or other acceptable means to hold the lamp secure against vibration. The socket shall be mogul sized for the lamp and porcelain enclosed. The luminaire housing shall be aluminum and shall be an enclosed unit with reflector and borsilicate glass

refractor forming an optical system that delivers a light pattern distribution equal to G.E. curve 35-176371 for the asymmetric units.

Replacement of Luminaires

The Contractor will be permitted to replace a roadway tower, sign, underpass, or post top luminaire only when the housing is broken or damaged, or as directed. All other repairs to luminaires shall be made as routine maintenance.

Capacitors and Starter Panels and Ballasts

All luminaires to be maintained shall have all components of the starter panels, capacitors, and ballasts replaced if they are faulty.

Electrical Conductors

Underground distribution cable shall be No. 4 copper of XHHW type installation.

Pole circuit and sign circuit conductors shall be No. 10, MTW, THHN, or THWN stranded copper.

Electrical Distribution Cable Repair

The Contractor will be permitted to replace only the electrical distribution conductors found inside the polyethylene plastic conduit or galvanized steel conduit. No underground splicing of the conductors will be permitted. Splicing will only be permitted inside in-ground handholes, the handholes of roadway luminaires, sign or high mast structures, and circuit breaker panels. The method of replacing the deteriorated or damaged conductors shall be that directed.

Repair of Polyethylene Conduit

The Contractor may repair the existing conduit if it has been damaged, instead of replacing the entire run with new cable duct. This repair shall be made by inserting and gluing the existing polyethylene conduit ends into a piece of PVC conduit, waterproofing both ends of the PVC conduit around the polyethylene conduit, and then running new cable through the entire run of conduit. The cable shall not be spliced underground in the conduit. No more than 3 splices of polyethylene conduit shall be permitted in 1 run of the conduit. If more than 3 occur, new cable duct shall be run in a relocated position if possible to avoid future damage to the cable duct.

The Contractor shall provide a detailed location of the point where the conduit has been repaired so that such repair may be noted on the plans.

Flexible Conduit

Galvanized steel, polyvinyl jacketed, liquid-tight flexible conduit of 3/4 in. (19 mm) diameter shall be installed as part of the underpass and sign luminaire circuits. The flexible conduit shall be installed as shown on the plans. The flexible conduit shall have UL approved terminal fittings with external grounding jumper to ensure grounding continuity. The grounding jumper shall be No. 6 AWG bare copper stranded wire.

Galvanized steel, polyvinyl jacketed, liquid-tight flexible conduit of 2 in. (50 mm) diameter shall be installed as part of conduit runs crossing bridge structure expansion joints. The flexible conduit shall have UL approved terminal fittings with external grounding

jumpers to ensure grounding continuity. The grounding jumper shall be No. 6 AWG bare copper stranded wire.

The flexible conduit shall be draped slightly to accommodate expansion or movement in the bridge or sign structure.

Expansion Fittings

Properly sized expansion fittings will be acceptable as an alternate to the use of the 3/4 in. (19 mm) and 2 in. (50 mm) diameter galvanized steel, polyvinyl jacketed, liquid-tight flexible conduit. Expansion fittings shall be installed when a bridge structure expansion joint is encountered. The expansion fitting shall be hot-dipped galvanized malleable iron, weatherproofed, and internally bonded. Expansion fittings shall include an external bonding jumper consisting of 2 hot-dipped galvanized steel U-bolts and malleable iron clamps with a tinned copper braid.

Drainage of Lighting Handholes

A drain shall be installed in all handholes which accumulate water inside the handhole. This drain shall be installed as shown on the plans. The drain shall be installed such that it empties to the nearest possible low point. Cable duct or underground utility lines shall not be cut or damaged when installing the drain. Damage to such underground lines shall be repaired with no additional payment.

Pipe Straps

Hot-dipped galvanized malleable pipe straps and spacer as shown on the plans sheet shall be used to attach conduit to bridge structures. Galvanized steel conduit hangers or pipe clamps will not be permitted. The pipe straps of proper size shall be installed 4 ft (1.2 m) center to center along the conduit.

A galvanized steel lag bolt with a minimum dimension of 3/8 in. (9 mm) diameter and 2 1/2 in. (64 mm) in length shall fasten the pipe straps and spacer to the bridge by means of an approved sleeve set into the concrete.

The pipe strap and spacer shall be fastened to steel beams by means of a threaded bolt of suitable size. The strap and conduit shall be attached to the beams as shown on the plans.

Wood Pole Lighting Supports

Wood pole lighting supports shall be creosoted, class IV and V as specified in the American Wood Preservers Association Manual of Recommended Practice, C4 and as described in AHSI 05.1. All guide wires and hardware except the mast arm and luminaire shall be included the cost of this work.

Foundation Anchor Bolts and Reinforcement

These materials shall be included in each light standard foundation to be installed. Each foundation shall contain 4 anchor bolts and reinforcing steel bars. This work shall also include foundation entrance sleeves for the cable duct to be later installed. This work shall not be used with high mast tower foundations.

Utilities

As specified in 107.20, the Contractor shall determine the location of underground utilities before excavating areas where

conflicts with underground structures may occur. Where conflicts do occur, the Engineer will determine the manner of procedure.

The Contractor shall determine the location of all overhead utility lines within the project limits and verify that the proper clearances between electric power lines and the lighting structures, as specified by the utility and required as a minimum by the National Electric Code, will be observed if the light standards are installed as shown on the plans. Where conflicts occur, the Engineer will determine the solution.

Department Furnished Underground Electrical Distribution Cable and Duct

The underground power distribution circuits for highway lighting shall be cable-duct in accordance with 920.01(c)2 and as shown on the plans. Such cable-duct will be furnished in the quantities necessary on 2,000 ft (600 m) cable reels at the Traffic Support Center.

The Contractor shall install the cable duct as shown on the plans and as specified in 807.08. Nicking or other damage to the insulation of the electrical conductor contained inside the duct shall be avoided when cutting the duct away from the cable.

Sign and Underpass Circuits

Wire for sign and underpass circuits shall be in accordance with 920.01(c)4 from the circuit breakers or fuse point to the last luminaire.

Adjustable end support sign structure circuits, and bridge bracket sign or underpass circuits shall be protected by circuit breakers mounted on the bridge or sign structure and connected to the underground distribution circuit in a handhole or pole base as shown on the plans.

Illumination circuits for sign structures with an underground power supply shall be protected by means of fuse connector kits in the base of the sign support as shown on the plans.

Sign and underpass luminaires connected phase to neutral shall be alternately connected to opposite load conductors to balance the load.

Conductor splicing will not be permitted within the conduit, flexible conduit, or expansion fittings when sign or underpass circuits are installed. Splicing will only be permitted in junction boxes, in ground handholes, inside handholes of sign and roadway lighting structures, and circuit breaker enclosures.

Aiming of High Mast Luminaires

The plans show the aiming of the luminaires. Where 1 arrow is used, all the luminaires shall be aimed in the direction of the arrow. Where 2 arrows are used, 1/2 of the luminaires shall be aimed in 1 direction and the others aimed in the other direction. Where more than 2 arrows are indicated, the Engineer will furnish information in the field for aiming purposes. When the aiming process is being done, the luminaire shall be oriented to conform to its raised position and the ring properly tethered to prevent rotation during the aiming adjustment. The long axis of the luminaire shall be parallel to the aiming point shown on the plans.

Pole Circuit Cable

AWG, THWH, MTW No. 10 stranded copper, 600 V, 1/C shall be installed in roadway luminaire standards which require rewiring. Aluminum pole circuit wire shall not be reinstalled.

Waterproofing of Electrical Connectors

Multiple compression fittings installed in handholes shall be taped and waterproofed. Insulating links installed in handholes shall be waterproofed. These waterproofing devices shall be designed for insulating multiconductor cables with a minimum voltage carrying capacity of 600 V.

As an alternate to the waterproofing of electrical connections, heat shrinkable waterproof insulating devices may be used. Multiple compression fittings may be waterproofed and insulated by the use of a wrap-around, heat shrinkable sleeve precoated with a minimum of 60 mils (1.5 mm) of thermoplastic adhesive. The insulation shall be coated with a heat sensitive paint that changes colors when enough heat has been applied to properly shrink the wrap-around material. The kit shall contain a metal channel which securely connects the wrap-around insulation together before shrinking. The metal channel may be left in place or cut off after shrinking. Heat shrinkable tubing will not be acceptable for use on multiple compression fittings.

Insulating links may be waterproofed by the use of heavy walled heat shrinkable tubing with a minimum of 40 mils (1 mm) of thermoplastic adhesive continuously co-extruded into the tubing. The minimum recovered wall thickness of the tubing shall be 90 mils (2.3 mm).

All heat shrinkable waterproofing and insulating devices shall be designed for a minimum voltage carrying capacity of 600 V, designed and tested to ANSI C 119.1, be installed in accordance with the manufacturer’s instructions, and be of the proper size for the height and length of the connector. The thermoplastic adhesive shall be visible around and between all cables at the ends of the sleeve after the shrinking, or the connection will not to be considered waterproofed and the sleeve shall be replaced. The addition of more thermoplastic adhesive or more waterproofing material after the shrinking process has begun or has been completed will not be acceptable. If the waterproofing sleeve or the cable insulation is burned or split, the waterproofing will be rejected. The full run of cable and all connectors shall be replaced with no additional payment if there is not sufficient cable to cut off the burned cable insulation and wire and make a new connection. The manufacturer’s name shall appear on the insulation and shall be legible before and after shrinking.

Ground Rods and Connections

Ground rods shall not be installed within the perimeter of the lighting standard, sign structure, or high mast tower foundation. All ground rods shall be installed in accordance with 807.11 and shall be placed outside the foundation in earth. A ground rod placed within the concrete foundation perimeter shall result in immediate rejection of the grounding system.

All ground rods shall be connected to the ground wire. The free end of the ground wire shall be attached to the material to be grounded. The ground wire shall be connected to the top or side of the ground rod. The ground rod or ground wire connection shall be made by

means of a thermo weld process. The ground rod and wire shall be properly cleaned, free of oxidized materials, moisture, and other contaminants prior to inserting the wire and ground rod into the properly sized mold. The welding material shall sufficiently cover and secure the conductor to the rod. The completed connection shall be porous free.

As an acceptable alternate to this process, a ground grid connection will be permitted. Ground grid connections shall be properly sized and shall consist of a shear head bolt, a C shaped body, nest, and wedge to allow proper securing of the ground wire to the ground rod. The connector components shall be fabricated from aluminum-bronze alloy, silicon-bronze alloy, and copper. Tap type clamps, parallel type clamps, U-bolt flat clamps, and crossover clamps will not be accepted as suitable alternates. The 2 types of connections noted above shall be used when grounding systems are installed.

Maintenance of Traffic

Maintenance of traffic shall be in accordance with 801. Traffic control layout sheets on the plans show minimum guidelines for situations which may occur. If unusual working conditions occur, the Contractor shall provide the Engineer a proposal for the traffic control measures to be used, subject to approval.

If the Contractor finds it necessary to temporarily occupy a part of a shoulder or the traveled width of pavement and restrict traffic, the Contractor shall provide all barricades, lights, flaggers, and other protection of traffic as may be deemed necessary by the Engineer and as specified in 801.

Construction warning lights shall be in accordance with the applicable requirements of 801.14, except that type II barricades, plastic drums, or construction warning signs used only for maintaining traffic during daylight hours will not require a type B low intensity flashing warning light.

When barricades, plastic drums, or other channelization devices are used to divert traffic, the length of the taper L shall be determined by means of the formulas as follows:

For a speed limit of 40 mph or less:

$$L = \frac{S \times S \times W}{60}$$

$$(L = \frac{S \times S \times W}{60} \times 0.3048$$

For a speed limit of 45 mph or greater:

$$L = S \times W \times 0.3048$$

$$(L = S \times W)$$

where:

L = Length of the taper, ft (m)
S = Speed limit, mph
W = Lateral distance traffic is being moved, ft

When these devices are used to close a travel lane, the spacing, in feet shall be the same as the numerical value of the speed limit. (The spacing in meters of these devices shall be the same as the numerical value of the speed limit times 0.3048). When used to define the presence of a vehicle or workers temporarily occupying the traveled way, without lane closure, these devices shall be appropriately spaced to clearly outline the work area and prevent vehicles from entering the work area. A 48 in. by 48 in. (1.25 m by 1.25 m) “Workers Ahead” sign shall be placed just off the shoulder 700 to 800 ft (210 to 240 m) ahead of each operation. The signs shall be removed from view when no work operations are being conducted. Traffic control requirements not addressed herein shall be as shown on the plans. Extended work shall consist of work which takes place on the roadway for over 30 min. Short term repair activity and short term repair work shall consist of work which takes place for 30 min or less.

If a work activity involves frequent moving of the work setup, such that no work setup is in place for more than 30 min, the Engineer may require that the work being performed at an intersection, or series of intersections, be treated as an extended work zone.

When aerial work is being performed which occupies a portion of the traveled way, a minimum of 1 flagger will be required.

All equipment which is used on or near a traveled way shall be equipped with revolving amber warning lights. These warning lights shall be a minimum of 8 in. (200 mm) in diameter. Such lights shall be clearly visible to approaching vehicles through all phases of the equipment operation for a minimum distance of 500 ft (150 m). Strobe warning lights may be used provided that they output 2,000,000 candlepower (2,000,000 cd) during daylight hours and 1,000,000 candlepower (1,000,000 cd) during other hours.

Identification placards shall be affixed to all equipment.

The longitudinal spacing of multiple construction signs, where required, shall be 500 ft (150 m). This distance may require adjustment based upon location conditions. All variations shall be subject to approval.

Specific traffic control requirements may be directed to be used as a result of blacked-out traffic signals.

The Contractor shall adjust suspension cables or take other actions as directed, to release the tower ring before lowering the high mast tower.

Group Replacement of Lamps

All lamps replaced shall be disposed of so that reuse of the old lamps shall not occur. The Contractor shall replace individual lamps as routine maintenance.

Breakaway Devices

The breakaway devices on all lighting standards consisting of transformer bases or breakaway couplings shall be upgraded to the AASHTO requirements when it is necessary to replace the breakaway device or the entire light standard.

When the entire standard with a breakaway device shall be replaced, the Contractor shall submit shop drawings for approval prior to ordering the standard. If a light standard is designed for the AASHTO standards and has been approved for a previous Department installation, the Contractor may order the replacement standard without submitting shop drawings. The Contractor shall submit a copy of the previously approved drawing with the material certification.

When only the breakaway device is replaced, the Contractor shall submit approval drawings prepared by the light standard manufacturer who is supplying the breakaway devices. The drawings shall show the load limitations recommended by the light standard manufacturer based upon their tests of the breakaway devices.

The drawings submitted for approval shall identify the breakaway device and shall include the following:

(a) Complete top and bottom dimensions for transformer bases.

(b) Maximum recommended mounting height.

(c) The maximum shaft thickness which may be used for each tested bolt circle. Bolt circles smaller than those tested shall not be used.

(d) All required installation hardware.

(e) All other application limitations.

The Contractor shall supply sufficient data on each replacement installation to the Engineer to prove that the installed equipment is in accordance with the load limitations of the breakaway device. The data shall include the bolt circle used, the installed mounting height, the arm length, the bottom diameter of the shaft, and the wall thickness of the shaft. The data shall be furnished with the material certification.

Where the existing light standard exceeds the load limitations of the latest breakaway device, the Contractor shall advise the Engineer of the problem in writing. The Department will then authorize a change in the replacement installation which permits the use of a standard breakaway device, or relieve the Contractor of maintenance responsibility for the problem light standard.

Method of Measurement

Wiring, circuit breakers, breaker enclosures, conduit, flexible conduit, flexible conduit fittings, and grounding required for such maintenance will not be measured for payment. Routine maintenance of luminaires will be measured per each month each luminaire is maintained. Lighting supports, repair of anchor bolts, and repair callouts for emergency maintenance will be measured by the number of units or times such work is performed. Electricians will be measured by the number of hours worked. Breakaway couplings will be measured by the number of sets installed. Polyvinyl chloride pipe will be measured by the linear feet (meter), complete and in place. Copper wire or copper cable required for purposes other than maintenance of roadway lighting will be measured in accordance with 807.18.

Basis of Payment

Wiring, circuit breakers, breaker enclosures, conduit, flexible conduit, flexible conduit fittings, grounding, and incidentals from the breaker enclosure with conduit riser, or from the connector kits in the sign support base, to the last luminaire will be paid for at the contract lump sum price for each location complete and accepted. Routine maintenance of luminaires will be paid for at the contract unit price per month each luminaire is maintained.

Lighting supports, repair of anchor bolts, and repair callouts for emergency repair will be paid for at the contract unit price per each. Electricians will be paid for at the contract unit price per hour. Breakaway couplings will be paid for at the contract unit price per set, complete and in place. Polyvinyl chloride pipe will be paid for at the contract unit price per linear foot (meter). Copper wire or copper cable required for purposes other than maintenance of roadway lighting will be paid for in accordance with 807.19.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Anchor Bolt, Repair	EACH
Breakaway Coupling	SET
Callout, Repair	EACH
Electrician	h
Lighting Support	EACH
Pipe, PVC, _____ (diameter) in. _____ (diameter) (mm)	LFT (m)
Routine Maintenance, Luminaire, ____ (type), ____ W	MOS

The costs of starter poles, capacitors, and diagnostic service shall be included in the cost of maintenance of roadway lighting. The costs of installation or reinstallation of vibration dampers, fabreeka pads, and anchor base adapter plates shall be included in the cost of light standards. The cost of repair to polyethylene circuits shall be included in the cost of the copper wire pay items. The cost of foundation excavation shall be included in the cost of class A concrete. The cost of pole numbering shall be included in the cost of sign, underpass, roadway lighting location identification. The cost of overtime or double time work required of electricians shall be included in the cost of the electrician pay item.

The Contractor will not be paid a renegotiated price for pay items for which the quantities used would normally be considered an excessive overrun or excessive underrun. The requirements of 104.02 and 109.03 shall otherwise apply.

The quantities listed for the pay items shown in the Itemized Proposal are only estimates. Payment for these pay items will be made upon invoice by the Contractor to the Department. Payment will be made only after the material, labor, and equipment are incorporated into the work and only in the amount actually used in the work. Similar payment procedures shall be followed if additional highway lighting systems are added to the contract.