

DIVISION 14
LIGHTING
SECTION 1400
ROADWAY LIGHTING

1400-1 DESCRIPTION

Furnish, install, connect, and place into satisfactory operating condition lighting at locations shown on the plans. Perform all work in accordance with the contract and the National Electrical Code.

This division is for methods, materials and equipment to construct and put in working order the proposed lighting; however, every fitting, minor detail, or feature may not be shown or described. The Contractor shall be an expert in the trade, capable of understanding the intent of the contract and constructing the lighting and electrical system(s) in accordance with the best practice of the trade.

The Contractor actually performing the work described in the contract shall have a license of the proper classification from the North Carolina State Board of Examiners of Electrical Contractors.

Have the licensed contractor available on the job site as necessary when work is being performed or when requested by the Engineer. Have this contractor maintain a set of project plans and Specifications in his possession on the job site and a set of accurate as built plans. This contractor shall be qualified to responsibly instruct and direct all employees regarding the electrical work.

1400-2 MATERIALS

(A) General

All materials used in the work are to be new materials unless noted elsewhere in the contract. References in the contract to any proprietary device, product, material, fixture, form, type of construction, etc. by make or catalog number, with or without the words or approved equal, is to be taken as establishing a standard of quality, and is not to be construed as limiting competition. In such case, the Contractor may use any material, equipment or type of construction which has written approval as being an acceptable equal to that named for the particular use intended by the contract.

Provide materials that are labeled or listed by an acceptable organization, which is defined as an organization that maintains periodic inspection of the production of the materials and verifies, by the labeling or listing procedure, that the materials comply with appropriate standards of performance or are suitable for use in a specified manner. Provide Underwriters' Laboratories (UL) labeled and listed materials when such labeling and listing is available for such materials.

Make sure that materials are in compliance with requirements for use of domestic products, as specified in other sections of the Specifications.

(B) Conduit

Use conduit and duct that is either metallic (Rigid Metallic Conduit) or non-metallic (Polyvinyl Chloride or High Density Polyethylene), as noted on the plans and as described in Section 1098-4.

(C) Wire

Use stranded copper conductors unless specifically noted otherwise on the contract. Use wire and cable which conforms to IPCEA specifications and has marks for identification (manufacturer's name, type insulation, and gauge of conductor) and the UL label.

Use wire insulation rated at 600 VAC or greater.

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Use the following types of wiring unless noted otherwise on the plans:

Service Lateral	UL Type USE
Control System	UL Type THW or RHW or THHN
Feeder Circuits in Conduit	UL Type USE
Branch Circuits in Light Standards	UL Type NM Cable
Equipment Grounding Conductor	Solid MHD, Bare or Insulated
Grounding Electrode Conductor	ASTM B-2

Feeder circuits in conduit with #8 conductors and smaller may consist of a cable assembly rated UL Type UF. Use #6 AWG for the grounding electrode conductor unless noted larger on the plans.

(D) Grounding and Bonding Equipment

Use Ground Rods which are 15.9 mm diameter x 2.4 m copper clad steel and which have a one piece silicone bronze clamp with a socket or hex head screw. Make sure that all grounding and bonding equipment conforms to UL Standard 467, *Electrical Grounding and Bonding Equipment*.

(E) Fuseholders

Provide fused overcurrent protection in the base of each light standard, and other locations as noted. Use a fuseholder that is rated 600 VAC, 30 amp minimum, waterproof, and constructed so that the fuse will be disconnected from the line side power every time the fuseholder is opened. It may be made of molded plastic or rubber and have insulating boots. Use terminals which are specifically rated for the size and number of conductors required.

Use fuses which have 5000 amp minimum interrupting capacity at the supply voltage, are rated 10 amp or as noted on the plans, and are not glass type unless specified different in the contract. Use the same type fuse in all fuseholders on a project unless specified differently at specified locations.

Use fuseholders that have been specifically designed as breakaway devices in fiberglass standards and standards with breakaway bases. Use fuseholders that have been designed to disconnect line side power without damage to the terminals or conductors every time sufficient pulling force is placed on the line and load side conductors.

(F) Hardware

Use mounting or attachment hardware including bolts, nuts, washers, straps, clamps, and hangers which is made of stainless steel, hot dipped galvanized or of equal corrosion resistance. Use bolts, which are minimum length and are not less than 1 nominal size smaller than the opening being utilized.

(G) Lamps

Use lamps that conform to ANSI specifications, are of the type and wattage indicated on the contract, are rated for a minimum of 24,000 hours life, have a mogul base, and have special coatings for premium efficiency and color rendition. Clearly mark the installation date on the base. Provide and install lamps for all luminaires furnished on the project.

(H) Duct and Conduit Sealer

- (1) Use duct and conduit sealer or mastic which is a putty-like compound and:
- (2) is permanently non-hardening, non-oxidizing, and non-corrosive to metals, rubber, plastic, lacquer and paints,
- (3) is readily workable for thumbing into openings and forming into seals around wires inside conduits and openings around conduits,

- (4) has a service temperature range of minus -1°C to 93°C
- (5) is clean, non-poisonous and non-injurious to human skin,
- (6) seals against water, dust and air and shall adhere to wood, glass, plastics, metal, rubber, and painted surfaces.

(I) Pull Lines

Place pull lines specifically designed for pulling a rope in all empty conduits and electrical duct so that electrical circuits can be installed in the future. Use pull lines which are 2 ply with a tensile strength of 1067.6 N minimum and resistant to tangling, rot, and mildew.

1400-3 SUBMITTALS

(A) Catalog Cuts

Submit for approval catalog cuts and/or shop drawings for materials proposed for use on the project. Allow 40 days for review of each submittal. Do not deliver materials which have not been approved to the project. Submit 8 copies of each catalog cut and/or drawing and show for each the material description, brand name, stock-number, size, rating, manufacturing specification and the use for which it is intended.

Three copies of approved submittals will be returned to the Contractor. Present a catalog cut or drawing for all components of each contract item. Present the submittals neatly arranged in the same order as the contract bid items.

(B) Certifications

In accordance with Article 106-3, furnish a Type 3 - Manufacturer's Certifications for light standards, high mounts and lowering devices and a Type 6 - Supplier's Certifications for conductors. Submit certifications when the above materials are delivered to the project.

Type 3 or Type 6 Certifications may be requested for any or all of the other material which does not have a name plate showing sufficient information to verify that the material was manufactured to the requirements of these Specifications.

(C) Samples

Random samples will be taken of the various items for the purpose of verifying conformance with Specifications. The selection of the items to be sampled and the taking of the samples will be done by the Engineer.

Failure to meet specification requirements by 2 samples of any material will be sufficient reason for rejection of all materials from the same lot.

Upon request, there will be reimbursement for the actual verified cost of such material taken as samples, including any handling charges less any discount allowed on the invoice, but with no percentage added, and such material will thereafter become the property of the Department.

(D) As-Built Plans

Submit two complete sets of as-built plans for review upon completion of the work, showing the location of all buried electrical circuits, with pavement crossings dimensioned from fixed objects or from survey stations.

Include in the as-built plans the title (No. 1), index (No. 1A), summary of quantities (No. 3), and all of the layout and detail (E) sheets of the project with all changes indicated. After review and approval, place one set of these as-built plans in a waterproof envelope and file in each Control Panel.

Submit one set of as-built plans to the Roadway Design Unit.

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Show the light standard foundations that are relocated (by permission of the Engineer) on the as-built plans in their final locations.

Keep a daily record of the location of all items in order to ensure the accuracy of the as-built plans.

(E) Warranties

Turn over warranties from each manufacturer of electrical materials and equipment pertinent to the complete and satisfactory operation of the system prior to the acceptance of the project. Indicate on each warranty furnished its expiration date; it shall not be less than those provided as a customary trade practice.

(F) Computations and Welding Procedures

Submittals of structural design computations and drawings showing material and welding specifications as required in other sections of the Specifications, such as High Mount Standards, may require 10 weeks for review.

1400-4 CONSTRUCTION METHODS

(A) Location Surveys

All light standards, high mount foundations, and electrical duct will be located unless indicated differently elsewhere in the contract. Mark the proposed location of circuits, circuit markers, control systems, service poles, junction boxes, luminaires, and all other components for approval prior to installation. The top of foundation elevations will be provided unless indicated differently.

The plan locations of the light standards and high mounts may be adjusted in order to be behind guardrail, to avoid obstructions, or to avoid undesirable foundation conditions. Have location changes approved prior to construction. Have longitudinal relocations of luminaires of more than 3 m or lateral relocations of more than 0.6 m approved by the Roadway Design Unit.

Verify project dimensions on the site, actual measurement always taking precedence over scaled plan dimensions, with every part of the work fitted to actual conditions at the site.

(B) Damage to Facilities

Take all precautions necessary to avoid damage to existing underdrains and other buried facilities located in certain areas. Hand trenching may be required to avoid damage to the underdrains, storm sewer systems and other facilities. Construct light pole foundations which have a minimum horizontal clearance of 3 m to storm sewers or other underground installations which might affect the foundation stability. Make lateral and longitudinal changes in pole locations in the field to provide the required clearance, as directed.

Trenching and construction operations may require the removal of or result in damage to existing shoulders and paved ditches. Restore all disturbed portions of the project to their original condition or as approved.

Installation of conductors may require trenching through existing guardrail locations. Trenching may be done beneath the guardrail in a manner that will not disturb the guardrail installation or the Contractor may remove short sections of guardrail to facilitate mechanical trenching. Reinstall all removed guardrail by the end of the day's work. Permission is required prior to removal of any guardrail. Repair any damage to the guardrail installation or to the galvanizing of the material as directed.

Repair all trenched, excavated, or otherwise damaged earth surface areas by shaping, smoothing, seeding, and mulching the damaged areas as required by the Specifications and as directed.

(C) Existing Utilities

Water, sewer, telephone, fire alarm, traffic signal, and power lines may be located in the same area that lighting standards and circuits are to be installed.

Locate these lines before operations are begun. Field changes approved by the Engineer may be made to provide clearance required by the National Electrical Safety Code.

Foundations or other construction which is installed in conflict with existing utilities will not be acceptable. Remove this construction and repair damage to utilities at no cost to the Department.

When the work involves replacing or renovating existing lighting, make all reasonable efforts to prevent dark spots in the lighting system. Phase lighting construction to allow existing lighting to remain in operation as long as possible.

(D) Operation of Equipment

Use a bucket truck to raise workers into position to install and/or adjust luminaires and lamps after the initial setting of the standards. Taking down the light standard to check or make adjustments at the top is not allowed.

Install all bore pits outside the clear zone.

(E) Conduit Installation

Install conduit continuous, watertight, free of kinks, and make all runs with as few couplings as standard lengths will permit. Do not exceed a total angle of 270° between outlets unless otherwise approved. Conduit bodies with covers and neoprene gaskets may be used to facilitate the installation of the wires at locations indicated on the plans.

Provide protection at all times against the entrance of water or other foreign matter into the conduit. Plug or cap conduit when work is temporarily suspended, including nightly stoppage of work.

Clean all conduits before installation, and upon completion of the system. Snake an approved cleaner with a diameter not less than 85% of the nominal diameter of the conduit through each conduit prior to installing the wire.

Install the conduit in such a manner that temperature changes will not cause elongation or contraction that might damage the system. Provide expansion fittings where conduit crosses structure expansion joints.

Avoid short radius bends in non-metallic conduit to prevent burn-through of the pulling cable or conductors during pulling operations.

Install caps or plugs on stub-outs for future use made of the same material as the conduit. Where non-metallic conduit is joined to metallic conduit, use a non-metallic female threaded adapter. Install bushings on all conduit ends projecting into panels, boxes, or other enclosures. Provide pull lines in all conduits for future installation of circuitry. Coat field cut threads and other uncoated metal or damaged galvanizing with organic zinc repair paint. Securely fasten conduit. For the spacing of fasteners, do not exceed 1.2 m for 38.1 mm conduit and larger or 1.8 m for 31.8 mm conduit and smaller. Use fasteners that are hot dipped galvanized or stainless steel. Provide backs with all conduit straps installed on flat surfaces. Rotary-impact drills may be used for installing expansion anchors in concrete. Do not use powder explosion type units.

Do not install underground conduit until the area has been brought to final earth grade. Give careful attention to the vertical and horizontal alignment of the conduit to provide the smoothest installation.

(F) Wiring Methods

Do not pull wire through a conduit system until the system is complete and has been cleaned. Use approved wire pulling lubricants. Pull wires into conduit at a slow steady pace and give careful attention to assure that no wire is damaged.

Color code all conductors per the NEC (grounded neutral- WHITE, grounding - BARE or GREEN) and use phase conductors which are BLACK and RED. Approved marking tape, paint, or sleeves may be used in lieu of continuous colored conductors for No. 8 AWG and larger. Do not mark a white conductor in a cable assembly any other color. However, a white, red, or black conductor may be stripped at all accessible points and used as a bare equipment grounding conductor.

Joints, taps, and splices will only be permitted at locations indicated on the plans and by the following methods.

Locations in junction boxes and bases of standards:

- (1) Cut and remove the insulation only as far as necessary to make a secure mechanical and electrical connection. Use connectors which are a removable type (split-bolt, set screw, wire nut, etc.) and covered with self-vulcanizing rubber tape applied in half-lap layers, to give a smooth covering of not less than 2 times the thickness of the original insulation. Over the rubber tape, apply half-lap at least two layers of vinyl plastic tape. Use rubber tape which is a self-fusing type putty in tape form that can be wrapped, stretched, or molded around irregular shapes for smooth insulation build-up. Use vinyl plastic tape that is 7 mil ultraviolet, abrasion, moisture, alkali, acid and corrosion resistant.
- (2) Install a manufactured mechanical or compression connector with factory made waterproof insulating boots in accordance with procedures and using tools as specified by the manufacturer.

(G) Grounding Electrodes

Install grounding electrodes at each junction box, and control system as shown on the plans. Where installed in earth, drive them flush with the ground after installation of the clamp and conductor.

(H) Equipment Mounting

Mount equipment securely at locations shown on the plans in conformance with the dimensions shown and make vertically plumb and level. Install fasteners as recommended by the manufacturer and space evenly. Utilize all mounting holes and attachment points for attaching enclosures to structures.

(I) Concrete Foundations

Use concrete foundation dimensions verified in accordance with the details shown on the plans or approved drawings. Construct concrete foundations in accordance with Section 825. Use class A concrete, meeting the requirements of Section 1000 and reinforcing steel which conforms to the requirements ASTM-A615, Grade 60, Deformed .

Perform foundation excavations that conform to the applicable requirements of Section 410. Construct the sides of the excavation to conform as nearly as practicable to the required dimensions. Place concrete against undisturbed soil unless otherwise permitted. If large discontinuities in the required configuration of the excavation are created by the removal of boulders or due to any other causes, backfill the excavation and compact as provided for in Section 410. Re-excavate the foundation to the proper dimensions. If rock or boulders are encountered during the excavation, they shall be removed to a depth sufficient to obtain the stability necessary to support the structure for the design loads.

Form foundations with prefabricated cardboard forms down to 152.4 mm minimum below top of ground. Concrete shall be cast against undisturbed soil. If temporary shoring is required in conjunction with the excavation, smooth steel pipe of the specified diameter shall be installed and retracted as concrete is cast against undisturbed soil. If permanent casing, either smooth or corrugated, is used it shall be pushed or screwed into undisturbed soil and then cleaned of debris prior to casting concrete. No water shall be allowed to accumulate before or during the casting.

Set the top of foundation elevation relative to the surrounding ground surface as shown on the plans. Chamfer corners at the top of foundation. Give exposed vertical concrete surfaces an ordinary surface finish and exposed horizontal concrete surfaces a float finish. Use galvanized steel hardware cloth or welded wire fabric, between the top of foundation and bottom of mounting base if indicated on the plans or other sections of the Specifications. Attach hardware cloth to anchor bolts with size AWG 14 copper wire or small gage galvanized wire.

Do not erect standards before test cylinders representing the foundation concrete have attained a minimum compressive strength of 20.7 MPa. Do not remove forms until the concrete has properly cured, and in no case less than 24 hours after the concrete has been placed.

Arrange anchor bolts symmetrically about the center of the foundations, brace securely, and hold in the proper position and alignment. Install electrical conduits of the size and number required by the circuits in the concrete as shown on the plans. The number of conduits shown on the plans is a guide only, with the actual number required being based on the number of circuits to be installed at the foundation being constructed; however, in no case should less than 2 conduits be installed.

To avoid vehicle undercarriage snagging of any substantial remains of a breakaway support (when it is broken away), the edge of the foundation or top of anchor bolt should not extend more than 101.6 mm above a 1524 mm chord aligned radially to the centerline of the highway, and connecting any point within the length of the chord on the ground surface on one side of the foundation to a point on the ground surface on the other side.

1400-5 INSPECTIONS

Maintain responsibility for having each electrical system inspected and approved by the electrical inspector having jurisdiction in the area in which the systems are located. Furnish written verification, prior to the final acceptance of the project, that the inspector has approved the electrical systems. Inspection by local authorities will neither eliminate nor supersede the inspection by the Engineer to ensure compliance with the contract.

Comply with all local ordinances and regulations. Apply for and obtain all permits and/or licenses required by local regulation.

Have all work inspected and approved before concealment. An inspection will be made during the progress and after the work has been completed. It will also include an inspection made at night to determine the optical qualities of each luminaire. Adjust all luminaires having unsatisfactory qualities as directed.

Provide the necessary personnel and equipment for aiming luminaires during nighttime inspections by the Engineer.

1400-6 PERFORMANCE TESTS

Prior to acceptance, operate the lighting system, including automatic control equipment and all other apparatus, without interruption or failure attributable to poor workmanship or defective material for 2 consecutive weeks. All lights and equipment will be inspected for normal operation. Make all necessary repairs or replacements.

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Conduct the performance test at the same time for all lights which are energized from the same utility company service point.

Performance tests of individual circuits or groups of lights will not be acceptable.

Arrange with the power company to provide the electric power necessary. Separate payment will not be made for labor, materials, equipment, and incidentals required for performing the tests.

After all wiring has been installed and connected in the proposed permanent manner, but prior to the above operation period, give each feeder circuit conductor an insulation resistance test by the Engineer. The insulation resistance for each conductor shall exceed 5 megohms after charging for 30 seconds at 500 VAC or 1000 VDC.

If the insulation resistance test of any conductor indicates a value of less than 5 megohms, locate the fault. If the fault is in a conductor between terminal connections, replace the conductor. If the fault is at a terminal connection, repair or replace the terminal device as directed. Have satisfactory insulation resistance on all wiring prior to beginning the 2 week operation test.

1400-7 IDENTIFICATION

Identify each component of the lighting/electrical system as indicated on the plans. Use a method of identification which includes an approved paint, adhesive label, heat shrink label or embossed concrete. Label conductors on components requiring identification at each terminal, circuit breaker, light standard, high mount standard, control system, junction box, and underpass panel.

Label each circuit conductor at each terminal and access point with the circuit number indicated on the plans.

Identify light standards and high mount standards by the control system and location number indicated on the plans. Put the identification on the front side of the standard facing the traffic at a height of 1.8 m above ground level. Identify control systems and underpass panels on the exterior of the front panel.

1400-8 LOCKS AND KEYS

Supply all access doors to control cabinet enclosures with locks that meet the Engineer's approval. Key all locks alike and furnish 8 keys to the Engineer.

1400-9 ELECTRICAL SERVICE

Coordinate all work to ensure that electrical power of the proper voltage, phase, frequency, and ampacity is available to complete the project. Contact the utility company, make application, pay all deposits and other costs to provide necessary electrical service. The Contractor will be reimbursed for the actual verified cost of any utility company charges.

The Engineer will provide authorization to the Contractor for electrical service to be obtained in the name of the Department and for the monthly power bills to be sent directly from the utility company to the Department. The Department will be responsible for direct payment of monthly power bills received from the utility company.

1400-10 TERMINOLOGY

The terms *high mast* and *high mount* are used synonymously in the contract.

The term *by others* means work to be accomplished and paid for under contract items other than those clearly pertaining to the work specified or shown. Work by others may be included in this contract for the Contractor to provide, or it may be provided under another contract or by someone other than the Contractor.

Abandon means that the materials will not be used in the final completed form of the work. Remove all abandoned materials from the project or terminate at least 460 mm below subgrade so that they will not be in conflict with the finished project.

1400-11 CONSTRUCTION PHASING

Accomplish lighting work along with other roadway construction in the appropriate phases as indicated in the Traffic Control Plans and these Specifications.

1400-12 MEASUREMENT AND PAYMENT

There will be no direct payment, except where specifically noted in the Subarticle 1400 - 3(C) Samples and Subarticle and 1400-9 Electrical Service for the work required in the preceding sections of this division. Payment of the contract unit prices for the various items in the contract will be full compensation for all work required.

**SECTION 1401
HIGH MOUNT STANDARD**

1401-1 DESCRIPTION

Furnish and install a high mount standard 22.9 m or greater in height with a top-latched lowering device and portable drive unit including the drive, winch, wiring, cables, brackets, hardware, transformer, power cord, storage case, and operating manuals.

1401-2 MATERIALS**(A) High Mount Standard**

The standard may be either a multisided or round tubular member. Furnish 8 copies of completely detailed drawings and 1 copy of the complete design computations for each height of standard for approval prior to fabrication. Have the drawings show all details relating to pole, access hole, base, anchorage, and lowering device. Show references to ASTM specifications or to other material specifications for each type of material used on the drawings. Make sure that all drawings are clearly identified with a drawing number and signed and dated by the manufacturer's authorized representative.

Show clearly full and complete information regarding location, type, size, and extent of all welds on the drawings. For groove welds, indicate the particular detail and process to be employed in production of the work. For prequalified joints, use of the Bridge Welding Code letter classification designation of the joint (B-Lzb-S etc.) will satisfy this requirement.

Note the total weight in kilograms on the drawings for each component and the total assembly.

The Contractor's attention is directed to the fact that it will take approximately 10 weeks to secure approval after submission of the complete drawings and computations.

Have the design of the support including base plate and anchorage conform to *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, and the Interim Specifications* valid at the time of letting. Fatigue Category I shall be used in design. The welding design and fabrication shall be in accordance with Article 1072-20. The support is to be designed for the wind velocity shown on the plans.

Fabricate the support in accordance with the details shown on the approved shop drawings and with the requirements of the Specifications.

Fabricate support steel and hot-dip galvanize it after fabrication has been completed.

Test all base plate to upright welds using magnetic particle testing (MPT) prior to galvanizing. All base plates shall be tested at 100%.

Have the galvanization conform to ASTM A153 for fasteners and to ASTM A123 for other structural steel.

Have all welding of steel components conform to the *Standard Specifications* with the following exception. Partial penetration longitudinal groove welds on shaft

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sections having a minimum throat of 60% of the thickness of material being joined will be acceptable provided the qualification requirements of the Bridge Welding Code are met. However, full penetration will be required on longitudinal groove welds within 152.4 mm of circumferential welds and in areas where a shaft section telescopes over another shaft section. No field welding of any part of the assembly will be permitted.

Allow easy access to all components in the base of the standard with a hand hole with a hinged and lockable door. Allow for opening of the door without the use of special tools or wrenches. Make the hand hole large enough for removal of the circuit breaker and the hoist gearbox and winch assembly (minimum 228.6 x 457.2 mm). Make the door hinge and lock mechanism sturdy enough to prevent vandalism and to prevent freeze-up or binding due to corrosion or too tight fit. Achieve locking with a conventional pad-lock. Built in locks or latching mechanism for the door will not be acceptable.

(B) Lowering Device

Furnish 8 copies of completely detailed drawings of the lowering device with manuals describing the assembly, erecting and operating procedures. Include precise instructions on stringing the cables and leveling the carrier ring.

On each high mount lighting standard have a device to lower the luminaires from the operating position at the top of the standard to a service position approximately 0.9 m above the base of the standard. Include on the device a head-frame, top latching carrier ring, and winch assembly. Design the lowering device for the number of luminaires as shown on the plans, each weighing and each having a projected area in accordance with Section 1403.

Mount the head frame on the standard with a slipfitter and set screws and have sheaves or rollers for the lifting and power cables. Also have sockets to automatically secure the carrier ring at the top in the raised position, and have a hood on the entire assembly for protection from the weather. Attain latching and unlatching by alternately raising and lowering the carrier ring. Use sheaves that are non-corrosive materials with bronze bushings and stainless steel shafts. Provide suitable retainers to assure that the cables stay in correct position.

Have slipfitter tenons equally spaced for mounting the luminaires on the carrier ring. Have the carrier ring automatically latched to the head frame when raised into position by suitable pins and sockets which will prevent the luminaires from swaying, turning, vibrating, or otherwise moving out of proper position. Include on the carrier ring spring loaded roller arms to guide the ring during raising and lowering operations. Use springs made of stainless steel and rollers made of nylon. Mount a weatherproof junction box on the ring for connection of individual luminaire circuits to the electrical power supply cable. Include in the junction box a flanged inlet for connection of the power supply cable. Use an inlet and cable connector which is of the locking type and weatherproof.

Use a winch assembly that is a self-locking worm gear type designed for operation with a portable power unit. Have the winch drum automatically reverse the lay of the hoist cable and prevent uneven build-up or tangling.

Provide a terminator for joining the hoist cable and 3 suspension or lifting cables. Provide the means to compensate for variations in the lengths of the 3 lifting cables. Use hoist and lifting cables made of stranded high strength stainless steel extra flexible aircraft type. Use hoist and lifting cables that meet structural requirements of Military Specification MIL-W-83420D and have the center strand not protruding more than 1.5 mm after the cable is cut.

Use a power supply cable that is rated for suspension and has approved strain relief fittings at each end. At the base of the standard, provide a locking type plug with waterproof cover to connect to a short power supply cable stubbed from the circuit breaker panel.

(C) Portable Drive

Supply a portable drive unit with a heavy duty reversible electric motor with torque limiter type drive of adequate capacity, complete with a grounding type cord, suitable couplings for attaching the unit to the winch assembly, and a sturdy storage container for the unit and accessories involved. Provide one portable drive unit for the completed project. Provide a drive unit with a lever switch controller with clearly marked UP and DOWN positions. Connect the controller to the drive unit with a cord of sufficient length to let the operator stand a minimum of 4.6 m from the base of the high mount during lowering or raising operations.

Shop assemble the portable drive unit and remove all rough edges. Use mounting or adjustment bolts which allow hand tightening.

Provide a complete unit that includes a durable metal storage case with all equipment and instructions for operation. Use a case which is the approximate size as shown on the plans, has a continuous hinge on the lid, and has sturdy carrying handles on each end. Furnish a hasp with padlock as shown on the plans. Construct the case with 16 gauge formed and welded steel with bracing to prevent warping. Paint the inside and outside with a durable quality paint. Provide an identification label as noted in the plans on the storage case.

(D) Circuitry

Install an enclosed circuit breaker in the base of the high mount standard. Use a breaker which is rated 480 VAC, 2 pole, 30 ampere unless noted otherwise on the plans.

Provide a supply cord originating from the circuit breaker with a female twist lock connector for testing the luminaires at ground level, during lowering operation using the portable drive unit, and when in the raised position during normal night operation.

Provide a junction box mounted on the lowering ring with a flanged inlet to accept the female twist lock connector from the supply cord. Use plugs, flanged inlets, and connectors for the supply cable and drive unit which allow grounding and are weatherproof.

Install the wiring for each high mount luminaire separately from the luminaire to the junction box. Series or loop circuitry is not allowed.

Provide a transformer, branch circuit breaker, and GFCI receptacle as a power source for the portable drive.

Provide an equipment grounding conductor in the supply cable. Include an equipment grounding conductor in the wiring for each luminaire.

(E) Operation

Demonstrate the operation of the lowering device by raising and lowering the carrier ring with luminaires a minimum of 5 times for each high mast. Include in this demonstration latching and unlatching at the top and connection of test cables at the bottom. Twisting of the cables, failure of the carrier ring to latch or unlatch, unlevelness of the carrier, or hang-up of guide arms will be sufficient reason not to accept the lowering device.

1401-3 CONSTRUCTION METHODS

Use suitable blocking and slings to prevent warping of the high mount standard during storage and transportation. Assemble all parts and string all cables in strict accordance with the manufacturer's instructions.

Make sure that the top of the standard is not out of plumb more than one half of one percent of its height. Tighten anchor bolts according to the Engineer's directions.

Include assembly instructions and any special tools, blocks, washers, etc. in the portable drive storage case.

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Remove all dirt, stains, marks, etc. prior to erecting the high mast.

1401-4 MEASUREMENT AND PAYMENT

High Mount Standards with lowering devices to be paid for will be the actual number of standards which have been installed and accepted. High mount lighting standards with lowering device, measured as provided above, will be paid for at the contract unit price each for _____ *High Mount Standard* of the appropriate height.

Portable Drive Units with storage cases to be paid for will be the actual number of portable drive units that have been furnished and accepted. Portable drive units with storage case, measured as provided above, will be paid for at the contract unit price each for Portable Drive Unit.

Payment will be made under:

Pay Item	Pay Unit
_____ High Mount Standard	Each
Portable Drive Unit	Each

SECTION 1402 HIGH MOUNT FOUNDATION

1402-1 DESCRIPTION

Construct a concrete foundation for a high mount standard 22.9 m or greater in height, including concrete, reinforcing steel, placing of the anchorage assembly, conduits, forms, shoring, excavation and backfilling.

1402-2 MATERIALS

Use materials which are new and in accordance with Subarticle 1400-4(I).

1402-3 CONSTRUCTION METHODS

Construct foundations in accordance with Subarticle 1400-4(I), and as shown on Roadway Standard Drawing 1402.01. Either the Engineer or the Contractor may choose to construct foundations as specified under Site Specific High Mount Foundation described below. The Standard Drawing is based upon the following assumed soil parameters:

Total Unit Weight	=	120 pcf
Friction Angle	=	30 degrees
Cohesion	=	0 psf

The groundwater elevation is assumed to be at a depth of 2 m below the ground surface and the ground surface is assumed to be level. If the Engineer determines these assumed conditions are not applicable to a specific site, or the Contractor chooses not to use the Standard Drawing, a site specific foundation design is required.

Arrange anchor bolts symmetrically about the center of the foundations, brace securely and hold in the proper position and alignment. Reinforcing steel shall be hooked or bent per ACI code, and tied sufficiently to retain its proper shape during concrete placement. Provide PVC conduits in the foundation concrete as shown on Roadway Standard Drawing 1402.01.

Site Specific High Mount Foundation

If the assumed soil parameters are not applicable to a specific site, the Engineer may require a site specific foundation design. Conditions requiring a site specific design include but are not limited to very soft or loose soil, muck (generally, standard penetration test (SPT) blow counts per 0.3 m less than 4), weathered rock or hard rock (generally, SPT refusal). The Engineer may also require a site specific design if the groundwater elevation is shallower than 2 m or the ground surface is steeper than 2:1 (H:V). If the Engineer requires a site specific design, rough grade the site (within 1 m of

final grade) and ensure accessibility for a drill rig. Notify the Department when the site is accessible. Within four weeks of notification, the Department will perform a subsurface investigation and provide a site specific foundation design. Payment will be made for the actual quantity of concrete required for high mount foundations based upon the site specific foundation design provided by the Department.

In lieu of using Roadway Standard Drawing 1402.01, the Contractor may choose to provide a site specific foundation design. If the Contractor chooses to provide a site specific design, perform a subsurface investigation, and submit the site specific foundation design to the Department for approval, in accordance with the requirements listed below. If the Contractor provides a site specific design, payment will be made for the plan quantity of concrete for high mount foundations shown in the Standard Drawing, and no additional payment will be made for the costs of the subsurface investigation and foundation design.

Subsurface Investigation

Perform a boring at each high mount foundation location and provide boring data on an NCDOT Standard Boring Log form. Download this form from the NCDOT ftp site. A licensed geologist or a professional engineer licensed in the State of North Carolina and employed by an NCDOT Highway Design Branch pre-qualified Geotechnical Engineering Firm shall seal each boring log. Use only an NCDOT Highway Design Branch pre-qualified Geotechnical Engineering Firm to conduct the subsurface investigation. Perform the investigation only after rough grade (within 0.9 m of final grade) is achieved.

Locate the boring within 1 m of the center of the high mount foundation. Drill the boring a minimum of 1.5 m deeper than the foundation depth required by Roadway Standard Drawing 1402.01. Conduct Standard Penetrating Tests at 305 mm, 762 mm, 1.5 m, 2.3 m, 3 m, and every 1.5 m after 3 m below the rough grade, in accordance with ASTM D-1586. A boring may be terminated above the minimum depth required (3 m below the foundation elevation), if one of the following conditions occur: (a) a total of 100 blows have been applied in any 2 consecutive 152 mm intervals; (b) a total of 50 blows have been applied with less than 75 mm penetration.

Foundation Design

Use only an NCDOT Highway Design Branch Pre-Qualified Geotechnical Engineering Firm to provide a site specific foundation design. A North Carolina Licensed Professional Engineer shall seal all design calculations, drawings and recommendations. Submit 8 copies of the subsurface investigation and foundation design to the Engineer for approval and allow 30 days for review.

Design foundations in accordance with the wind zone load shown on the plans. Provide reinforced concrete design in accordance with Section 13.6.2, allowable stress design method, of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals* (including interims).

Consider sloping ground in the design, if applicable. Design the foundations to provide horizontal movements of less than 12.7 mm at the top of the foundation.

Provide a 1 m level work area around each high mount foundation with cut and fill slopes extended to final grades as directed.

1402-4 MEASUREMENT AND PAYMENT

High Mount Foundations will be measured and paid for as the number of cubic meters of concrete necessary to construct foundations in accordance with the dimensions authorized by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
High Mount Foundations	Cubic Meter

**SECTION 1403
HIGH MOUNT LUMINAIRES**

1403-1 DESCRIPTION

Furnish and install luminaires, including lamps and ballasts, for high mount standards 22.9 m and greater in height.

1403-2 MATERIALS

Provide luminaires consisting of a die cast aluminum ballast housing a cast aluminum slipfitter housing, and cover which do not weigh more than 29.5 kg and have an effective projected area not more than 0.19 square meter.

Provide ballast capable of operating a high pressure sodium lamp from a source with a nominal voltage as shown on the plans with a tolerance of $\pm 10\%$. Provide luminaires with IES Distribution: Medium, Cutoff, Type V, and the wattage shown on the plans. Provide glare shields for each luminaire, and position to eliminate spill light outside the right of way. NCDOT will evaluate photometric data for submitted luminaire to ensure adequate light output from the fixture.

Provide slipfitter housing suitable for use with 50 mm horizontal mounting, adjustable for leveling, and which secures the mounting assembly to prevent twisting of the luminaire about the bracket.

Use an optical assembly which contains a porcelain enclosed mogul socket with spring loaded center contact and lamp grips and has an insulated outboard lamp grip to protect the lamp from damage due to vibration. Position the socket for base up lamps.

Provide complete photometric, assembly and electrical data for each type luminaire proposed. Include in the data candlepower distribution and isofotcandle graphs, assembly drawings with replacement part numbers, and electrical schematic with ballast input/output voltage/ampereage/wattage ratings.

1403-3 CONSTRUCTION METHODS

Lamp all high mount fixtures just prior to testing the system. Mark the date of installation with the code on the base of each lamp.

Level and secure each luminaire in all directions. Careful attention should be given to aim the main beams and house-side outputs of all asymmetrical units in the direction indicated on the plans. Securely terminate the wiring for each luminaire and include an equipment grounding conductor to bond the housing to the supply cord grounding conductor.

1403-4 MEASUREMENT AND PAYMENT

High Mount Luminaires ___ of the appropriate wattage and type will be measured and paid for as the actual number of luminaires of each size and type that have been installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
High Mount Luminaires _____	Each

SECTION 1404 LIGHT STANDARDS

1404-1 DESCRIPTION

Furnish and install light standards less than 22.9 m high complete with bracket arm(s), including the impact attenuation device (breakaway base) as shown on the plans.

1404-2 MATERIALS

Provide a standard that meets the design criteria of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, and the Interim Specifications valid at the time of letting. The support is to be designed for the wind velocity shown on the plans.

Provide a standard designed to support an ellipsoidal shaped luminaire, which has a center of gravity not more than 457.2 mm from the end of the support, with a minimum weight and projected area and a bracket arm length as indicated in the contract.

Make sure that each lighting standard has a grounding lug in the standard near the base or in the transformer base. Locate it within 152.4 mm of the hand hole.

Deliver standards with a smooth uniform finish, free of disfiguring scratches or dents, and with suitable protection for further handling during erection.

Wrap or package each light standard as recommended by the manufacturer to prevent damage during shipping and handling. Repair or replace, at the option of the Engineer, any standards with abraded finishes or other damage.

Furnish aluminum or steel standards and arms; however, use the elected material throughout the project.

Galvanize steel components after fabrication. Use galvanization which conforms to the requirements of ASTM A123 for tubes, plates, and bars, and to ASTM A153 for hardware.

Use connecting bolts, washers and nuts compatible with the transformer base as recommended by the light standard manufacturer and which comply with the contract.

Use anchor bolts, washers, nuts and shims which comply with the Specifications and details shown in the plans as recommended by the light standard and transformer base manufacturer(s).

Furnish anchor and/or connecting bolt covers and pole top caps with standards as indicated on the plans.

Provide pole hardware - Nuts, bolts, and washers for aluminum standards from 18-8 stainless steel or aluminum alloy 2024-T4. Provide nuts, bolts, and washers for steel standards from 18-8 stainless steel or steel conforming to ASTM A307. Submit drawings for approval, which show material specifications for each component.

Use bracket arms for each standard, which are the length shown on the plan sheet and of the same material as the standard.

Provide light standards with an approved impact attenuation feature (breakaway base) that complies with *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and one of the following descriptions.

- (A) A cast aluminum transformer base
- (B) A frangible base insert or adapter
- (C) A breakaway or progressive shear base
- (D) A slip base

Use the same type of breakaway device throughout the entire project. All breakaway devices shall be FHWA approved. Include in the device protection for wiring and conduit at the base of the standard, in the form of a special heavy-formed material secured in place.

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1404-3 CONSTRUCTION METHODS

Locate and number the light standards as shown on the plans.

Do not lay the standards on the ground, without proper blocking and protection to prevent warping and discoloration. Protect them from damage by other construction work, including landscape mulching and fertilizing operations.

Securely mount the standards on the anchor bolts, and plumb up with nuts torqued according to the manufacturer's recommendation.

Mounting height is defined as vertical distance from luminaire to surface of pavement of heaviest traveled lane in area illuminated by the luminaire. A tolerance of ± 457 mm from the required mounting height will be permitted. If this tolerance is exceeded, furnish and install an acceptable standard within this tolerance.

1404-4 MEASUREMENT AND PAYMENT

Light Standards, ___ will be measured and paid for as be the actual number of light standards with arm assemblies of each appropriate mounting height and bracket arm type and length that have been installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Light Standards, _____	Each

**SECTION 1405
STANDARD FOUNDATION**

1405-1 DESCRIPTION

Furnish and install all materials necessary to construct concrete foundations for light standards, including concrete, reinforcing steel, anchor bolts, nuts, forms, excavation, and backfilling.

1405-2 MATERIALS

Use new materials that are in accordance with Subarticle 1400-4(I).

1405-3 CONSTRUCTION METHODS

The foundation design shown on the plans is based upon placing foundations into undisturbed soil or fill of at least medium density. The Engineer will stake each location and determine the top of foundation elevation unless indicated differently elsewhere in the Specifications. The foundation type and depth will be determined by the plan details in accordance with the final soil and slope conditions at each location.

Pour the pedestal portion concrete monolithic with the barrier portion, on light standard foundations that are an integral part of a barrier. Construct the barrier portion as specified in other sections of the contract, and continuous through the foundation. Coordinate construction of foundations in median barrier with the signing plans to avoid conflict with overhead sign structure foundations.

Where rock creates a conflict with construction of the standard foundations, an alternate foundation may be constructed if approved.

1405-4 MEASUREMENT AND PAYMENT

Standard Foundation ___ will be measured and paid for as the actual number of foundations for each appropriate height and type of standard, that have been completed and accepted.

The quantity of bedrock foundations to be paid for will be the actual number of alternate foundations for bedrock locations for standards of the appropriate type, which have been installed and accepted.

Alternate foundations for rock locations will be paid for at 1.5 times the contract unit price each for Standard Foundations, _____ of the appropriate type that would have been installed if rock had not been encountered.

The requirements of Article 104-5, which pertain to adjustments in contract unit prices for overrunning or underrunning pay items, will not be applicable to pay items covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Standard Foundation _____	Each

SECTION 1406

LIGHT STANDARD LUMINAIRES

1406-1 DESCRIPTION

Furnish, install, and place into satisfactory operation, luminaires on the bracket arm complete with all lamps, ballasts, wiring inside standard from circuit conductors to luminaire, in-line breakaway fuses and ground wiring at the pole on light standards less than 22.9 mm in height.

1406-2 MATERIALS

Use luminaires that are ellipsoidal shaped with a center of gravity not more than 457 mm from the end of the luminaire support, do not weigh more than 24.9 kg, and have a maximum effective projected area of 0.11 square m.

Use luminaires that are UL listed and labeled.

Use luminaires that have a lens holder latch on the street side and ballast, plug-in starter, and capacitors mounted on a removable door. The removable door shall have a continuous hinge bar to prevent door opening due to vibration. The luminaire shall have a slipfitter for 2 mounting brackets, with a stainless steel shield ring, a 4-bolt adjustable pipe clamp and leveling steps for tilt adjustment. Use luminaires with a replaceable mogul base lamp socket adjustable in both vertical and horizontal directions, capable of producing the specified IES distribution pattern. Third party certification for photometric data shall be provided upon request. Provide a heat resistant tempered flat glass lens, and a reflector with a hard glasslike highly reflective corrosion resistant finish. Provide a filter between the lens and reflector tub.

Use luminaires that have an internal high power factor ballast of the regulated type, capable of operating from a multi-wire circuit and energize a high intensity discharge lamp. The luminaire shall have a barrier between the ballast compartment and the reflector tub. Transformer windings shall be covered and protected. Lamps shall operate satisfactorily with a line voltage variation of $\pm 10\%$. Provide a ballast pre-wired to the lamp socket and terminal board, requiring only the connection of the power supply leads to the terminal board.

Use luminaires with a wattage rating, voltage rating, lamp type, and light distribution as indicated on the plans.

1406-3 CONSTRUCTION METHODS

Date lamps using the date code on the base and install just prior to the system being ready for testing.

Level luminaires using leveling pads on the luminaire enclosure. Adjust any luminaires, as directed, to give optimum illumination distribution.

1406-4 MEASUREMENT AND PAYMENT

Light Standard Luminaires ___ will be measured and paid for as the actual number of luminaires of each appropriate size and style that have been installed and accepted.

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Payment will be made under:

Pay Item	Pay Unit
Light Standard Luminaires _____	Each

**SECTION 1407
ELECTRIC SERVICE POLE AND LATERAL**

1407-1 DESCRIPTION

Furnish and install wood service poles, wire, conduit, bushings, fittings, connectors, meter base, and weatherhead from the service point to a control system.

1407-2 MATERIALS

Provide service poles which are Class 4 and in accordance with Subarticle 1082-3(F). Provide poles with preservative treatment in accordance with Subarticle 1082-4(G).

Use stranded copper Type USE conductors installed in rigid galvanized steel conduit sized as shown on the plans for the service lateral.

1407-3 CONSTRUCTION METHODS

Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 152.4 mm maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.

Set the pole to a depth of 1.7 m minimum unless shown otherwise on the plans. When utility power is available from outside the right-of way, locate the service pole a maximum of 3 meters inside the right-of-way. The utility company will install overhead conductors from their facilities. Install an underground service lateral from the service pole to the control system. If the utility company provides a pad mount transformer, allows attachment of the riser and weatherhead to their pole, or provides underground service from their pole, then any proposed service pole will be deleted from the contract.

Make connections at the service head at the bottom of the drip loop to prevent siphoning of water through the cable.

Provide for a meter in accordance with the requirements of the utility company's condition of service.

A meter base for a self-contained meter may be mounted on the service pole or back of the control enclosure as indicated on the plans. A current transformer (CT) cabinet and meter base may be mounted in either location if requested by the utility company.

1407-4 MEASUREMENT AND PAYMENT

Electric Service Pole ____ will be measured and paid for as the actual number of the appropriate length and class electric service poles that have been installed and accepted.

Electric Service Lateral ____ from service pole to control panel will be measured and paid for as the actual number of linear meters of the appropriate size and type service lateral that has been installed and accepted. Measurement will be along the longest conductor from electrical terminal to electrical terminal.

Payment will be made under:

Pay Item	Pay Unit
Electric Service Pole _____	Each
Electric Service Lateral _____	Linear Meter

SECTION 1408 LIGHT CONTROL SYSTEM

1408-1 DESCRIPTION

Furnish and install an entire control system, including enclosure, control panel, photocell, switches, contactors, breakers, terminal blocks, wiring, concrete foundation, and lightning arrester. The control system will be standard electrical components in a stainless steel enclosure mounted on a metal pole with a concrete foundation as shown in the contract.

1408-2 MATERIALS

Provide concrete foundations and wire in accordance with the applicable Sections of the Specifications.

Use a piece of rigid galvanized steel conduit, embedded in concrete as shown on the plans for mounting the control system

Provide a NEMA type 3R stainless steel enclosure with external stainless mounting flanges, drip shield, back panel and continuous hinge door with a print pocket. Provide a door closing mechanism interlocked with a flange mounted operator handle to prevent the opening of the door with the service circuit breaker in the ON position, except by use of safety override devices.

Provide an enclosure approximately 914 mm high by 762 mm wide by 254 mm deep unless noted otherwise on the plans.

Provide only openings necessary for the entrance of conduits as shown on the plans. Do not use knockouts. Have the enclosure conform with *NEC* Article 312 and mount the devices so the *NEC* clearances will be provided, except use 38.1 mm where not specified is noted in the tables for min. wire bending space.

Use galvanized slotted steel framing channel with straps and bolts, sized as shown on the plans for the mounting brackets and hardware for attaching the enclosure to the pole. Use galvanized finish on the brackets and hardware and coat all field cuts or scratches with organic zinc repair paint.

Provide a neutral bar, bonded to the panel and with sufficient box lug type terminals to accept the required number of wires.

Mount components to the back panel with manufacturer supplied mounting brackets or permanently attached screw studs.

Use a service circuit breaker providing an interrupting rating of 22,000 amperes minimum. Provide breakers which are thermal magnetic molded case permanent trip type. Provide multi-tap solderless load side box lugs, or distribution terminal blocks of the appropriate size. Use insulating material approved for NEMA 3R applications. Provide a breaker with a voltage and amperage rating as indicated on the plans.

Provide a control circuit breaker which is rated 240 VAC phase to ground, has a current interrupting capacity of 5000 amps minimum, and is a single pole, open type with a high magnetic trip setting of 20 amps.

Provide 3, 60 ampere, 4 pole, mechanically held contactors that have coil clearing contacts and coil voltage rating as indicated on the plans. Contactor latching with hooks or semi-permanent magnets is unacceptable.

Use a control relay rated 240 VAC with one normally open contact and one normally closed contact and has a continuous load rating and inductive make rating greater than that required by the mechanically held contactor. Use a coil rated for 240 VAC 60 Hz.

Use a selector switch which is a heavy duty 3 position maintained contact unit in a surface mount (NEMA 1) enclosure with a legend consisting of On-Off-Auto and having continuous current rating of 10 amperes at 240 VAC for the contacts.

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Use feeder circuit breakers which are rated 14,000 amps minimum interrupting capacity and have an open type molded case with a non-adjustable thermal magnetic trip setting of 50 amps maximum, and as noted in the plans.

Use a photo-control which is the encapsulated cadmium-sulfide type, suitable for use on an operating voltage range of 105-285 volts and nominal control voltages of 120, 208, 240, and 277 volts. Have the control rated for 1000 watts resistive load or 1800 volt-amperes of inductive load. Set the light-level within a range of 1.0 to 3.0 footcandles. Have internal protection for surges in excess of 2000 volts peak for the control. Mount a receptacle directly to the top of the enclosure with a weatherproof fitting. Use controls and receptacles which conform to IEEE Standard C136.10-1996, *Locking-type photocontrol devices and mating receptacles-physical and electrical interchangeability and testing* for roadway lighting equipment.

Use a lightning arrester of the thyrite type, designed to contain and snuff out an arc of 10,000 amps. Install the arrester on the load side of the service breaker.

Use terminals and lugs rated for the connection of the appropriate size copper conductors. All conductors shall be made of copper and neatly wrapped in bundles or run in plastic raceways.

Perform all galvanizing in accordance with Section 1076.

Provide a drawing to scale showing the location, brand and catalog number of each component of the control system for approval.

The completed light control system shall be marked "Suitable for Use as Service Equipment", in a prominent location in the enclosure, in accordance with NEC Article 230.66. If the control system is not made in a certified UL 508 Panel Shop, a third party, recognized by the Department of Insurance as having the authority, shall label the control systems.

1408-3 CONSTRUCTION METHODS

Construct the foundation for the control system as shown on the plans with the top of the foundation 76.2 mm above finished grade.

Fasten the enclosure to the pole by means of a galvanized bracket assembly as shown on the plans. Make all cuts square and remove all rough edges. Have mounting holes match existing mounting holes of the enclosure.

Arrange all conduits entering the enclosure in a neat symmetrical manner and extend directly downward into the foundation. Install all conduits shown on the plans. Stub and cap spare conduits for future circuits underground.

Apply 2 coats of organic zinc repair paint to all field cut metal and conduit threads.

1408-4 MEASUREMENT AND PAYMENT

Light Control Equipment (Type) will be measured and paid as the actual number of the appropriate type light control systems that have been completed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Light Control Equipment (Type) _____	Each

SECTION 1409 ELECTRICAL DUCT

1409-1 DESCRIPTION

Furnish and install electrical duct including materials, equipment, and labor for trenching, backfilling, and jacking or boring so that electrical circuits may be easily installed at locations shown on the plans.

1409-2 MATERIALS

Use electrical duct that is non-metallic rigid PVC (Polyvinyl Chloride) heavy wall conduit, HDPE (High Density Polyethylene) Standard Dimension Ratio (SDR) 13.6 or rigid galvanized steel conduit, in accordance with Section 1098-4.

1409-3 CONSTRUCTION METHODS

Duct is a passageway for electrical circuits. Install ducts in accordance with NEC requirements for an approved raceway. Locate the duct as shown on the plans and at a minimum depth of 762 mm unless indicated otherwise on the plans. Locate bore pits outside the clear zone, as defined in the *AASHTO Roadside Design Guide*.

The lengths noted on the plans are only typical. Make actual field measurements to place the ends of the duct at the required locations. Make up lengths of duct with the minimum number of pieces joined together with couplings and solvent as recommended by the manufacturer.

Clean and plug the duct in accordance with Subarticle 1400-4(E).

Plug the duct with oakum or duct seal after feeder circuits in conduit are extended through duct.

Place buried duct in a trench with essentially vertical walls and only wide enough for easy installation of the duct. Tunneling by hand or other approved methods may be required to install duct beneath existing walks or paved ditches. Perform backfilling in accordance with Article 300-7.

Jacked duct may be installed by either of the following methods at the Contractor's option, when placement of electrical duct beneath pavement by jacking is noted on the plans.

- (A) The duct may be pushed beneath the pavement through earth without prior construction of an opening.
- (B) A bored opening not more than 25.4 mm larger than the outside diameter of the duct may be made by augering and the duct inserted.
- (C) A drilled opening not more than 25.4 mm larger than the outside diameter of the duct may be made with a pneumatic vibrating machine and the duct inserted.
- (D) HDPE conduit may be installed in accordance with Subarticle 1715-3(D).

Do not install non-metallic conduit by jacking method (A) as listed above.

If installation of a duct is begun and not completed, plug any opening as directed. Installation of duct by water jetting will not be acceptable.

At locations where it is indicated on the plans that the duct is to be connected to boxes, foundations, or other raceways, install in accordance with Subarticle 1400-4(E) Conduit Installation to provide an approved raceway as specified by the NEC.

1409-4 MEASUREMENT AND PAYMENT

Electrical Duct (Size and Type) will be measured and paid as the actual number of linear meters of duct, measured in place to the nearest whole meter, that has been installed and accepted.

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Payment will be made under:

Pay Item	Pay Unit
Electrical Duct, (Size & Type) _____	Linear Meter

**SECTION 1410
FEEDER CIRCUITS**

1410-1 DESCRIPTION

Furnish and install all conductors and conduit, including tools, equipment, trenching, and backfilling to provide electrical circuits at locations shown on the plans.

1410-2 MATERIALS

Use load current carrying conductors which are UL Type USE, except that UL Type UF may be used for sizes 8 AWG and smaller. The equipment grounding conductor may be bare or insulated. Use conductors which are copper and in accordance with Subarticle 1400-2(C). For feeder circuits size 10 AWG, a cable assembly UL Type UF with the proper number of conductors may be used in lieu of individual conductors. Give careful attention to the required color code. Do not mark a white conductor in a cable assembly any other color; however, it may be stripped at all accessible points and used as a bare equipment grounding conductor.

Provide metallic (rigid galvanized steel) and non-metallic (polyvinyl chloride or high density polyethylene) conduit in accordance with the Subarticle 1400-2(B) Conduit with the appropriate type being used at locations as shown on the plans.

1410-3 CONSTRUCTION METHODS

Install feeder circuits in continuous runs, without splices, except at junction boxes or within light standard bases.

Install conductors in accordance with the Subarticle 1400-4(F) and conduit in accordance with the Subarticle 1400-4(E).

Excavate trenches to depths and widths as shown on the plans with essentially vertical walls and as straight as possible, when underground feeder circuits are required. Locate underground feeder circuits a minimum of 1.8 m back of the face of curb or outside the limits of the paved shoulder and stone base, as directed. Use care to prevent conflict with existing or future guardrails, sign posts, delineators, and similar devices.

Surround the underground feeder circuit in conduit with clean soil and use backfill free of rocks and other objectionable materials which might damage the conduit. This will require partial backfilling by hand in areas where it is likely that objectionable materials will be included if mechanical methods of backfilling are used.

Perform all necessary search methods, including but not limited to use of underground metal detection equipment and excavation equipment, to locate existing electrical duct. Locate the duct and perform all necessary work including cleaning of the duct before installation of proposed circuits.

When a feeder circuit in conduit passes through electrical duct, make the conduit continuous through the duct unless specifically noted otherwise on the plans. After feeder circuits in conduit are extended through duct, plug the duct with oakum or duct seal.

When only feeder circuits are required, install the load current carrying conductors and grounding conductors in either existing conduit or conduit installed under other contract items.

When more than one circuit is installed in a single raceway, a single equipment grounding conductor sized as required for the largest circuit may be used without change in the contract unit bid prices.

Multiple circuits may be placed in the same trench if they are grouped and separated a minimum distance of 76.2 mm. When more than one circuit is installed in the same trench there will not be any adjustment of the contract unit bid prices.

1410-4 MEASUREMENT AND PAYMENT

___ *Feeder Circuits* will be measured and paid for as the actual number of linear meters of each size and type feeder circuit that has been completed and accepted. Measurement will be to the nearest whole meter from electrical terminal to electrical terminal of the longest load current carrying conductor.

___ *Feeder Circuit in ___ Conduit* will be measured and paid for as the actual number of linear meters of each size and type feeder circuit that has been completed and accepted. Measurement will be to the nearest whole meter from electrical terminal to electrical terminal of the longest load current carrying conductor.

Payment will be made under:

Pay Item	Pay Unit
___ Feeder Circuit	Linear Meter
___ Feeder Circuit in ___ Conduit	Linear Meter

SECTION 1411 ELECTRICAL JUNCTION BOXES

1411-1 DESCRIPTION

Provide junction boxes made from fiberglass reinforced polymer concrete and cast-metal boxes encased in concrete of the appropriate type at locations noted on the plans, complete with all necessary covers, conduits, duct, and hardware, in accordance with the contract.

1411-2 MATERIALS

Use polymer concrete (PC) boxes which are stackable, and have bolted covers and are sized as shown in the plans.

Use polymer concrete material made of an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. Use material with the following minimum mechanical strength properties: 75.8 MPa compressive, 11.7 MPa tensile, 51.7 MPa flexural.

Have the material meet minimum acceptance criteria for: chemical resistance, accelerated service exposure, simulated sunlight exposure, water absorption, flexural properties, and flammability in accordance with ASTM D-543, D-756, D-1501, D-560, D-790, and D-635 respectively.

Provide light vehicular traffic design and base it on a 22.2 kN load over a 254 mm x 254 mm area.

Provide a bottom box which is open footed unless specifically noted as closed bottom on the plans.

Provide a standard Electric logo on the cover unless specifically noted otherwise on the plans. Provide a minimum of 2 size 10 mm hex head stainless steel cover bolts and inserts.

Backfill beneath and around the boxes using ABC in conformance with Section 1005.

Use ground rods that are 15.9 mm in diameter, 2.4 m long solid steel core with copper jacket. Provide a ground rod clamp made of one-piece bronze with a hex head screw. Both the rod and clamp shall conform to *UL Standard 467 Electrical Grounding and Bonding Equipment*.

Provide cast-metal (BR) box, replaceable frame, and cover that are hot dipped galvanized with factory or field drilled conduit entrances. Provide a cover with checkered imprint, pry bar slots, and reinforcing ribs for heavy loading, neoprene gasket,

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and brass or stainless steel bolts. Provide a blind tapped (6.4 mm NC thread minimum) boss on interior of box for grounding.

1411-3 CONSTRUCTION METHODS

Install conduits and duct before the polymer concrete (PC) boxes are set in place. Do not rest the bottom of the box directly on conduits, ducts or cables.

Place the top of the box on the same grade as the surrounding area except raise it 76.2 mm minimum to allow the backfill material to be sloped to prevent surface drainage from entering the box. Perform backfilling with sufficient care that no part of the junction box, conduit or duct is displaced or moved out of alignment. Place backfill material in 152.4 mm layers and compact to a density comparable to the adjacent undisturbed material.

Locate junction boxes for best routing of conduit and duct, and to minimize drainage problems. Do not locate boxes in useable shoulders or pavements or other areas where they may be subjected to traffic loadings.

Install a ground rod as indicated on the plans with bonding jumpers, etc. as required. Stub the ends of conduit and duct up vertical as near the top of the box as practical and seal. Arrange wiring so that it will not lay in the bottom of the box.

Place sealant between the cover and box to prevent surface drainage from entering the top of the box.

Install cast-metal (BR) boxes and arrange conduits and ducts to best fit field conditions. Place boxes, conduit, and ducts as the work is built up, thoroughly bonded and accurately spaced and aligned. Place boxes with covers flush with surface of concrete (generally traffic side of median barrier).

Place mastic between the cast metal box frame and the cast concrete barrier, as shown on plans to allow easy replacement of the frame.

1411-4 MEASUREMENT AND PAYMENT

Electrical Junction Boxes ____ will be measured and paid for as the actual number of the appropriate type and size junction boxes that have been installed and accepted. Payment for the conduit, duct and wiring will be paid for under other contract items. Ground rods, clamps and bonding jumpers are incidental to the junction boxes.

Payment will be made under:

Pay Item	Pay Unit
Electrical Junction Boxes _____	Each

SECTION 1412 UNDERPASS LIGHTING

1412-1 DESCRIPTION

Furnish and install wall mounted and/or pendant mounted luminaires with electrical circuitry, for underpass lighting at locations shown on the plans. Work includes but is not limited to furnishing and installing underpass luminaires with lamp, ballast, and mounting hardware as well as furnishing and installing circuit breakers and enclosure, pull boxes, conduit, conductors, expansion fittings, anchors, straps, and ground rod.

1412-2 MATERIALS

Use luminaires that are listed as Suitable for Wet Locations according to UL Standard #1572, with sealed and filtered optical assemblies. Use high power factor ballasts that are completely pre-wired integral units, for reliable starting and operating of high pressure sodium lamps at -40°C ambient temperature. Use heavy-duty mogul base lamp sockets, with split shell tempered brass lamp grips and a free-floating, spring-loaded center contact. Use the luminaire type, wattage, voltage and IES illumination distribution pattern as shown on the plans.

Provide type WM luminaires that are wall mounted, with cast aluminum housing painted with premium quality gray or dark bronze paint. Provide a prewired ballast and terminal board assembly, and cast aluminum side-hinged door with glass refractor. Use the same color WM luminaires throughout the project. Provide factory installed mounting holes in the back, and conduit entrances in the sides and top. Provide a formed aluminum reflector and socket assembly, with a chemically bonded lightweight non-breakable glass finish, which is removable with only a screwdriver.

Provide type PM luminaires that are a pendant mounted assembly of ballast, optical and mounting components, including a safety chain and hanging hardware. Provide a die-cast aluminum ballast housing with gray paint finish, with a prewired ballast assembly and an external quick electrical disconnect receptacle for attachment of hanging hardware. Provide a faceted aluminum reflector with an Alzak (proprietary term of Aluminum Company of America) finish, and a lightly diffused refractor made of UV stabilized, injection molded, prismatic, heat-resistant, acrylic. Provide hinges and stainless steel, over-center, vibration-resistant spring latches for easy access to the lamp, and clamping of the gasket between the refractor and ballast housing.

Use a 19.1 mm rigid galvanized steel conduit with a hook and power cord entrance as the pendant. Provide a 3-conductor type SO power cord and a 19.1 mm female threaded wiring compartment with quick electrical disconnects, to attach the ballast housing to the pendant as shown in the plans.

Use galvanized weldless forged steel eye-nuts that comply with Federal Specification WW-H-171E (Type 17), or Manufacturers Standardization Society SP-69 (Type 17). Attach eye-nuts to galvanized steel or stainless steel threaded rod that has been anchored to the bridge deck with adhesive anchors. Use galvanized steel or stainless steel safety chain, S hooks and lock nuts.

Use conduit and wire in accordance with Article 1400-2, and gasketed PVC junction boxes as shown in the plans.

Use a 2-pole, 480 VAC, 20 AMP circuit breaker, installed in a NEMA 3R enclosure that has been primed and painted with a premium grade exterior paint before installation, to increase corrosion resistance. Install an equipment ground bar, and provide a lock in accordance with Article 1400-8.

1412-3 CONSTRUCTION METHODS

Mount luminaires as shown in the plans. Use galvanized steel or stainless steel clamps and attachment hardware.

Install circuitry in accordance with the requirements of Article 1400-4, titled Wiring Methods and Conduit Installation.

1412-4 MEASUREMENT AND PAYMENT

Underpass Luminaires ____ will be measured and paid for as the actual number that have been installed and accepted.

Underpass Circuitry will be paid for at the contract lump sum price for Underpass Circuitry at ____ at the appropriate location.

Payment will be made under:

Pay Item	Pay Unit
Underpass Luminaires _____	Each
Underpass Circuitry at _____	Lump Sum

**SECTION 1413
PORTABLE CONSTRUCTION LIGHTING**

1413-1 DESCRIPTION

Furnish, operate and maintain everything necessary to provide lighting for compliance with Article 105-14 Night Work requirement for artificial lighting.

1413-2 MATERIALS

Furnish all lighting equipment as required and retain after the work is completed. Material and/or equipment is not required to be new but shall be in good operating condition and in compliance with applicable safety and design codes.

Submit, for the review and approval catalog cuts giving the specific brand names, model numbers and ratings of the lighting equipment. Include in the submittals power ratings and photometric data. Allow 40 days for review of the submittals. Do not begin night work without approval of the equipment and/or materials.

1413-3 TOWER LIGHT

Use tower lights which consist of mercury vapor, metal halide, high pressure sodium or low pressure sodium fixtures mounted on a tower approximately 9.1 m in height. Use tower light fixtures which are heavy duty flood, area, or roadway style with wide beam spread, have an output of 50,000 lumens minimum, have the combined outputs of all fixtures on each tower light not exceed 460,000 lumens, and are weatherproof and supplied with attached waterproof power cord and plug. Use a sturdy tower which is freestanding without the aid of guy wires or bracing. Provide sufficient capacity in the power supply to operate the light(s) and locate it for the shortest safe routing of cables to the fixtures. A tower light consisting of the combined fixture(s), tower and power supply is preferred.

Provide tower lights of sufficient wattage and/or quantity to provide an average maintained horizontal illuminance greater than 20 footcandles over the work area.

Aim and position the lights to illuminate the area for construction work. Make sure that there is not any disabling glare to the motorist. In no case should the main beam of the light be aimed higher than 60° above straight down. The lights should be set as far from traffic as practical and aimed in the direction of, or normal to, the traffic flow.

1413-4 MACHINE LIGHTS

Use machine lights which have mercury vapor, metal halide, high pressure sodium or low pressure sodium conventional roadway enclosed fixtures mounted on supports attached to the construction machine at a height of approximately 4 m. Use fixtures for machine lights which have light output between 22,000 and 50,000 lumens. Use a power supply with sufficient capacity to operate the light(s) and securely mount on the machine. Perform electrical grounding of generators to frames of machines on which they are mounted in conformance with the National Electrical Code (NEC).

Use machine light fixtures with sufficient wattage and/or quantity to provide an average maintained horizontal illuminance greater than 10 footcandles on the machine and the surrounding work area. Machine lights are in addition to conventional automotive type headlights which are necessary for maneuverability.

1413-5 CONSTRUCTION METHODS

Use tower lights when the night work is confined to a fairly small area and is essentially a stationary operation. Space tower lights no closer than 30 m apart and no further than 92 m apart. Actual spacing will be determined by approved equipment. At any spacing, the required 20 footcandles of light will be the determining factor.

Use machine lights when the night work is not confined to a small area and is essentially a continuous moving construction operation.

Tower lights may be provided in lieu of machine lights upon approval by the Engineer. Use of tower lights in lieu of machine lights will be considered when the number of machines, type of work, or need for inspection justify their use as decided by the Engineer.

Illuminate the work area where traffic control devices are being set up or repositioned at night.

The work areas to be illuminated are the areas where construction equipment and labor are in operation and may be different from the work areas shown in the plans.

Illuminate a large enough work area so that the movements of all personnel and equipment engaged in the work will be contained in the area.

Provide sufficient fuel, spare lamps, generators, and personnel qualified to operate the lights to assure that they will be maintained in operation during night work.

Existing streetlights do not eliminate the requirement for the Contractor to provide lighting. Consideration may be given to the amount of illumination provided by existing lights in determining the wattage and/or quantity of lights to be provided.

1413-6 MEASUREMENT AND PAYMENT

Portable Lighting provided by tower and machine lights will be made only when a significant amount of nighttime work is explicitly required and a pay item for portable lighting has been included in the contract. Otherwise, portable construction lighting will be considered incidental to other contract items and no direct payment will be made.

The aggregate amount to be paid on each partial payment estimate will be equal to the percentage that the item of Portable Lighting is complete as estimated by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Portable Lighting	Lump Sum