Section 819. ELECTRICAL AND LIGHTING

819.01 Description. The Contractor shall furnish all materials and perform all work necessary to provide for complete operating electrical and lighting units and the removal and either salvage or disposal of existing electrical and lighting components. Unless otherwise specified, excavation, granular material, backfill, disposal of waste excavated material, together with (in kind) replacement associated hardware, and No. 8 pole wire extending from the fusing at the base of the pole to the luminaire will be included. Two wires shall be extended for each luminaire.

819.02 Materials. Materials shall meet the following requirements.

A. **Conduit.**

1. **Direct Burial Application.** Direct burial conduit shall be smooth surface. The diameter will be as shown on the plans. Conduit for direct burial applications may be one of the following (use schedule 80 for traffic signal work).

   Galvanized steel conduit

   Smooth-wall, schedule 40 rigid (PVC)

   Smooth-wall, schedule 80 rigid (PVC)

   Smooth-wall, coilable, schedule 40 (PE)

   Smooth-wall, coilable, schedule 80 (PE)

   Rigid fiberglass

2. **Jacking and Boring Application.** Conduit used for jacking and boring shall be schedule 80 (PVC) and the diameter shown on the plans.

3. **Encased Conduit Applications.** Conduit used for encased conduit applications shall be of the schedule 40 and the diameter shown on the plans. Concrete shall be Grade P2 and meet section 601.

4. **Conduit on Structure Application.** Conduit installed on structures shall be schedule 80 (PVC) and the diameter shown on the plans.

5. **Directional Boring Application.** Conduit used for directional boring shall be schedule 80 coilable (PE) and the diameter shown on the plans.

B. **Cable.** Direct burial cable shall be Type USE, single conductor, insulated, jacketed and rated for 600 volts. The cable shall be UL listed for direct burial use and be rated 194 °F dry and 167 °F wet. Conductors in conduit shall be single conductor, XLP insulated rated USE and RHW for 600 volts.

819.03 Construction.

A. **Conduit.** This work consists of the installation of a specified conduit for direct and encased burial; jacking and boring; directional boring; and installation on structures. Conduit runs shall be built in as straight a line as possible. Where sweeps are necessary, the radius of the sweep shall be as great as practical. Lengths of conduit shall be joined per current NEC methods. Where the method is not clearly described in the NEC, the Contractor shall install the conduits according to the manufacturer's recommendation. The Engineer shall approve the method of installation prior to beginning work.

1. **Bends.** Unless otherwise specified on the plans, the radii of conduit bends shall conform to the current NEC requirements.

2. **Excavation.** The conduit trench shall be excavated to a depth sufficient to provide a minimum earth cover of 30 inches over the finished conduit.

3. **Drainage.** The trench shall be graded to handhole location, so that the finished conduit runs will drain into a handhole.

4. **Grades.** Conduit grades shall be staked at 50-foot intervals or less. Grade shall have a fall to the lowest manhole or handhole or from the middle toward both holes, of not less than 4 inches over 100 feet.

5. **Backfill.** In all conduit installations, backfill below the conduit shall be granular material Class II, tamped in place. The remaining backfill for trenches outside the roadbed shall be the excavated material unless the Engineer determines it is unsuitable for backfill. If unsuitable, the trenches shall be backfilled entirely with granular material Class II. Backfill for trenches within the limits of the roadbed shall be granular material Class II and shall be placed according to subsection 402.03.D.

6. **Supports.** When holes are built over existing duct runs, adequate support shall be provided for the conduit running through the holes. Where ducts are built into an existing hole, a 4-inch tapered pocket, exactly the same as that shown for new holes, shall be built into the wall. Where new service ducts are built into existing holes, they shall not interfere with proper cable racking. The Contractor shall install specified inserts.

7. **Clearances.** No conduit or concrete encasement shall be in contact with any obstruction. A vertical clearance of 9 inches shall be provided, except that conduits parallel to water lines, gas mains, and other underground structures not associated with the electrical system shall be separated by not less than 12 inches. If these clearances cannot be provided, the Engineer and the owning agency shall determine a proper method of protection.

8. **Clearing.** After the conduit runs are installed, the Contractor shall pull a mandrel 12 inches long (shorter in conduit runs with bends) and ½ inch smaller in diameter than the conduit and a suitable swab or cleaning device designed to clear the conduit of small pebbles, etc. The Contractor shall notify the Engineer prior to performing this phase of work so that work may be observed.

9. **Encased Conduit.** Conduit runs shall be encased in Grade P2 concrete. Adjacent conduits shall be spaced a minimum of one inch from each other and the space filled completely with concrete. There shall be a minimum of 3 inches of concrete on the top, bottom, and side of the conduit encasement. Where steel reinforcement is required the reinforcing bars shall be separated from the conduits by 2 inches of concrete, and there shall be a minimum of 3 inches of concrete between the reinforcing bars and the outer surface of the encasement. Conduit joints shall be staggered vertically. Separators, spacers, blocks, or supports to be left in the finished concrete structure shall be composed of concrete, plastic, or bituminized fiber.

   A bank of encased conduits may be constructed in either of two ways:

   a. **Tier by Tier Method.** A foundation of concrete at least 3 inches thick is first placed on the bottom of the trench after it has been graded. Where steel reinforcement is required, the concrete thickness shall be at least 5 inches with reinforcing bars in place. On this concrete base the bottom tier of conduits are laid, separated from each other by suitable spacers. The space between conduits of this first tier shall then be filled with concrete and the conduits covered to the height of the next succeeding conduit tier. Succeeding tiers shall be constructed in a similar manner. Work shall proceed as a continuous operation with no interruptions in excess of 45 minutes between the placing of successive layers of concrete.

   b. **Build-Up or Monolithic Methods.** Masonry supports at intervals of 3 feet to 5 feet, or a foundation of concrete at least 3 inches thick, shall be first placed in the bottom of the trench after it has been graded. Where steel reinforcement is required, the thickness of the concrete foundation shall be at least 5 inches with the reinforcement bars in place. All the conduits shall then be placed, using plastic or concrete separators, to erect a rigid, self-supporting structure of conduits in position before the concrete is placed. Care shall be exercised in placing the concrete to completely fill the spaces between the conduits without damaging or displacing the conduits.

      No conduit shall be encased with concrete until it has been inspected by the Engineer. A coupling shall be placed on the ends of all conduit terminations and plugged with a suitable removable plug.

      The Contractor shall sheet and brace the trenches as required, and shall adequately support all pipes or other structures exposed in the trenches if support is necessary to prevent damage.

10. **Directional Bore**. The depth of bore below the pavement or shoulder for the specified conduit diameter shall be as follows:

    Conduit 4 inch diameter or less shall have a minimum of 4 feet depth of cover.

Conduit 4 inch to 6 inch diameter shall have a minimum of 5 feet depth of cover.

The method of boring consists of auguring or jacking a steerable rod under the roadway; then pulling back a cone that expands the soil or a wing cutter, which cuts a hole to the desired diameter. The diameter of the reamer or wing cutter shall not exceed the diameter of the conduit being placed by more than 2 inches.

A drilling fluid of water and bentonite may be used in all operations of a directional drill. The use of a polymer for lubrication in the drilling fluid is acceptable. A directional bore does not require the use of a drilling fluid.

The placement of directional bore or drill equipment or supplies shall be a location that will not interfere with traffic on the trunkline or with the use of adjacent property. All equipment and supplies shall be a minimum of 30 feet from the edge of pavement on limited access highways, or 15 feet from the edge of pavement of all other trunkline highways.

11. **Jacking and Boring.** The following types of equipment or methods are approved for use on small diameter bores up to 4 inches.

    a. Compaction auger (packer, expander) - This method of boring consists of augering a rotating stem under the roadway then pulling back a series of graduated cones which squeeze the soil to obtain the desired diameter.

    b. Hydraulic push rods or stem (pipe puller, packer) - This method consists of pushing rods or stems by means of a hydraulic ram under the roadway and the pulling of series of graduated cones which squeeze the soil to obtain the required diameter.

    c. Other methods approved by the Engineer prior to construction.

    Jetting, or using water or air in advance of the casing, is NOT APPROVED.

    Air rams; or advancing an unrestrained missile with a compressed air ramming device; may be used longitudinally in the right-or-way but it is PROHIBITED unless specifically authorized by the Engineer for use under state trunklines.

    When jacking and boring, a starter alignment trench shall be excavated to the elevation of the proposed conduit. The length of level trench shall be a minimum of 15 feet for trench depths to 4 feet and increase 5 feet for each additional 1 foot increment of depth.

    Guide rails, sills, or other positive alignment devices shall be used to start the crossing. Drive rods, if used, shall be securely restrained against horizontal and vertical movement.

    Where heads are used to develop the conduit opening, holes over 2 inches shall be developed by increasing the head size in one-inch increments.

    Where the highway is superelevated, the bore shall be started from the lower side of the pavement.

    Sheeting and bracing shall be required when boring or receiving pits are located within the 1:1 slope from the edge of any paved surface or back of curb.

    The bore and jack record sheet or log will not be required unless requested by the Engineer.

12. **Record Drawings.** Within 5 days after completion of the conduit work or any portion where a working cable is installed, the Contractor shall furnish a record drawing to the Engineer. The drawings shall show the length of the duct lines as constructed, clearly showing any departures from the original plans. The lengths shall be measured from the inside walls of the handholes and the center of post foundations and cable poles.

B. **Direct Burial Cable.** This work consists of furnishing and installing a single conductor, direct burial cable.

1. **Manufacture and Test.** Cables shall be manufactured and tested according to Insulated Cable Engineers Association (ICEA) Publication S-68-516, or NEMA WC8.

2. **Submittals.** The manufacturer shall submit seven copies of Type A certification for all cable.

3. **Acceptance.** Certified test reports shall be provided to the maintaining agency upon request. The cable shall be accepted by the agency maintaining the facility in which the cable is to be utilized. Unless specified otherwise, the Department will be the maintaining agency.

4. **New Cables.** All cables shall be new, having been manufactured within the 18 months preceding the date of delivery to the site. A certification from the cable manufacturer attesting to compliance with this requirement shall accompany the submittal.

5. **Delivery.** All cable shall be delivered to the site in full reels. Cable on the reels shall be protected from damage during shipment and handling by wood lagging or other means acceptable to the Engineer. Reels shall be tagged or otherwise identified to show the UL listing.

6. **Installation.** The cable shall be installed as indicated on the plans according to the manufacturer's recommendations. Care shall be taken to avoid dragging the cable on the ground. No underground splicing of the cable will be permitted. The cable shall be installed in continuous spans.

7. **Location.** Direct burial cable shall be installed parallel to the edge of pavement, or in a straight line between visible reference points such as handholes or light standards to facilitate locating the cable after burial.

8. **Excavation.** Direct burial cable shall be laid in a trench at least 10 inches deep which is cut after the subbase in the shoulder area is compacted to at least the elevation of the top of the base course.

   In general, direct burial cable shall be placed along the shoulder edge, clear of guard rail locations.

   Rocks or other sharp objects which might damage the cable shall be removed from the trench.

   All underground conduit or cable, except jacked and bored conduit, shall have marking tape installed 6 to 18 inches above the installed conduit line. This marking tape shall have the MDOT logo and telephone number on it and will be furnished by the Department’s Maintenance Division Signal Shop.

   Direct burial cable installed outside the shoulder area shall have 3 feet of cover.

9. **In Conduit.** Where direct burial cable is installed in conduit, conduit shall be clean and free of rough spots which could injure the cable before the installation of the cable.

   Wires and cables shall be installed to avoid damage to insulation and cable jackets.

   Lubricating compounds approved by the cable manufacturer shall be used to facilitate installation of the cable in the conduit. The lubricants shall be non-injurious to conduits, conductors, insulations or jackets and the lubricant shall be UL listed.

   Each run of cable shall have sufficient slack.

   Where a number of wires are trained through a box, manhole or handhole, they shall be grouped by circuit where applicable and bundled using appropriate cable ties and supported to minimize pressure or strain on cable insulation. Wire and cable shall not be bent to a radius less than the manufacturer's recommended bending radius, either in permanent placement or during installation.

   Cable pulling apparatus shall have no sharp edges or protrusions which could damage cables or conduits.

   Splices and terminations shall be incidental to this item.

10. **Testing.** After installation and backfilling, the cable shall be field tested for continuity, shorts and grounds. Cable failing to pass the field test shall be replaced with new cable at no additional cost to the Department.

C. **Equipment Ground Conductor.** This work consists of furnishing and installing a grounding conductor (bare or THHN) to provide a continuous and effective grounding of all equipment throughout the entire electrical system.

   The grounding conductor shall be installed and connected to light standard shafts and ground rods such that it is continuous between the control cabinet and the light standards.

   Where conductors are installed directly in earth with no conduit protection, the grounding conductor shall be installed 4 inches above the electric cable.

   Where installed in conduit, avoid damage to the conductor during installation. When more than one circuit conductor run is installed in conduit, only one run of the grounding conductor shall be installed and measured for payment.

   Ground conductor runs shall be extended individually to the ground bus of the lighting controller.

D. **Handholes.** This work consists of furnishing and installing, or the removal, reconstruction, abandonment or adjustment of handholes, including covers and fittings.

   1. **Remove or Abandon.** Handholes shall be removed completely or abandoned as specified in section 204.

   2. **Adjusting.** Adjusting handholes shall be as specified in section 403.

   3. **Reconstructing.** Reconstructing handholes shall be as specified in section 403. Existing frames and covers shall be used unless otherwise directed by the Engineer.

   4. **Installation.** The frame and cover shall be installed flush with the top of the handhole and both shall be flush with the pavement surface.

Handholes shall be reinforced concrete either cast in place or precast. The inner surface shall be smooth. Where castings are used, they shall be sand blasted. Castings shall be free of pouring faults, blow holes, cracks, and other imperfections. They shall be sound, true to form and thickness, clean and neatly finished and shall be coated with coal tar pitch varnish.

Cable racks and hooks shall be provided and included in the installation and will not be paid for separately.

Unused conduit entrances and conduit openings to be extended by others shall be blanked off, to prevent entrance of earth, with suitable removable plastic plugs or other plugs approved by the Engineer.

Upon completion of all handholes, the holes shall be free of all rubbish, construction debris and water.

5. **Excavation.** Earth excavation shall be of the diameter and depth required for installation of the specified handhole.

6. **Drainage.** Drain holes at the bottom of the handhole shall be as specified on the plans. Handholes shall be installed to ensure the drainage of underground conduits.

7. **Backfill.** The handhole shall be installed on granular material Class II. Material excavated for the installation may be used to backfill the remaining voids if the material is determined suitable by the Engineer. Where unsuitable, the entire backfill shall be granular material Class II.

E. **Light Standard Foundation.**

1. **General.** These construction methods apply to light standard foundations installed in earth.

   Where light standards are to be installed on bridges, retaining walls, or structures in general or on barrier walls, refer to the standard plans included in the contract documents.

2. **Remove.** Foundations shall be completely removed as specified in section 204 and the site restored as directed by the Engineer.

3. **Installation.** The hole for the foundation shall be made by drilling with an auger, of the same diameter as the foundation, or excavating when the diameter of the auger cannot accommodate the proposed size of foundation.

   No construction rubble, broken sidewalk, or other foreign material will be permitted in place of concrete. Cracked or otherwise deformed foundations will not be acceptable.

   No foundation shall be poured until approval to do so is obtained from the Engineer. The steel reinforcement, the raceway conduits, and the anchor bolts, shall be secured in place to each other and positioned in the augured hole so that at the time of placing the concrete mixture, these components retain their positions. Special attention shall be paid to the positioning of the anchor bolts. The anchor bolt projections on top of the foundation, after placement of the concrete, shall remain vertical. The anchor bolts shall be accurately spaced on the bolt circle and in lines parallel to the curb. The lower portion of the foundation shall be poured without forms, provided there is no cave-in.

When the soil is subject to cave-in, forms shall be used for the entire depth of the foundation.

Forms shall be used for the upper 12-inch portion of the foundation, and shall be finished smooth, with the top surface horizontal.

Bases and standards shall not be installed on foundations until the concrete has been cured for seven days.

a. **Excavation.** Earth excavation shall be as required for proper installation.

b. **Backfill.** Material excavated for the installation may be used to backfill the remaining voids if the material is determined suitable by the Engineer. Where unsuitable, the entire backfill shall be of granular material Class II.

F. **Light Standard.** Light standards may be installed on new foundations, bridges, retaining walls, concrete barrier walls, frangible transformer bases or other structures. Light standard shall be composed of a light standard shaft and a light standard arm. Materials may be new or salvaged.

1. **Submittals.** The fabricator shall submit a Type A certification according to the *Materials Quality Assurance Manual.*

   The Contractor shall submit to the Engineer for approval, prior to installation, four copies of shop drawings of the complete light standard installation, including fabrication drawings.

   A minimum of nine or more sets of final approved shop drawings shall be furnished to the Department. Applicable contract and project numbers shall be shown on all shop drawings.

   The manufacturer shall submit a Type A certification for all frangible transformer bases.

2. **Shipping.** All shafts shall be clean and free from scratches, dents, or similar disfiguring markings.

   Round standards shall have a uniform polished finish. All other designs shall have a blasted satin finish.

   Protection shall be provided to protect the standards during shipping, handling, storage, and erection.

   All galvanized steel light standard components on which the galvanized coating has been damaged in transportation, handling or erection shall be repaired according to subsection 716.03.E by the Contractor at no cost to the Department.

3. **Testing.** At the option of the Engineer:

   a. The standard shall sustain a vertical load of 250 pounds applied within 3 inches of the luminaire end of the bracket arm without collapse or rupture of any portion of the standard assembly.

   b. The bracket arm may be permanently deformed by the application of such test load but no part shall collapse, rupture, tear apart, or fail so that the weight falls to the ground.

Bracket arms which are deformed by applying the test load shall be replaced at no cost to the Department.

4. **Light Standard Frangible Base.** This work consists of furnishing and installing, or the removal of, light standard frangible bases.

5. **Light Standard Arm.** This work consists of furnishing and installing, or the removal of, light standard arms. Light standard arm shall include a bracket arm assembly.

   a. **Light Standard Arm - Install**. Install a light standard arm (that is to be provided to the Contractor, at no cost to the Contractor) on the specified light standard shaft.

   b. **Light Standard Arm - Install Salvaged.** Install a light standard arm that was salvaged as described in subsection 819.03.F.5 on the specified light standard shaft.

   c. **Light Standard Arm - Remove.** Remove the light standard arm from its shaft. The removed light standard arm shall become the property of the Contractor.

   d. **Light Standard Arm - Remove And Salvage.** Remove and salvage a light standard arm from its shaft. Include handling and storage. If storage is required, the location shall be specified.

      All parts of the light standard arm damaged during the disassembling, handling or storage operations shall be replaced at the Contractor's expense.

   e. **Light Standard Arm.** Furnish and install a light standard arm on the specified light standard shaft.

6. **Light Standard Shaft**. This work consists of furnishing and installing, or the removal of, light standard shafts. Light standard shaft shall include the shaft, anchor base, associated hardware, and No. 8 pole wire extending from the fusing at the base of the pole to the luminaire. Two wires shall be extended for each luminaire.

   a. **Light Standard Shaft - Install.** Install a light standard shaft (that is to be provided to the Contractor, at no cost to the Contractor) on the specified light standard foundation.

   b. **Light Standard Shaft - Install Salvaged.** Install a light standard shaft that was salvaged as described in subsection 819.03.F.9 on the specified light standard foundation.

      All parts of the light standard shaft damaged during reassembly of the light standard shaft and arm shall be replaced at the Contractor's expense.

   c. **Light Standard Shaft - Remove.** Remove the light standard shaft from its foundation. The removed light standard shaft shall become the property of the Contractor.

   d. **Light Standard Shaft - Remove and Salvage.** Remove and salvage the light standard shaft from its foundation. Include handling and storage. If storage is required, the location shall be specified.

      All parts of the light standard shaft damaged during the disassembling, handling or storage operations shall be replaced at the Contractor's expense.

e. **Light Standard Shaft - (Single), (Double) or (no arm).** Furnish and install a light standard shaft (of the length specified for single, double or no arms as specified) on the specified light standard foundation.

7. **Installation.** Install the light standards so that the upper third of the shaft is in a vertical position with the bracket arm and luminaire in place. Bracket arms shall be at right angles to the edge of pavement. The light standards shall be installed so that the handhole in the light standard is on the side away from oncoming traffic except on barrier wall and bridge installations, where the handhole shall be accessible from the roadway when facing the railing.

   Wiring joints and splices will be permitted only at access points such as the handhole at the anchor base, and the handhole in the side of the light standard. Direct burial wire shall loop up into the standard so that connections can be made at the handhole in the standard. All joints shall be firmly bonded together; insulated and taped as recommended by the manufacturer for the type and voltage class of cable specified. Bonding may consist of lug connectors or soldering with noncorrosive flux; taping shall be done with UL approved plastic tape. The completed joint shall provide the proper insulation level for the voltage specified and be moisture proof. Preinsulated solderless connectors or mechanical connectors that require the use of special tools will be allowed if samples are submitted to the Engineer and approved.

   The Contractor shall be responsible for all interior and exterior damage to the luminaire prior to operation.

   Light standards shall be grounded according to current NEC for grounding of equipment or conform to the Standard Practices of the local municipality or agency.

G. **Luminaires.** This work consists of furnishing and installing, or the removal of, luminaires. Luminaires shall be new or salvaged as specified on the plans.

1. **General.** New installations shall have high pressure sodium luminaires. The candlepower distribution shall be according to the *National Standard Practice for Roadway Lighting.*

   Luminaires shall be individually packed for shipment to insure arrival at their destination undamaged.

   For cobra head type luminaires, the hood and refractor supporting member shall be painted metallic gray.

2. **Submittals.** A drawing showing a general diagram of the unit, indicating how it is to be assembled and installed, shall be provided.

   Luminaires shall be accepted on the basis of a Type D certification which states that they meet the specifications.

3. **Installation.** The luminaire reflector and glassware shall be clean after installation. Cleaning shall be according to the luminaire manufacturer's recommendations.

H. **Tower Lighting Unit.** This work consists of furnishing and installing a tower lighting unit, complete with the steel shaft and base plate, headframe assembly, luminaire mounting ring, luminaires complete with ballasts and lamps, lowering device, fused safety switch, lightning

arrester, rodent screen and related items necessary to mount a complete operating tower lighting unit on its foundation.

1. **Submittals.** The Contractor shall submit to the Engineer for approval, prior to fabrication, four copies of shop drawings, which include welding details, of the complete tower lighting unit. Applicable contract and job numbers shall be shown on all shop drawings. Eight sets as finally approved shall be furnished to the Engineer for distribution. One set of transparent reproducibles on film shall be furnished to the Engineer.

   The Contractor shall submit a Type A certification covering the material specified for use by the fabricator in the design of the lighting installation. The Engineer may request check tests on material certifications.

   The Contractor shall submit the manufacturer's certification of the adequacy of the design of the tower lighting unit, and two copies of design calculations covering all stress sized components of the luminaire mounting ring, head frame assembly lowering device, pole at all joints and a section through the handhole and anchor base.

2. **Shipping.** All galvanized poles and related components on which the galvanized coating has been damaged in transportation, handling or erection shall be repaired per subsection 716.03.E by the Contractor at no cost to the Department.

3. **Installation.** When the luminaires are raised to the normal operating position, the center of the apparent light source of each luminaire shall be within 2 feet of the nominal mounting height when measured from the top of the foundation for the tower lighting unit.

   The pole shall be furnished and erected with no field welds.

   Should the Contractor elect to furnish a sectional pole, it shall be field assembled prior to erection on its foundation by methods which ensures a true-straight alignment.

   During the final assembly, the pole shall be placed on truly aligned supports and the final seating of each splice shall be obtained by applying a sufficient force to obtain proper seating. In obtaining the last 3 inches of the lap, axial or concentric compressive loading shall be applied by means of hydraulic jacks, turn buckles or the necessary cable coffing hoist. To ensure proper lapping of the joint, place a temporary circumferential mark (chalk, etc.) on the outside of the lower tube a distance below its top equal to 1½ diameters plus 12 inches. When the joint is tight, the bottom of the overlapping section shall be within 12 inches of the temporary mark as measured equally around the pole.

   After erection, the horizontal offset at the top of the pole shall be within 4 inches of its true position, and the offset at the midpoint shall be within ¼ of that at the top. A rodent screen shall be installed at the base of the pole. The rodent screen shall be galvanized per ASTM 123.

   The time and means of the determination of the pole alignment after erection shall be determined by the Engineer.

   The Contractor's proposed assembly of the pole shall be approved by the Engineer prior to commencing work.

4. **Acceptance.** After the tower shaft is anchored in place, the Contractor will contact the Engineer to arrange for MDOT personnel to witness the raising and lower of the luminaire ring. The ring will be raised and lowered a minimum of three times. After the ring is raised to its proper working position and visually checked for levelness, the lamps shall be energized and allowed to burn for a minimum of 15 minutes before being lowered. When lowered, the ring should be inspected for proper cable tensioning, levelness, hardware tightness, electrical connections and power cord adjustments as a minimum. All adjustments required to insure proper operation of the lowering device and electrical system will be made at this time. If the operation of the ring requires more adjustments after the required three tests, the ring shall be raised as many times as necessary to correct all operational deficiencies.

   Upon completion of these tests, the Engineer will document the events of this meeting noting that this particular tower is approved for operation. Payment for the above described tests will be included in Tower Lighting Unit and will not be paid extra.

I. **Wood Pole.** This work consists of furnishing and installing, or either relocating or removing wood poles and all associated hardware suitable for supporting span wire and bracket arm mounted traffic signals and guying the pole where required.

All earth replaced around poles shall be thoroughly tamped. Holes shall be filled, tamped, and leveled after poles are removed. Turnbuckles, tension tie bars, and associated steel hardware shall be hot-dip galvanized according to ASTM A 153.

Minimum setting depth for wood poles shall be as follows:

Pole Length	Depth
35 foot Class 4 pole	6 feet
40 foot Class 4 pole	6 feet
45 foot Class 4 pole	6½ feet
50 foot Class 4 pole	7 feet
55 foot Class 4 pole	7½ feet
60 foot Class 4 pole	8 feet

819.04 Measurement and Payment.

Contract Item (Pay Item)	**Pay Unit**
Conduit, Rem	Foot
Conduit, Encased, __ , __ inch	Foot
Conduit, Directional Bore, __ , __inch	Foot
Conduit, DB, __ , __ inch	Foot
Conduit, Fiberglass, Schedule __ , __inch, Structure	Foot
Conduit, Galv Steel, __ inch	Foot
Conduit, Galv Steel, __ inch, Structure	Foot
Conduit, Galv Steel, __ inch, Jacked in Place	Foot
Conduit, Schedule 80 PVC, __ inch, Jacked in Place	Foot

Conduit, Schedule 40, __ inch . . . . . Foot
Conduit, Schedule 80 PVC, __ inch . . . . . Foot
Conduit, Schedule 80 PVC, __ inch, Structure . . . . . Foot
Conduit, __ , __ , Jacked in Place . . . . . Foot
Conduit, Jacked Bored . . . . . Foot
DB Cable, 600V, 1/C# __ . . . . . Foot
DB Cable, in Conduit, 600V, __ , 1/C# __ . . . . . Foot
DB Cable, in Conduit, Rem . . . . . Foot
Cable, Rem . . . . . Foot
Cable, __ , Rem . . . . . Foot
Cable, Pole, __ , Disman . . . . . Each
Cable, P.J., 600V, 1, __ . . . . . Foot
Cable, Sec, __ , __ , __ . . . . . Foot
Cable, Shielded, __ , __ , __ , __ . . . . . Foot
Cable, St Ltg, __ , __ , __ , __ . . . . . Foot
Cable, Equipment Grounding Conductor, 1/C# __ . . . . . Foot
Electric Serv, Rem . . . . . Each
Hh, __ . . . . . Each
Light Std Fdn . . . . . Each
Light Std Fdn, Rem . . . . . Each
Light Std, Frangible Transformer Base . . . . . Each
Light Std, Frangible Transformer Base, Rem . . . . . Each
Light Std Arm, Install . . . . . Each
Light Std Arm, Install Salv . . . . . Each
Light Std Arm, Rem . . . . . Each
Light Std Arm, Rem and Salv . . . . . Each
Light Std Arm, __ foot . . . . . Each
Light Std Shaft, Install . . . . . Each
Light Std Shaft, Install Salv . . . . . Each
Light Std Shaft, Rem . . . . . Each
Light Std Shaft, Rem and Salv . . . . . Each
Light Std Shaft, Square, __ foot . . . . . Each
Light Std Shaft, 30 foot or less . . . . . Each
Light Std Shaft, __ foot to __ foot . . . . . Each
Light Std Shaft, 30 foot or less, Single arm . . . . . Each
Light Std Shaft, __ foot to __ foot, Single Arm . . . . . Each
Light Std Shaft, 30 foot or less, Double Arm . . . . . Each
Light Std Shaft, __ foot to __ foot, Double Arm . . . . . Each
Light Std Shaft, Spec, 30 foot or less, Single Arm . . . . . Each
Light Std Shaft, Spec, __ foot to __ foot, Single Arm . . . . . Each
Light Std Shaft, Spec, 30 foot or less, Double Arm . . . . . Each
Light Std Shaft, Spec, __ foot to __ foot, Double Arm . . . . . Each
Luminaire . . . . . Each
Luminaire, Salv . . . . . Each
Luminaire, Install Salv . . . . . Each
Luminaire, Rem . . . . . Each
Luminaire, Rem and Salv . . . . . Each
Luminaire, __ High Pressure Sodium . . . . . Each

Luminaire, __ High Pressure Sodium, Spec . . . . . Each
Luminaire, __ High Pressure Sodium, Rectangular . . . . . Each
Tower Ltg Unit, __ foot __ Luminaire . . . . . Each
Tower Ltg Unit, Elec Drill . . . . . Each
Tower Ltg Unit, Fdn Cased . . . . . Foot
Tower Ltg Unit, Fdn Uncased . . . . . Foot
Wood Pole . . . . . Each
Wood Pole, Cl__ , __ foot . . . . . Each
Wood Pole, Rem . . . . . Each
Wood Pole, Fit-Up, __ . . . . . Each

The items listed include all costs associated with completing the work as described. Unless otherwise specified, excavation, granular material, backfill, disposal of waste excavated material, together with (in kind) replacement of sod or seed, mulch, and fertilizer is also included and will not be paid for separately.

A. **Conduit.**

1. The following shall apply to conduit items as applicable.

   a. Conduit will be measured by length in feet in place, from the inside walls of manholes and the centers of handholes, post foundations and cable poles.

   b. Sheeting and bracing, removal of boring pit and filling voids are included in the associated item when required.

   c. Marking tape is included in the associated item.

2. **Conduit, Fiberglass, Schedule, __ inch, Structure** and **Conduit, Galv Steel, __ inch, Structure** include installation of the conduit on or in locations where the conduit requires special equipment other than that used for direct burial installations. Work shall include, but is not limited to, installing approved conduit hangers, hardware, expansion joints and junction boxes as needed to install the conduit as specified.

3. **Conduit, Jacked Bored** includes installing the rigid metal conduit and a schedule 80 PVC conduit of size and type specified on the plans.

B. **Direct Burial Cable** This cable is intended to be installed directly in earth with no conduit protection.

1. The following shall apply to direct burial cable items as applicable.

   a. Cable will be measured in place for the total length in feet of the specified single and/or multiple conductors.

   b. Measurements, when taken at grade, shall be between centers of handholes, light standards, poles, etc.

   c. No additional allowance will be made for looping, sag, trainers, splicing, racking, slack length, or length inside equipment, except that vertical length of cable from 2 feet 6 inches below grade to the pothead or service head will be measured at cable poles.

   d. Bonding and tagging, and making all splices and connections is included in the associated item.

e. Marking tape is included in the associated item.

2. **DB, in Conduit, 600V,1/C#** __ includes pulling the cable in the conduit.

3. **DB Cable, In Conduit, Rem** includes removing the specified cables from the existing conduit.

C. **Cable, Rem** and **Cable,** __ **, Rem** includes removing and disposing of all wire, support cable, guys, anchors, cross arms and line hardware. Dead ending, circuit cutting, installing any necessary guying and all other work required to leave the circuits in an operable condition are included.

D. **Cable, Pole,** __ **, Disman** includes dismantling and off-site disposal of the riser pipe, cross arms, lightning arrestors, pot heads, cutouts, molding, weather cap, concrete encased bend and all other related materials. All labor and materials including connections and splicing required for a complete and operating project are included.

E. **P.J. Cable, Sec Cable**, **Shielded Cable** and **St Ltg Cable** of the type, including the number and size of conductors, shown on the plans will be measured in place by length in feet from centers of manholes or handholes and between wood poles. The contract unit price includes installing cable as called for in conduit between manholes, handholes and wood poles, pole line hardware, ¼-inch messenger for support, racking in manholes and handholes and for bonding and tagging every cable in every manhole and handhole identification, and making splices and connections and cutting cable and re-splicing where required for service to traffic signals, installed in final position or during a particular stage. If installed in a trench, the installation of marking tape, is included.

F. **Equipment Grounding Conductor, 1/C#** __ includes installation of the grounding conductor in conduit. Measurements shall be made in a straight line between changes in direction and to the centers of light standards and the control cabinet. All vertical conductors and permissible slack shall be measured for payment. Bonding, tagging and making all splices and connections required for a complete grounding system are also included.

G. **Electric Service, Rem** includes the removal of the meter, meter socket, cable, risers, concrete encased conduit bends, and all other related hardware. Return of the meter to the local utility company and disposal of materials from the site is included and will not be paid for separately.

H. **Handholes (Hh)**.

1. The following shall apply to all handhole items as applicable.

a. Handhole items will be measured as units, each.

b. Breaking away concrete encasement and conduit where new manholes or handholes are broken into an existing conduit run is included in the associated item of work.

2. **Hh, Adj** includes excavation, backfilling, and disposing of surplus materials required to adjust the handhole. Existing frames and covers shall be used.

3. **Hh, Heavy Duty Cover** and **Hh, Light Duty Cover** include covers and fittings.

4. **Hh, Polymer Concrete** and **Hh, Round** and **Hh, Square**. The type shall be shown on the plans. The contract unit price includes the frame and cover, ground rod(s), treated wood foundation, and other materials required to complete the work. Where existing cables are maintained in new manholes or handholes, additional cable shall be spliced into the cable for proper racking on the manhole or handhole walls.
5. **Hhe, Abandon** will be measured as a unit. The unit shall be as indicated on the plans. The contract unit price shall include the removal of the frame and cover, and breaking down the wall structure.
6. **Hh, Access** will be measured as a unit**.** The contract unit price shall include installing an access handhole opening and cover in an existing steel pole and any additional hardware, reinforcing frame, stainless steel screws and such other material as required to complete the work as described and as shown on the plans.
7. **Hh, Reconst** includes using existing frames and covers.
8. **Hh, Rem** includes completely removing the handhole and restoring the site.

I. **Light Std Fdn** includes reinforcing steel, anchor bolts, ground rod and wire, conduit and all miscellaneous hardware required to complete the construction of the foundation.

J. **Light Standard Arm.** Contract unit prices for **Light Std Arm** items include removing, installing or salvaging of light standard arms as described.

K. **Light Standard Shaft.**

1. Contract unit prices for **Light Std Shaft** items include installing the light standard shaft on the specified light standard foundation or frangible transformer base. Necessary street lighting circuit cable cutting, and splicing is included.
2. **Light Std Shaft, Spec** includes providing materials including, but not limited to, shaft, a tenon, short arm or special arm required to mount the luminaire.

L. **Luminaire**.

1. **Luminaire** and **Luminaire Salv** of the type specified on the plans will be measured as a unit. The contract unit price includes the luminaire, lamp, wiring, and such other material, and making all connections as required to provide a complete and operating job.
2. **Luminaire, Install Salv** includes installing the salvaged luminaire, and furnishing and installing a new lamp.
3. **Luminaire, Rem** includes removing, and disposing of the removed luminaire.
4. **Luminaire, Rem and Salv** includes removing, salvaging and storing the luminaire at the site.
5. **Luminaire __ , High Pressure Sodium** includes furnishing and installing the complete luminaire, including the ballast(s), lamp(s), and associated hardware and wiring.

M. **Tower Lighting.**

1. **Tower Ltg Unit, __ foot, __ Luminaire** of the size and type shown on the plans includes the complete tower lighting unit, erected, plumbed, anchored to the foundation, and electrically wired ready for operation. Testing of the unit is also included.
2. **Tower Ltg Unit, Elec Drill** includes furnishing the specified electric drill to raise and lower the tower lighting luminaire ring.
3. **Tower Ltg Unit, Fdn Cased** and **Tower Ltg Unit, Fdn Uncased** shall be measured vertically from the bottom of the shaft to the top of the shaft. Payment includes reinforcing steel, casing, anchor bolts, ground rod and wire, conduit and all miscellaneous hardware required to complete the construction of the foundation.

N. **Wood Pole.**

1. **Wood Pole** of the size and class shown on the plans will be measured as a unit. Payment includes furnishing and installing the pole, pole marker, and providing any additional support as shown on the plans. Transfer of wires from old to new pole and installation of necessary, crossarms, pole line hardware and grounding shall be included in this item.
2. **Wood Pole, Cl __ , __ foot.** Where guying is required, guying will not be paid for separately.
3. **Wood Pole**, **Rem** will be measured as a unit. The unit shall be as shown on the plans. This item includes the removal of the wood pole, any concrete encasement or base of a self-supporting wood pole, associated hardware, and storage of materials if required.
4. **Wood Pole, Fit-Up, __** of the type specified on the plans will be measured as a unit. This item includes furnishing and installing the lightning arresters, trainer wires, crossarms, ground rod(s), ground wire, PVC schedule 80 or galvanized rigid metal pipe risers, concrete encased conduit bend(s) and line hardware. Wire arrangement on all poles is included in the item.