

SECTION 2800 – STREET LIGHTING

**CITY OF LEES SUMMIT, MISSOURI
STANDARD SPECIFICATIONS**

The City of Lee’s Summit hereby replaces Section 2800 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications with the City of Lee’s Summit Design and Construction Manual Section 2800.

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2801 GENERAL

2801.1 Scope

This work shall consist of furnishing of all material, equipment, and labor for the installation and testing of a complete, operational street lighting system.

2801.2 Codes and Standards

All work and material shall be in accordance with the latest requirements of the Illuminating Engineering Society of North America (IESNA), National Electrical Code (NEC), National Electrical Safety Code (NESC), Standards of the American Society of Testing Materials (ASTM), American Standards Associations (ASA), National Electrical Manufacturers Association (NEMA), and all applicable local ordinances. The standard referred to shall be the latest revision of said standard as amended at the time of the Advertisement, except as noted on the Plans or in the Project Special Provisions.

2801.3 Modification of Specifications

These Specifications may be modified or deleted by appropriate items in the Project Special Provisions or by written authorization by the City Engineer.

2801.4 Appurtenances

All appurtenances shall be installed as shown on the Plans, or as specified in the Project Special Provisions. Any deviations must be established by the Contractor and authorized by the City Engineer.

2801.5 Incidental Work and Parts

Work incidental to the installation of a street lighting system that is not covered in these Specifications shall be performed in accordance with the City of Lee's Summit specifications and standards. All incidental parts, which are not shown on the Plans or specified in the Specifications and which are necessary to complete the street lighting system, shall be supplied and installed by the Contractor to the satisfaction of the City Engineer. No additional payments will be made for incidental work or parts.

2801.6 Existing Lighting

Existing lighting shall be maintained in effective operation by the Contractor except for shutdowns with approval from the City Engineer for alterations or final removal. The Contractor shall take all precautions necessary to minimize the downtime of the existing street lighting systems to be modified.

2801.7 Permits and Inspections

The Contractor shall contact the Public Works Department before any project work begins to notify the City Engineer of the construction schedule and to request project inspections. The Contractor is responsible for obtaining all necessary permits from the City, and is responsible for all associated costs, before any work can begin.

2801.7.1 Owner's Building Permit

The Contractor is responsible for obtaining the owner's building permit from the City's Codes Administration Department before electrical service can be delivered to a power supply. The Contractor shall contact the City's Codes Administration Division for an electrical inspection when each power supply is ready for operation. The Inspector will obtain an address for each power supply, which the Contractor shall use when dealing with the electrical utility company.

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2801.8 Electrical Service

The Contractor is responsible for contacting the electrical utility company in advance to schedule delivery of service to each power supply. The City shall pay the electrical utility company's fees to deliver electrical service. The Contractor shall be billed for all electrical utility service charges until the entire project is substantially complete and the burn test is successfully completed. After those milestones the electrical service can be transferred to the City.

2801.9 Maintenance Work

The Contractor is responsible for making all repairs and replacements, including downed poles, damaged or cut cables, and burnt out lamps, to the street light system, regardless of the cause or responsible party, until the work is determined by the City to be substantially complete.

2802 MATERIALS AND EQUIPMENT

2802.1 Scope

This section governs the furnishing of all luminaires, poles, conduits, cables, and other material and equipment supplied by the Contractor, as required, to complete the street lighting system as shown on the Plans, the Standard Drawings, and as specified in the Project Special Provisions. All lighting equipment shall be of new stock unless the contract provides for relocation of existing units or use of units furnished by others. New equipment and material shall be of the best grade, and shall meet the approval of the City Engineer.

2802.2 Street Light Poles

The type of pole and length of bracket arm shall be as specified on the Plans. This specification is in addition to the City of Lee's Summit "Pole and Luminaire Details" Standard Drawing, which describes the Specifications and pertinent design details. It is the responsibility of the fabricator to verify and attest that the material sizes proposed are structurally adequate and in full compliance with this specification and Standard Drawings.

The aluminum street light pole shaft assembly shall be spun from one piece of seamless tubing, and after fabrication it shall have mechanical strength of not less than T6 temper. The cross section of the pole shall be round, and the shaft shall be fabricated in a continuous true taper from at least 6" above the hand hole to the top of the shaft. The shaft shall have a vibration damper bolted to the inside of the shaft, except for the 14-foot poles. The shaft shall have no longitudinal or circumferential welds, except at the lower end, joining the shaft to the shoe base. The shaft shall have a factory applied protective paper wrapper conforming to the manufacturer's standard practice to protect the shaft during shipping. For all poles except the 14-foot poles, the top of the shaft shall be equipped with a cast aluminum removable pole cap held securely in place by means of set screws. All 14-foot poles shall have a 3" O.D. slipfitter end, without a tenon, for mounting the post-top luminaire.

Pole dimensions shall be as specified on the Standard Drawings. It is the responsibility of the fabricator to verify and attest that the material sizes proposed are structurally adequate and in full compliance with this specification and the pole detail drawing.

The aluminum shoe base shall be a permanent mold casting. The base shall be free of cracks, pits, and blow holes and of sufficient size and strength to withstand full design loads. The base shall telescope the shaft; and one weld shall be on the inside of the base at the end of the shaft while the other weld shall be on the outside at the top of the base. The shoe base and the two (2) welds shall develop the full strength of the pole assembly. The base shall be cast with four (4) slotted

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holes to receive the anchor/connecting bolts and tapped holes for attaching the four (4) cast aluminum alloy removable bolt covers provided for each pole. The bolt covers shall attach to the upright portion of the body of the base. The bolt circle diameter is provided in standard the drawings.

If poles are to be placed on existing bases or structures with anchor bolts in place, the Contractor shall furnish poles with a shoe base to fit the anchor bolt spacing.

2802.3 Bracket Arms

The bracket arm assembly shall be a one piece welded assembly consisting of an upper arm and lower arm (brace) securely joined by a vertical strut and a connector or weld at the outboard end of the arm assembly. The upper arm shall be tapered by cold working from round tubing. After tapering, the upper arm shall then be flattened to produce an elliptical cross-section with the major diameter in the horizontal plane, parallel to the wind. The outboard end of the upper arm shall remain round with a two inch (2") slipfitter for mounting the luminaire. The lower arm shall be 2 inch (2") IPS aluminum pipe. The outboard end of the lower arm (brace) shall be covered by an end cap. The bracket arm shall be capable of being mounted to the pole shaft with aluminum clamp-on style plates. Small holes shall be drilled at the ends of both arms on the bottom side to allow for drainage of condensation.

All poles, except 14-foot poles, shall be attached to a cast aluminum breakaway base sized according to the Standard Drawings. The breakaway base shall conform to the breakaway criteria of *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, 1994 edition.

2802.4 Screw-In Anchor Bases

Screw-in anchor bases shall be of the size and type specified in the Standard Drawings, based on the pole mounting height. It is the responsibility of the fabricator to verify and attest that the material sizes proposed are structurally adequate and in full compliance with the Standard Drawings.

2802.5 Flowable Backfill

All flowable backfill shall be mix design Type A as described in Section 2600 of the City of Lee's Summit Design and Construction Manual.

2802.6 Concrete

All concrete for bases and pads, whether reinforced or non-reinforced, shall be a KCMMB 4k psi, or higher, approved concrete mix. Concrete construction shall be in accordance with ACI 301 Standard Specifications for Structural Concrete.

2802.7 Reinforcing Steel for Concrete Bases

All reinforcing steel shall meet the requirements of steel bars for concrete reinforcement. AASHTO specifications, when referenced, will control the physical properties, chemical properties and handling and storage of the material, except as otherwise specified herein or shown on the Plans.

Unless otherwise specified, reinforcement shall be deformed bars in accordance with AASHTO M 31, AASHTO M 42 or AASHTO M 53. Bars in accordance with AASHTO M 42 and M 53 shall be in straight lengths only. Splicing of bars is not allowed.

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Upon request, Contractor shall provide documentation of reinforcing steel that shall include the steel manufacturer's certified mill test report showing complete chemical and physical test results for each heat.

2802.8 Anchor Bolts

Anchor bolts shall be steel with 50,000 PSI minimum yield. Anchor bolts shall be threaded for the length of the bolt that is to be exposed. The anchor bolts shall be hot dipped galvanized on the top ten inches (10") of the threaded end, after threading. All accessories shall be galvanized to ASTM A153 standards. Threads shall be Coarse Thread Series as specified in ANSI B1.1 and may be formed by cutting or rolling.

2802.9 Luminaires

The manufacturer, type, and model of luminaires shall be supplied as shown on the Plans, Standard Drawings, or as specified in the Project Special Provisions.

2802.9.1 Cobra Head Luminaires

Cobra Head style luminaires shall be a power door or drop ballast type and be constructed of a single piece die-cast aluminum upper housing and one-piece or two-piece bottom door, hinged at the back and latched on the street side. The luminaire shall be equipped with an integral slipfitter for 2-inch luminaire arm mounting. The mounting device shall allow the luminaire to be mounted absolutely level and shall have no more than four (4) fasteners serving both the leveling and clamping functions. It shall allow one person to install the luminaire by simultaneously holding it in position and tightening the fasteners, such that the luminaire will be properly level at the first attempt. The luminaire shall be equipped with a 'trigger latch' for easy, one-hand, no-tools opening of the fixture for installation and servicing. A factory installed bird guard shall fit snugly around the mounting device. The luminaire shall provide a moisture proof and dust proof chamber and weather protection for the ballast. A removable power-pad/module with quick-connect electrical hookup for easy installation of the electrical system and easy access to the ballast compartment shall be mounted on the door. Top housing mounting or a bridge assembly configuration will not be accepted.

The lens shall be a single piece of optically clear, flat, heat-resistant, impact resistant glass. The sealed optical assembly shall be fully shielded (emitting no direct uplight). The reflector shall be natural unpainted alzak aluminum and shall be secured to the top housing.

The lamp socket shall be preset at the factory to meet the requirements of the IESNA classification for Type III cutoff light distribution at a minimum.

The luminaire shall not be provided with a photocell receptacle unless otherwise noted on the Plans or Project Special Provisions.

Luminaires shall be pre-wired, requiring only connection of service wires to a terminal board. The ballast shall be a regulator type, high power factor, for high-pressure sodium at a voltage of 120/208/240/277 volts. The ballast shall be capable of reliably operating the lamp with a line voltage varying plus or minus 5 percent from normal. The entire ballast, including condensers, shall be mounted on a power door or drop assembly and be easily removable and replaceable with gloved hands and without tools through the use of quick disconnecting mechanical devices and electrical plugs.

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2802.9.2 Post-Top Luminaire

The luminaire housing shall be constructed of cast aluminum and shall have a gray appearance. The ballast shall be a regulator type, high power factor, for high-pressure sodium at a voltage of 120/208/240/277 volts. The ballast components shall be housed in a totally enclosed integral compartment, and the optical section of the unit shall be completely sealed and gasketed. The pressed prismatic refractor shall be one piece polycarbonate plastic. The refractor shall be for IESNA Type III distribution, unless otherwise specified on the plans.

2802.10 Lamps

Luminaires shall be equipped with high-pressure sodium (HPS) vapor lamps. Lamp life shall be rated not less than twenty-four thousand (24,000) hours. Burnout at twenty thousand (20,000) hours shall not exceed twenty percent (20%). Rated initial lumen output shall be as follows:

- A. 150 watt lamps shall be rated 16,000 lumens.
- B. 250 watt lamps shall be rated 30,000 lumens.
- C. 400 watt lamps shall be rated 50,000 lumens.

2802.11 Conduit

The location and type of conduit shall be as shown on the Plans or Standard Drawings. The Contractor may furnish and install polyvinyl chloride (PVC), or high-density polyethylene (HDPE) conduit for the distribution system. Galvanized Rigid Steel (GRS) conduit shall be used where conduit is to be installed externally on a structure. For projects where the surface is largely unpaved, it is the Contractor's option to furnish and install cable-in-duct, instead of separate conduit and cables for the distribution system.

2802.11.1 Polyvinyl Chloride (PVC)

Rigid non-metallic conduit shall be polyvinyl chloride (PVC), Schedule 40 or Schedule 80, and shall conform to NEMA Standard TC-2 and NEMA TC-3. The conduit shall bear an Underwriters' Laboratories (U.L.) label and shall conform to Federal Specification WC-1094A (latest version). The conduit shall be clearly and durably marked at least every 10 feet with the material designation, nominal duct size, and the name and/or trademark of the manufacturer. Fittings for PVC conduit shall be in accordance with U.L. 514. Cement used for the fittings shall be in accordance with the conduit manufacturer's recommendations. Conduit, fittings, and cement shall be supplied by the same manufacturer.

2802.11.2 High Density Polyethylene (HDPE)

Flexible non-metallic conduit shall be high-density polyethylene conduit (HDPE). The conduit shall be smooth walled inside and out, and shall be gray in color. The conduit shall be a plastic duct which is intended for underground use and which can be manufactured and coiled or reeled in continuous transportable lengths and uncoiled for further processing and/or installation without adversely affecting its properties of performance. The conduit shall be manufactured to NEMA Standard TC-7 and ASTM D 3035 SDR11 specifications. The conduit shall be clearly and durably marked at least every 10 feet with the material designation, nominal duct size, and the name and/or trademark of the manufacturer. Fittings for HDPE conduit shall be in accordance with ASTM D 2683. Epoxy used for the fittings shall be in accordance with the conduit manufacturer's recommendations.

An approved factory coupling shall be used for connection of the HDPE conduit to a 90° factory PVC elbow or between two lengths of HDPE conduit. The coupling shall be of high density polyethylene material. The coupling shall provide an airtight and watertight lock connection.

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2802.11.3 Galvanized Rigid Steel (GRS)

Galvanized rigid steel conduit shall be in accordance with ANSI C80.1. GRS conduit shall be galvanized on both the inside and the outside surfaces. The weight (mass) of zinc coating shall be no less than 0.5 ounce per square foot of coated surface, as determined in accordance with AASHTO T 65. The interior or exterior surface, or both, may be given a coating of suitable material to facilitate installation of wires and cables and to permit the conduit to be readily distinguished from pipe used for purposes other than electrical. All metal conduit ends shall be provided with a bushing to protect the cable from abrasion. Fittings shall be in accordance with ANSI C80.4. A sufficient number of conduit hangers shall be supplied to attach the GRS conduit to the structure, as recommended by the manufacturer. One (1) No. 6 AWG, bare copper ground wire shall be attached to each end of the GRS conduit with a grounding bushing. The ground wire shall be connected to a ground rod at each end of a GRS conduit run, or extended to an adjacent GRS conduit or ground rod.

2802.11.4 Cable-In-Duct

Cable-In-Duct shall consist of three low voltage, insulated power cables, factory installed in conduit intended for direct burial. The duct shall meet all the specifications for high density polyethylene, as described in Section 2802.11.2. The duct shall be clearly and durably marked at least every 10 feet with the material designation, nominal duct size, and the name and/or trademark of the manufacturer. The cables shall meet all the specifications for distribution cable, as described in Section 2802.13.

2802.12 Pull and Junction Boxes

Pull and junction boxes shall be as shown on the Plans and shall be fiberglass reinforced polymer concrete of a size and shape as indicated on the Standard Drawings. Junction boxes may be either Type 1 or 2, and pull boxes shall be Class 1. Pull and junction box material is to be an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. Pull boxes shall withstand a wheel load of 20,000 pounds and junction boxes shall withstand a wheel load of 15,000 pounds. All pull and junction boxes are to have an open bottom.

Each pull or junction box shall be equipped with a bolt down cover. The threaded hole that receives the cover lock-down bolt shall be open at the bottom to allow the cleanout of sand, dirt and other debris. Lock-down bolts shall be stainless steel with a hex-head. Pull and junction box covers shall be polymer concrete and shall have a minimum wheel load rating of 20,000 pounds and 15,000 pounds respectively. A lift opening or pull slot shall be provided on all covers. Covers shall be embossed with "STREET LIGHTING".

2802.13 Cable

The types and lengths of cables shall be supplied as shown on the Plans, Standard Drawings, or as specified in the Project Special Provisions. All cable shall be stranded annealed soft drawn copper wire, and shall be the AWG size as listed on the Plans. Cable shall be 600-volt and be thermoplastic or thermosetting polyethylene insulated. All cable shall be plainly marked on the outside with the manufacturer's name and identification in accordance with industry practice.

2802.13.1 Distribution Cable

Distribution cables shall be insulated three-conductor cables (3c), type RHH, RHW-2 or USE-2, meeting the requirements of ICEA S-95-658. Average thickness of insulation shall be no less than 60 mils. The conductors should be no larger than No. 4 AWG and no smaller than No. 8 AWG.

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2802.13.2 Pole and Bracket Cable

Pole wiring above handhole, inside the pole to luminaire(s) shall be insulated two-conductor No. 10 AWG cables (2c #10), type THHN/THWN. For poles with dual luminaires separate cables will be required for each luminaire, which will extend up from the break-away fused connectors.

2802.14 Break-Away Fused and Non-Fused Connectors

Break-away fused connectors shall be in-line waterproof pre-molded fused slip connector assemblies with rubber insulating boots as shown in the Standard Drawings. Fused connectors shall be used for each hot cable, and non-fused connectors shall be used for the ground. Connectors shall have one or two copper set screw type terminals to accommodate the wire sizes indicated in the Plans. Fuses shall be high interrupting 8-Amp fuses.

2802.15 Splices

Splices shall be made in junction boxes with copper type K split bolt connectors. All splices shall be protected with a waterproof resin splice kit installed in accordance with the manufacturer's recommendations.

2802.15.1 Resin Splice Kits

Resin splice kits shall consist of a waterproof protective plastic case designed for the split bolt connector, filled with a resin insulating compound mixed in accordance with the manufacturer's recommendations.

2802.16 Power Supplies

Power supplies shall consist of all equipment and material necessary for the distribution of secondary electrical power as shown on the Plans. Power supplies shall be underground service type, rated for 100 amperes, 240 volts, capable of operating either one or four-circuits.

All power supply assemblies shall be warranted by the manufacturer to be free from defects in workmanship and material for at least one year from the date of project acceptance. Any components found to be defective during the warranty period shall be replaced free of charge. All warranties provided shall be transferred to the City upon project acceptance.

Insofar as practical, major items of electrical equipment supplied under a single contract or tied contracts shall be of the same type and consist of products of the same manufacturer to secure uniformity and satisfactory service.

2802.16.1 Cabinets

Power supply cabinets shall be of the type and size listed in the Plans or Standard Drawings. Cabinets shall be NEMA 3R construction, dust-tight, watertight, corrosion resistant, and constructed of 0.125-inch minimum non-anodized aluminum alloy and be of clean-cut design and appearance. The cabinet shall include individual meter, panel, contactor, and a service pull "compartment". The meter and panel/contactor compartments shall have piano hinged doors. All hinges, catches and other hardware shall be non-ferrous metal or stainless steel. The meter compartment shall include padlocking provisions, and the panel/contactor outer door shall have a factory installed Corbin lock assembly designed for a standard number 2 key. The panel/contactor compartment shall have an inside panel door. The outer and inside panel doors shall be equipped with an approved doorstop. Cabinets shall have a control panel constructed of the same material as the cabinet. All equipment such as photoelectric cells, contactors, relays, terminal blocks, circuit breakers, and lightning arrestors shall be installed on the panel as shown on the Plans. The panelboard shall have silver plated copper buss and shall accept the required number of 1 inch (1") plug-in breakers. Panelboard compartment shall contain photoelectric cell, and test switch.

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All factory installed wire shall be 600 volt rated copper. All terminals shall be approved for copper or aluminum wire. The cabinet shall have a natural aluminum finish.

2802.16.2 Photoelectric Cells

Photoelectric cells shall be of the solid-state type operating on 240 volts, and shall operate on a line supply of 50 to 60 hertz. The load capacity of the photoelectric cell relays shall be a minimum of 1000 watts. Photoelectric cells shall operate a lighting system through mercury load relays. The photoelectric cell circuitry shall be designed to be normally closed at night. The photoelectric cell shall be configured such that in the event of failure, the lights shall be on. The photoelectric cell shall be mounted inside the power supply cabinet such that all luminaires within the system operate simultaneously and shall illuminate only during hours of darkness or low visibility. Turn-on shall occur at 2.6 footcandles \pm 0.5 footcandles. The photoelectric cell shall have an inverse off/on ratio for energy savings. Photoelectric cells shall sense light levels with a non-drifting phototransistor. The photoelectric cell shall have a time delay to avoid turn off due to lightning and transient light. A suitable bracket for mounting the photoelectric cell shall be provided. The photoelectric cell shall be mounted into a three-prong twist lock socket, on the side of the cabinet. Test switches used with photoelectric controls shall be three-position switches as shown on the Plans. Test switches shall be clearly labeled and mounted in the cabinet.

2802.16.3 Contactors, Relays, and Terminal Blocks

Contactors, relays and terminal blocks shall be housed in the cabinet and shall be of the type shown in the Standard Drawings. The components shall be sized for each lighting circuit as shown on the Plans. Contactors shall not be electrically or mechanically held, nor shall they include any fusing.

2802.16.4 Circuit Breakers

All circuit breakers shall be molded-case thermal-magnetic Type B plug- on circuit breakers. The number and trip rating of circuit breakers shall be as shown on the Plans. All breakers shall be designed for panel mounting with cable connections on the line and load sides. Type B circuit breakers shall have a minimum of 10,000 amps alternating current interrupting rating at 240 volts alternating current. Type B circuit breakers shall have a nominal size no greater than one inch (1") wide by four inches (4") high by three inches (3") deep. Terminals shall be configured for the wire sizes as shown on the Plans. If the breaker terminals are not designed for the required wire sizes, suitable terminal adapters, connectors or terminal blocks shall be used to convert the wire sizes.

2802.16.5 Lightning Arrestors

Lightning arrestors shall be rated at 650 volts alternating current.

2802.17 Spare Equipment

If spare equipment is included in the contract, such equipment shall conform to these Specifications. The items shall be delivered new and undamaged at the place and time specified by the City Engineer. All existing equipment in excess of the requirements of this project shall be completely removed from the project site by the Contractor and delivered at the place and time specified by the City Engineer.

2803 CONSTRUCTION REQUIREMENTS

2803.1 Scope

This section governs the construction of all bases and the installation of all luminaires, poles, conduits, cables and other material and equipment as required to complete the street lighting

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system as shown on the Plans, the Standard Drawings, and as specified in the Project Special Provisions.

2803.2 Screw-in Anchor Base Installation

The Contractor is responsible for verifying the correct line and grade of all screw-in anchor bases prior to installation. The Contractor shall stake the location of all street lighting poles to be installed. The City Inspector shall inspect the staking prior to any excavation and/or construction. Minor relocation of equipment to avoid conflicts may be allowed with the approval of the City Engineer.

Screw-in anchors shall be of the size and type required for the pole. If rock is encountered, the screw-in anchor may be installed in a pre-drilled hole and backfilled with concrete, in accordance with Section 2802.6, or Type B flowable backfill in accordance with Section 2600 of the City of Lee's Summit, Missouri Design and Construction Manual.

The base shall be screwed straight into the ground and the steel base plate shall be at the proper elevation and properly oriented to receive the shoe base. During installation the anchor shall be plumbed with a level. The base plate shall be flush with the finished grade. Minor leveling adjustments may be made with the use of leveling shims or washers. Shims and washers shall be galvanized or cadmium-plated steel no more than one-quarter inch (0.25") thick. Only one shim or washer will be allowed at any one anchor bolt. The installing torque for screw anchor bases shall be between the maximum and minimum torque ratings shown on the Standard Drawings or per the manufacturer's recommendations.

Conduit bends shall be installed into all screw-in anchors through the slots in the base of the anchors. After conduit bends are installed and capped, the internal cavity of the screw in anchor shall be backfilled with sand or other fine aggregate material, as approved by the City Engineer.

2803.3 Concrete Base Installation

The Contractor is responsible for verifying the correct line and grade of all concrete bases prior to installation. The Contractor shall stake the location of all street lighting poles and power supplies to be installed. The City Inspector shall inspect the staking prior to any excavation and/or construction. Minor relocation of equipment to avoid conflicts may be allowed with the approval of the City Engineer.

All concrete bases shall be of the size and type show in the Standard Drawings, including all reinforcing steel.

Reinforcing steel for concrete bases shall be accurately cut and bent to the dimensions and shapes shown on the Plans. Cutting and bending tolerances for reinforcing steel shall be in accordance with the Concrete Reinforcing Steel Institute's *Manual of Standard Practice*. Flame-cutting of uncoated reinforcing steel may be permitted. Reinforcing steel shall be protected from damage at all times. When placed in the work and before concrete is placed, reinforcing steel shall be free from dirt, oil, paint, grease, loose mill scale, thick rust, any dried mortar and other foreign substances. A thin layer of powdery rust may remain. Reinforcing bars shall be positively secured against displacement. The bars shall be firmly tied at alternate crossings or closer. The steel shall be spot welded or tied in the correct position with proper clearance maintained between the forms and the reinforcement. The Contractor shall construct the unit as shown on the Plans. Measurements to reinforcing steel will be made to the centerline of bar, except where the clear distance from face of concrete is shown on the Plans. Splicing of bars shall not be allowed.

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PVC conduits and conduit bends should be set in the forms for concrete bases. Pole and power supply bases shall have separate conduits for exiting/entering cables and a separate one inch (1") conduit for the ground wire. The direction of the exiting conduits and the orientation of the power supply shall be as shown in the Plans. Conduit set in concrete bases shall extend approximately three inches (3") above the base vertically and a minimum of three inches (3") outside the base horizontally underground.

The bottom of all concrete bases shall rest on firm ground. Forms shall be true to line and grade. The top of the base for street light poles, except raised bases, shall be finished to curb or sidewalk grade, or as directed by the City Engineer. Forms shall be rigid and securely braced in place. Conduits and anchor bolts shall be placed in proper position, to proper heights, and held in place by means of a template until the concrete sets. Conduits shall be covered before concrete is poured to prevent concrete from entering the conduits. All portions of the anchor bolts extending above the base shall be threaded. Anchor bolts shall align with the bolt holes on the shoe base. Anchor bolts shall be provided with two (2) hex head nuts, flat washer, and lock washer. One nut shall be installed on each anchor bolt to be embedded in the concrete base, to within 1/8" above flush with the top of the base. Both forms and ground which will contact the concrete shall be thoroughly moistened before placing concrete.

Pole base and power supply bases shall be poured monolithic. Bases shall be consolidated by an internal type vibrator. The vibrator shall operate at frequencies of vibration not less than 5,000 cycles per minute under load. The amplitude of vibration shall be adequate to consolidate concrete properly. The concrete shall be cured with an approved moisture barrier such as wet burlap, polyethylene, etc., for a period of seventy-two (72) hours. Cold weather curing shall be such that the concrete temperature shall be maintained above freezing for the entire curing period. Forms shall not be removed until the concrete is thoroughly set. The exposed portions of the base shall be finished to present a neat appearance. Finishing should be done with the positioning jig in place. If the jig must be removed for finishing, it shall be re-installed immediately after finishing and left in place throughout the cure period. A safety device (traffic cone, Type I barricade, etc.) shall be installed over each pole base immediately after finishing and remain in place until the pole is installed. Prior to installing the pole, the positioning jig shall be removed and loose concrete cleaned from around the anchor bolts and conduits.

Cinders, broken concrete, broken rock or other hard or undesirable material shall not be used for backfilling around the finished base. The backfill material shall be placed in layers not to exceed six inches (6") deep, and each layer shall be thoroughly compacted to the approximate density of the adjacent material before the next layer is placed.

2803.4 Conduit Installation

Conduit shall be installed as shown in the Plans and the Standard Drawings. The size of the conduit used shall be as shown on the Plans. It shall be the privilege of the Contractor, at his own expense, to use larger size conduit if desired, as approved by the City Engineer. Where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted. No additional payment will be made for larger conduit.

Wherever a conduit passes beneath a curbed street, aluminum conduit markers shall be installed in the curb immediately over the conduit location. Conduit markers shall be furnished by the Contractor as detailed in the Standard Drawings and shall be installed in the top of the curb by drilling the curb and epoxying the conduit marker in place. Conduit markers are subsidiary to the installation of conduit.

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The ends of all conduits shall be well-reamed to remove burrs and rough edges. All conduits shall be cleaned and swabbed prior to installation of cable. Field cuts shall be made square and true so that the ends will butt or come together for the full diameter thereof. The end of each conduit run shall be covered to prevent water or debris from entering the conduit while the system is being constructed.

Existing underground conduit to be incorporated into a new system and GRS conduits shall be cleaned with a mandrel and blown out with compressed air.

An approved factory coupling shall be used for connection of the HDPE conduit to a 90° factory PVC elbow or between two lengths of HDPE conduit.

Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, conduit bends shall be made without crimping or flattening, using the longest radius practicable and utilizing an appropriate conduit bending tool.

The conduit shall be installed continuous from outlet to outlet or as otherwise shown on the Plans. With respect to HDPE conduit, no couplings or joints will be allowed at intermediate points unless approved by the City Engineer. The conduit may be directional bored to minimize disruption to the existing improvements or may be plowed or trenched. Conduit shall be installed under pavement sections at a depth not less than 24 inches (24"); and where laid in trenches in unpaved areas, conduit shall be laid to a depth of 24 to 36 inches (24" to 36") below natural ground level or finish grade.

At all outlets, conduit shall enter from the direction of the run. PVC conduit bends shall enter all junction or pull boxes from below the box and shall extend into the box a minimum of 4 inches (4") as shown on the Plans. GRS conduits may enter a pull or junction box from the side. The side of the box shall be drilled per the manufacturer's recommendations. The hole shall be no more than one-half inch (1/2") larger than the conduit. The gap between the box and conduit shall be filled with sealing compound.

2803.4.1 External Conduit on Structure

GRS conduit shall be used when conduit is to be installed externally on structures. Conduit on structures will include conduit on bridges, retaining walls or other structures, and shall be installed as shown on the Plans or as directed by the City Engineer. The final location of all conduit and junction boxes shall be approved by the City Engineer before installation begins. Conduit shall not be attached to prestressed concrete girders or prestressed, precast concrete deck panels. The conduit shall be secured to the concrete with clamps at no more than 5-foot intervals. Concrete anchors shall be in accordance with federal specification FF-S-325, Group II, Type 4, Class I, and shall be galvanized in accordance with ASTM A 153, B 695-91 Class 50, or constructed of stainless steel. The minimum embedment in concrete shall be 1 3/4 inches. If it is necessary to anchor the conduit to steel bridge members, the attachment method shall not involve drilling, grinding or welding. Attachment method to steel members shall be approved by the City Engineer. Expansion fittings shall be installed at each end of a bridge and each location where the conduit crosses a bridge expansion joint. The expansion fitting shall provide a minimum movement in either direction as shown on the Plans or as specified by the City Engineer. Clamps, concrete anchors, expansion fittings, and any hardware or material required for conduit installation on structures shall be at the Contractor's expense.

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2803.4.2 Trenching

Trenches shall be excavated to a maximum width of six inches (6") and deep enough to provide the minimum cover for conduits as shown in the Standard Drawings. Trenches leading to screw-in anchor bases shall not be wider than the shaft of the anchor. Conduit shall be allowed to "snake" in the trench, but there shall be no sharp bends and if two or more conduits are placed in a common trench, the conduits shall not cross each other. If the bottom of the trench is in rock or rocky soil, the conduit shall be placed on a six inch (6") protective layer of clean, tamped backfill material. Trenches shall be backfilled as soon as practical after the installation of conduit, but after inspection of the trench by the City Engineer or designee. Backfill material installed within six inches (6") of the conduit shall be free of rock or other solid material that might cause mechanical damage to conduit. The backfill material shall be placed in layers not to exceed 6 inches (6") deep, and each layer shall be thoroughly compacted to the approximate density of the adjacent material before the next layer is placed. Red burial tape imprinted with "CAUTION - BURIED CABLE BELOW" shall be installed in all trenches at approximately 1/3 to 1/2 of the depth of the trench. The four to six inches (4" to 6") of backfill material directly below finished grade shall be topsoil. All disturbed areas shall be restored to the satisfaction of the City Inspector.

2803.4.3 Plowing

Conduit may be installed by plowing in unpaved areas. The equipment used for plowing conduit is designed specifically for that purpose with the power and versatility to easily and accurately bury the various sizes of conduit under all normal soil conditions. This equipment places the conduit without twisting, kinking, or damaging the material in any way. The vibrating unit shall be attached to a tractor unit in such a manner that the tractor does not dampen the vibration. The cable way and guides shall be smooth, free of obstructions and sharp edges and shall not cause bending of the conduit at shorter than the minimum bending radius recommended by the manufacturer, nor cause excessive strain to the conduit. Conduit reels may be mounted on the tractor or conduit unreeled along the proposed route before plowing in such a manner to allow as direct a line as possible to the trench to avoid unnecessary bending of the conduit or rubbing of the conduit against the reel. The plow shall not be backed onto the conduit. If an underground obstruction is encountered, the plow shall be lifted out of the ground and the obstruction removed. Conduit may be installed utilizing the pull plow method if approved by the City Engineer. After installation of conduit by plowing, the disturbed earth shall be leveled and, if necessary, compacted by a device approved by the City Engineer. Ends of conduit shall be capped immediately after cutting to prevent moisture and debris from entering the conduit. Red burial tape imprinted with "CAUTION - BURIED CABLE BELOW" shall be installed in all trenches at approximately 1/3 to 1/2 of the depth of the trench. All disturbed areas shall be restored to the satisfaction of the City Inspector.

2803.4.4 Boring

Pavement shall not be disturbed without the written permission of the City Engineer and then only in the event insurmountable obstructions are encountered. Conduit shall be placed under existing pavement by boring. The Contractor shall complete the boring as to maintain minimum permissible clear distances, both horizontally and vertically, from all underground utilities. Boring pits shall be kept two feet (2') clear of the edge of any type of pavement wherever possible. Boring alignment shall be perpendicular to the curb line in order to achieve the shortest possible crossing distance. Excessive use of water such that pavement might be undermined or subgrade softened, will not be permitted. The Contractor shall at all times and for the entire length of the boring alignment be able to demonstrate the horizontal and vertical position of the alignment. All disturbed areas shall be restored to the satisfaction of the City Inspector. Boring may be used instead of trenching at all other locations.

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2803.5 Pull and Junction Box Installation

Pull and junction boxes shall be installed as shown on the Plans, Standard Drawings, or as directed by the City Engineer.

The top surface of all pull or junction boxes shall be flush with surfaced areas and approximately one inch above earth or sodded areas. All boxes shall have one-half inch ($\frac{1}{2}$ ") clean crushed aggregate or other porous material for a minimum depth of twelve inches (12") below the box for drainage. The excavated opening outside the junction box shall be wide enough to allow compaction of the backfill material. Cinders, broken concrete, broken rock or other hard or undesirable material shall not be used for backfilling. The backfill material shall be placed in layers not to exceed six inches (6") deep, and each layer shall be thoroughly compacted before the next layer is placed. All disturbed areas shall be restored to the satisfaction of the City Inspector.

A pull or junction box placed in an unpaved area shall have a concrete pad around the perimeter as shown on the Plans. Concrete for the pad shall be per Section 2802.6. The concrete shall be reinforced with welded wire fabric. Concrete pads will not be required for boxes installed in concrete. Pull or junction boxes shall not be installed in sidewalk ramps.

Each Class 1 Pull Box shall be equipped with cable hooks as shown on the Plans. Cable hooks shall be galvanized steel or brass with a minimum diameter of $\frac{3}{8}$ inch and a minimum length of five inches (5").

Additional pull or junction boxes may be installed when approved by the City Engineer. If it becomes necessary to increase the excavation depth and extend the box, no direct payment will be made.

2803.6 Power Supply Installation

The power supply, including the cabinet, photoelectric cell, contactors, circuit breakers, lightning arrestor, and any other required materials or equipment shall be constructed and installed as shown on the Plans or as directed by the City Engineer. The Contractor shall coordinate his activities with the electrical utility company to insure delivery of power to the power supply when and where required. The cabinet shall be cleaned of wrapping, shipping material, dirt, grease, etc. Scratches, abrasions or other surface damage shall be repaired to like new condition. The photoelectric cell shall be oriented to the North or to the East.

2803.7 Circuit Wiring

Installation of wiring shall be in accordance with the Plans and Specifications and appropriate articles of the NEC.

Distribution cables shall be continuous and unspliced from the control panel to the first light pole. Cable shall be pulled with minimal dragging on the ground or pavement. Frame mounted pulleys or other suitable devices shall be used for pulling cables out of conduits into pull boxes. Powdered soapstone, talc or other approved lubricant shall be used to facilitate pulling cable in conduits. All cable to be installed in one conduit shall be pulled by the Contractor in one operation, and all ends shall be taped to exclude moisture and shall be so kept until the splices are made or terminal appliances attached. Ends of spare conductors shall be taped. Tape shall be Scotch (3M) No. 33+ "Electrical Tape" or approved equivalent. After cables are installed all conduit ends shall be sealed around the cables with a readily workable, soft, sealing compound. The compound shall be workable at 30° F and shall not melt or run at temperatures up to 175° F.

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Underground cable splices shall be made in a pull or junction box. Splices in the distribution cable will only be permitted where circuits branch or tee. Tee splices shall be made with split bolt connectors or an approved equivalent. All splices shall be protected with a waterproof resin splice kit installed in accordance with the manufacturer's recommendations. All cables passing through a pull or junction box shall be coiled once around the inside of the box to allow for splicing and connecting wires in the future. Wiring within power supplies and boxes shall be neatly arranged and laced up.

All circuits shall be properly labeled in all power supplies and boxes by means of round brass or aluminum identification tags with a minimum thickness of 0.1 mil attached to the cables with copper wire. The ends of the copper wire should be wrapped with electrical tape. Circuits shall be labeled with the power supply ID number and the circuit number.

2803.8 Cable-In-Duct Installation

All applicable portions of the conduit installation and circuit wiring sections apply to cable-in-duct installation. Cable-in-duct may be installed by boring, trenching, or plowing operations. Cable-in-duct runs shall be continuous without splice between the control panel, pole bases, and junction or pull boxes. Cable-in-duct shall extend far enough to provide the required amount of cable slack at all terminations or connections. For concrete bases, rigid conduit of sufficient size to facilitate the pulling of cable-in-duct shall be cast in the base as shown on the Plans. The cable-in-duct shall be installed through the rigid conduit in the base. The plastic duct of the cable-in-duct is to be terminated six inches (6") above the bottom of junction or pull boxes and bases, leaving the cables exposed for connection. All terminations of this plastic duct are beveled free from any sharp edges or burrs. The insulation of the electrical conductor may not be damaged when cutting the duct.

2803.9 Street Light Pole Installation

Street light poles and luminaires shall be installed as shown on the Plans and Standard Drawings, and as specified in the Project Special Provisions or as directed by the City Engineer. Street light poles are to be kept dry and out of the weather until time for erection. The manufacturer's protective paper wrapper may be removed for inspection upon receipt from the manufacturer. Poles and luminaires shall be cleaned of dirt, grease, etc. Scratches, abrasions or other surface damage shall be repaired to like new condition.

Street light poles shall be fastened to screw-in anchor bases or concrete with a break-away base using galvanized hardware, except the 14-foot pole which does not require a break-away base. The pole shall be checked for plumb, minor corrections made using galvanized or cadmium plated steel shim stock, the nuts tightened, and the removable bolt covers installed. Hand holes in the pole and break-away base shall be oriented so that they are 180° from the direction of oncoming traffic. In a median, the hand holes should be oriented 180° from one direction of oncoming traffic, facing either North or East, for all poles installed in medians. The opening in the breakaway base should be located on the same side of the pole as the hand hole.

2803.9.1 Bracket Arm Installation

Bracket arms for luminaires shall project from the street side of the pole and be perpendicular to the roadway. Install a one inch (1") rubber grommet around the hole at the top of the light pole for the cable entrance. Sufficient lengths of pole and bracket cable shall be run inside the length of the street light pole shaft, out through the grommet at the top of the pole, and through the bracket arm. The bracket arm is to be attached to the pole with clamp-on style supports using stainless steel hardware. Cables shall not be pinched when bracket arms are attached to poles.

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For poles with dual luminaires, different color pole and bracket cables shall be run to each luminaire to indicate the directional orientation of each luminaire. When looking at the hand hole, red cables shall be run to the luminaire on the right-hand side of the pole, and black cables shall be run to the luminaire on the left-hand side of the pole.

2803.9.2 Cover Skirt

An aluminum cover skirt must be installed around all four (4) sides of the base plate of screw-in anchor bases if a gap of more than one inch (1") is visible between the bottom face of the base plate and the finished grade. The cover skirt is to be made of two solid sheets of aluminum, alloy designation 3003-H14, which are field cut and shaped to fit flush against the base plate and extend down to the finished grade. The aluminum sheets should overlap each other, and be fastened together with stainless steel self tapping screws.

2803.9.3 Luminaire Installation and Adjustment

Cobra head luminaires shall be installed on the slipfitter at the end of the bracket arm. To give proper illumination on the roadway, the frontal view of the luminaire should be parallel to the grade of the road surface, while in the side view the luminaire should be horizontal. Post-top luminaires not equipped with terminal blocks shall be connected to the pole wiring with approved butt connectors.

2803.9.4 Lamp Installation

The installation date shall be marked on the base of the lamp prior to installing it in the luminaire housing.

2803.10 Electrical Connections

Each distribution cable shall be connected to the corresponding pole and bracket cable in each pole base using a fused or non-fused break-away connector as shown on the Plans.

Two (2) fused connectors should be used for the hot leads, and one (1) non-fused connector should be used for the ground. Each break-away connector should allow two (2) cables to be attached to the terminal on the line side. The load side of the fused connectors should allow one (1) cable to attach to the terminal for single luminaires and two cables (2) for dual luminaires on a single pole. Two (2) pole and bracket cables are to be run from the load side of the fused connectors to each luminaire on the pole. One (1) pole and bracket cable is also to be run from the load side of the non-fused connector to the grounding lug on the street light pole. The connectors shall be installed convenient to the hand hole in the street light pole.

One foot of surplus cable shall be coiled at the line side of each connector and on the load side of each connector. Connectors shall be installed with the fuse or ground slug attached to the load side of the connector. From the load side of the non-fused connector, the ground wire shall be fastened to the factory installed ground lug in the base of the light pole by a 3/8" ring terminal and 3/8" - 16 x 3/4" long hex bolt.

2803.11 Grounding

At each concrete base a ground rod shall be driven in the trench adjacent to the base. This shall also include screw-in anchor bases backfilled with concrete or flowable backfill.

At each power supply base a ground rod shall be driven in the same trench as the 3" conduit for the secondary service connection. The completed ground rod installation and connection to the ground wire shall not be backfilled until it the power supply passes inspection by the City's

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Codes Administration Department. The grounding clamp connection and the listing mark on the rod must be visible for inspection.

The ground rod shall be copper coated to meet NEC requirements, not less than one-half inch (1/2") in diameter, and ten feet (10') in length. Ground rods shall be driven to a minimum depth of twelve inches (12") below the finished surface. If subsurface conditions exist which prohibit the placement of the ground rod in a vertical position, the rod may be driven at an oblique angle, not to exceed 45-degrees from vertical, or when authorized by the City Engineer, buried in a trench at least thirty inches (30") deep. The driven ground rod shall be connected to the grounding lug by a No. 6 AWG copper wire attached to the rod with a galvanized grounding clamp. The ground wire is to be run through a one inch (1") diameter conduit in the base.

2803.12 System Testing

The Contractor is responsible for testing the completed street lighting system. Prior to acceptance by the City, the Contractor shall notify the City Engineer for an inspection as soon as the system(s) is (are) ready.

After a power supply is energized, the resistance to ground shall be tested. The Contractor shall provide a suitable measuring device capable of measuring ground resistance from 0 to 1,200 ohms for the resistance test. The resistance test shall be performed by the Contractor in the presence of and documented by the City Engineer. The ground rod shall have a resistance to ground of 25 ohms or less. If the resistance is more than 25 ohms, the Contractor shall install additional ground rods which are bonded to the first ground rod, until the required resistance is achieved. No payments will be made for additional ground rods.

2803.12.1 Burn Test

All street lighting system elements shall function properly as a complete system for a minimum period of fifteen (15) days before acceptance by the City. The fifteen (15) day period shall be cyclical and initiated by the City Engineer. Any malfunction observed or recorded shall stop the test period for the entire system as of the time of the malfunction. A period shall start when the malfunction has been repaired to the satisfaction of the City Engineer. After the burn test is completed, the street light system(s) must remain in operation if the street is open to vehicle traffic.

2803.13 Maintenance Information

Before acceptance of the work, the Contractor shall furnish the City Engineer four copies of the manufacturers' written instructions for maintenance and operation of all lighting equipment and wiring diagrams of the installation or system. At a minimum, the manufacturer's instructions shall include documented, organized instructions, wiring and component layout diagrams, and parts lists with part numbers.

2803.14 As-Built Plans

Prior to acceptance of the work, the Contractor shall submit marked-up or corrected plans showing in detail all construction changes, especially the location and depth of conduit. The Designer will produce as-built plans from the Contractor's marked-up plans.

2803.15 Final Clean Up

Before final acceptance, the Contractor shall restore to a condition equal to or better than that existing prior to construction, for all property, both public and private, within, adjacent to and beyond the limits of construction that have been disturbed or damaged while executing the work. This includes, but not limited to, existing curb and gutter, sidewalk, pavement, drainage

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structures, irrigation systems, street lighting and traffic signal equipment. All unpaved areas damaged during construction shall be restored to the original condition. Unless otherwise directed, grassy areas which were originally sodded shall be re-sodded. Restoration work shall be at the Contractor's expense. All restoration work shall be acceptable to the Inspector.

2804 MEASUREMENT AND PAYMENT

See Division I – General Requirements for CIP, Section 01120.