



# WESTMINSTER

City of Westminster  
Street Lighting Design, Standards and Specifications  
Revised April 7, 2015

Section	Chapter Title
100	Street lighting Design Criteria
200	Standards and Specifications
300	Standard Details

**SECTION 100  
STREET LIGHTING - DESIGN CRITERIA  
CITY OF WESTMINSTER, CO**

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## STREET LIGHTING

### 101 GENERAL

**101.1 Scope:** These criteria shall be adhered to for the design of all street lighting systems to be installed in the public street right-of-way or of major and minor arterial roadways. The City Traffic Engineer shall be responsible for determining the scope of a street lighting system.

**101.2 System Composition:** The street lighting system shall consist of one (1) or more power supplies, distribution systems, poles, luminaires, and other appurtenances required to provide a complete, operable system. Components of the system shall conform to the specifications of Section 202 MATERIALS AND EQUIPMENT.

**101.3 Modification of Design Criteria:** These criteria are established to provide uniform procedures to aid the Design Engineer in preparing improvement plans for projects in the City of Westminster. These criteria are not to be a rigid set of rules that would restrict the Design Engineer from utilizing creative or original design; however these criteria may be modified only with prior authorization by the City Traffic Engineer.

### 102 DESIGN CRITERIA

**102.1** These criteria shall be followed when specifying the type and placement of equipment for a street lighting system. Copies of the City's Specifications and Standard Drawings are available through the Engineering Division.

**102.2 Illuminance Standards:** The street lighting design and layout shall be based on the illuminance criteria for continuous roadway lighting in the latest edition of the American National Standard Practice for Roadway Lighting, Illuminating Engineering Society of North America (ANSI/IESNA RP-8).

**102.3 Placement of Street Lights:** The street lighting system layout required is dictated by the street classification and is typically continuous. Photometric analysis shall be utilized to calculate the theoretical spacing of street lights to meet the illumination standards for each street classification. The City Traffic Engineer should be consulted to determine the appropriate street classification. The location of street lights shall conform to the criteria below.

**102.3.1** Several values are needed to complete the photometric analysis. A lighting loss factor (LLF) of 0.70 should be utilized. The minimum maintained average illuminance values and the average-to-minimum illuminance ratios listed below are based on the 2000 Edition of the Standard Practice. The values for the R2/R3 pavement surface reflective classification are used.

#### Illumination Standards

Roadway Classification	Area Type	Minimum Maintained Average Illumination (foot-candles)	Average-to-Minimum Illuminance Uniformity Ratio
Arterial	Commercial	2.0	3:1
	Intermediate	1.7	3:1
	Residential	1.3	3:1
Collector	Commercial	1.7	4:1
	Intermediate	1.3	4:1
	Residential	0.9	4:1

- Use Collector-Residential for local residential roadways

## STREET LIGHTING

**102.3.2** The actual spacing of street lights should be the possible spacing nearest to the calculated theoretical spacing. At locations where additional lighting may be beneficial, such as around curves or at intersections, pole spacing may be reduced to improve the lighting levels.

**102.3.3** Street lights can be installed in raised medians with straight curb faces that have a minimum width of four feet (4') between backs of curbs, and in mountable medians that have a minimum width of twelve feet (12') between edges of pavement. Street lights located in medians shall be installed as close as possible to the center of the median. All street light poles in medians shall be a minimum of fifteen feet (15') behind the median nose.

**102.3.4** Street lights should be located to have a minimum clearance of eight feet (8') from all overhead utilities.

**102.3.5** At a roundabout controlled intersection, a minimum of two (2) street lights should be located around the circular roadway, diagonally across from each other. On arterial type roadways, a minimum of four (4) street lights should be placed around the outside of the circulatory roadway. The spacing between the poles should be approximately equal to achieve uniform lighting throughout the roundabout. Street lights on the approaches to roundabouts should also be considered on multi-lane approaches, in areas with high traffic volumes, or where pedestrian traffic is expected.

**102.4 Street Light Poles:** Street light pole types, differentiated by mounting height and luminaire arm length, are illustrated in the Standard Drawings. Equipment to be utilized should be selected based on the criteria listed below.

**102.4.1** Screw-in anchor bases are not allowed.

**102.4.2** All street light poles shall have a minimum setback of three feet (3') measured from the back of curb to the center of the pole base on a curbed street. The minimum setback for a non-curbed street shall be six feet (6') measured from the edge of pavement to the center of the pole base. The minimum setback may be reduced to two feet (2') in raised medians.

**102.4.3** Luminaires should be installed at a maximum mounting height of thirty-five (35') to forty feet (40') above arterial and collector roadways. Poles mounted on structures, such as bridges and retaining walls, may require special lengths as not to exceed the maximum mounting height.

**102.4.4** Luminaire arms should be selected to position the luminaire over the traveled way for greatest utilization of available light. The arms should be oriented 90-degrees, or perpendicular, to the traveled way. Arm lengths should be selected in order to position the luminaires in a straight line when looking down the roadway with the typical arm length designated at 10 foot.

**102.4.5** Decorative street light poles are allowed only with the authorization of the City Engineer.

**102.5 Luminaires:** All luminaires shall utilize Light Emitting Diode (LED) lamps. Other types of lamps may be utilized with the authorization of the City Engineer. All luminaries must be fully shielded (emit no direct up-light) and should at a minimum meet the requirements of the IESNA classification for cutoff light distribution.

**102.6 Spare Equipment:** For large projects, the City will require the Contractor to supply spare street light pole, luminaire arm, luminaire, and break-away base assemblies. One (1) spare assembly should be included for every forty (40) poles to be installed. When non-standard or decorative poles are used, the City may require additional spare street light pole assemblies.

## **103 ELECTRICAL SYSTEM**

**103.1 Standards:** The electrical system shall comply with the National Electrical Code (ANSI/NFPA 70), the National Electrical Safety Code (ANSI C2), and the service standards issued by the appropriate electrical utility company that will be supplying power to the street lighting system. The Design Engineer shall coordinate and verify the location of proposed feed points with the utility company to ensure availability of service.

**103.2 Distribution System:** The following criteria shall govern the design of the electrical distribution system.

**103.2.1 Conduit:** The distribution system shall be underground in two inch (2") diameter Schedule 80 polyvinyl chloride (PVC) conduit or high density polyethylene (HDPE) conduit. Cable-in-duct may be installed for projects in mostly unpaved areas. If conduit is to be installed on a structure, galvanized rigid steel (GRS) conduit should be used. GRS conduit shall be attached to the structure with conduit hangers as shown in the Standard Drawings.

**103.2.1.1** Except where it crosses under a street, the conduit shall be behind the back of curb or outside the edge of pavement in the City right-of-way or approved utility easement. The conduit should be installed at a constant offset from the back of curb or edge of pavement preferably at the same distance as the pole setback, unless a common trench is being used. The minimum setback from the street to the center of the conduit should be the same as that specified for street light poles except in medians, where conduit setback may be closer to the back of curb to avoid landscaping. The setbacks may have to be adjusted in places to avoid storm sewers, utility conflicts, or other obstructions.

**103.2.1.2** In unpaved areas, conduit can be trenched or plowed. Conduit shall be bored under all sidewalks, drives, and streets unless otherwise approved by the City Engineer. Boring under streets shall be perpendicular to the roadway or the shortest possible crossing distance.

**103.2.1.3** The length of conduit is calculated by adding the center to center distances between equipment. All of the center to center distances should be subtotaled and multiplied by 102% to allow for bending of conduit to avoid obstructions.

**103.2.4 Junction and Pull Boxes:** Junction or pull boxes shall be installed at each light pole location and where splices in the distribution cable are required outside the pole base or where sharp 90-degree bends in conduit are required. The distance between boxes and/or street light poles shall not exceed three hundred feet (300') to facilitate the pulling of cable. Boxes must be installed at least three feet (3') away from street light poles. The installation of boxes in sidewalks should be avoided while the installation of boxes in streets and driveways is prohibited. The minimum setback from the street to the center of boxes should be the same as specified for street light poles. Type 1 junction boxes shall be used if one or two (1 or 2) conduits enter/exit the box. Type 2 junction boxes shall be used where three or four (3 or 4) conduits enter/exit the box. A Class 1 pull box shall be located adjacent to each four-circuit power supply, or where five or more (5+) conduits enter/exit the box.

**103.2.5 Circuits:** All circuits shall be two hundred forty volts (240V). Distribution cable shall be sized so that the voltage drop does not exceed five percent (5%) at any point in the system. The Design Engineer is required to submit voltage drop calculations. Three conductor (3c) cables shall be used for each circuit, which are no larger than No. 4 AWG and no smaller than No. 8 AWG.

**103.2.6** Each street lighting circuit shall be contained in a separate conduit, except for the conduit raceway between a four-circuit power supply and the adjacent class 1 pull box. For that raceway, two (2) conduits will be required. The distribution cable for each of the lighting circuits shall be routed through one of these two conduits into the pull box, and then routed out to the first pole for each circuit in separate conduits. Double taps on a circuit breaker are not allowed.

**103.2.7** Street lighting cable is permitted in traffic signal conduit runs and pull boxes, but not within conduits and pull boxes designated for traffic signal interconnect. Street lighting circuits are to enter a traffic signal pole through the adjacent traffic signal pull box. The distribution cables are to be spliced in the traffic signal pole base hand hole access (if necessary), and run up the traffic signal pole to the luminaire fixture. Street lighting cable shall not run through (or terminate in) the traffic signal controller cabinet.

**103.2.8** The length of distribution cable is calculated by adding the center to center distances between all equipment on a circuit. The length of all cable should be subtotaled and multiplied by 102% to allow for bending. Five feet (5') of slack should be added at each light pole base or power supply. Slack should also be added for junction and pull boxes; two feet (2') at each Type 1 junction box, three feet (3') at each Type 2 junction box, and five feet (5') at each Class 1 pull box.

**103.2.9** Pole wiring from the distribution cables to each luminaire shall be two conductor No. 10 AWG (2c #10) pole and bracket cables. The length of pole and bracket cable for each pole is calculated by adding the nominal pole height, the length of the luminaire arm and five feet (5') of slack. This quantity is then multiplied by two for poles with dual luminaires.

**103.2.10 Break-Away Connectors:** Each distribution cable shall be connected to the corresponding pole and bracket cable using a break-away connector. Two (2) fused connectors should be used for the hot leads, and one (1) non-fused connector should be used for the ground as shown in the Standard Drawings.

**103.2.11** All street light poles shall be bonded together to form a continuous system. A No. 6 AWG bare solid copper ground wire enclosed in one inch (1") PVC conduit shall be securely attached to a ground rod with a galvanized grounding clamp at each concrete street light pole base, at each direct buried base, and at each power supply base.

**103.3 Power Supplies:** As shown in the Standard Drawings, one-circuit or four-circuit or eight-circuit power supplies shall be utilized. Power supply bases should be located within the right-of-way or approved general utility easements and be adjacent to and behind the sidewalk, or at least ten feet (10') from the back of curb to the center of the power supply where no sidewalk exists. In locations where no curb exists, the power supply should typically be placed more than ten feet (10') from the edge of pavement to the center of the power supply if possible. Each power supply should be located at least 10 feet (10') from its secondary service point. When the location of the power supply has been finalized and the secondary service point has been verified with the electrical utility company, the City will provide the Design Engineer with an identification number for each proposed power supply. When a power supply contains a photoelectric cell, it shall oriented to the north unless headlights from southbound traffic will be directed at the photoelectric cell, then it should be oriented to the east.

**103.4 Secondary Service:** A 2-1/2 inch (2½") Schedule 80 PVC conduit with a pull string shall be installed from the power supply to the base of the secondary service point (utility pole, secondary pedestal, or pad-mount transformer) as designated by the electrical utility company. The conduit should be installed in a straight horizontal line in accordance with the Standard Drawings. Junction or pull boxes are not permitted in the conduit run between the power supply and secondary service point unless authorized by the electrical utility company. The electrical utility company shall designate who will supply and install the power cable.

**103.5 Pole Numbering:** Street light poles shall be numbered using the power supply identification number followed by the circuit number and pole number. For example the first pole on circuit number 1, from power supply number 6K05 should be labeled as 6K05-1-1. The second pole on the circuit shall be labeled 6K05-1-2.

## **104 PLAN REQUIREMENTS**

**104.1** This section governs the preparation of engineering plans for a street lighting project.

**104.2 General:** The street lighting plans shall include all information necessary to build and check the design of a street lighting system. For new developments, the street lighting plans shall be submitted with the public improvement construction plans (if any) and shall clearly show public street and stormwater drainage improvements and utilities in a deemphasized manner. The cover sheet for the plans shall be signed and sealed by a Colorado Registered Professional Engineer responsible for preparing the plans. The signed and sealed plans shall be submitted to the City Engineer for review and approval prior to construction.

**104.3 Private Improvements:** If any private improvements are shown on the public improvement plans, they shall be clearly defined and marked as such. An appropriate note shall be included on the drawings stating that these private improvements will not be maintained by the City of Westminster. This section is not intended to imply that private improvements will be allowed within the public right-of-way.

**104.4 Sheet Size:** The full-size plan sheet size for improvement plans shall be twenty-two inches by thirty-four inches (22"x34"). Full-size and half-size plans are required for all submittals and may be submitted in electronic form. All sheets in a given set shall be the same size.

**104.5 Types of Sheets in Plans:** The street light improvement plans shall consist of the following:

- Cover Sheet (if necessary)
- General Notes
- Street Lighting Plan Sheet(s)
- Wiring Diagram(s)
- City of Westminster's Street Lighting Standard Drawings
- Traffic Control Details (if necessary)

Each sheet should contain proper project identification, the type of sheet, a sheet number, including the individual sheet number and the total number of sheets, and dates of when the plans were originally prepared and all revisions.

**104.5.1 Cover Sheet:** A cover sheet is not required if street lighting is included as a part of a plan set for a larger improvement project. If necessary, the cover sheet shall include the following information:

A. The project title, centered at the top of the sheet as follows:

**CITY OF WESTMINSTER, COLORADO**  
**COMMUNITY DEVELOPMENT DEPARTMENT/ENGINEERING DIVISION**  
**STREET LIGHTING IMPROVEMENTS FOR**  
**[Name of Roadway], from [start point] to [end point]**  
**Engineering Project Number [when applicable]**  
**Date**

The City logo shall appear to the left of the title block.

- B. An index of the sheets included in the plans.
- C. A list containing the name and telephone number of each utility company and the State One-Call System.
- D. The name, address, and telephone and fax numbers of the Design Engineer.
- E. The name, address, and telephone and fax numbers of the owner/developer, where applicable.
- F. A vicinity map adequately showing the project location in relation to major streets and the section in which it is situated, with a north arrow and appropriate scale.
- G. A signature block to be signed and sealed by the Colorado Registered Professional Engineer responsible for preparing the plans.

**104.5.2 General Notes Sheet:** This sheet should contain a legend of symbols that apply to all sheets, a recapitulation of quantities table, and a list of general notes to the Contractor including any project specific notes. The lighting design calculations and criteria should also be included in the project specific notes.

**104.5.3 Street Lighting Plan Sheet(s):** The street lighting plan sheet(s) shall include the following information:

- A. One or more plan sheets adequately showing the street lighting system in relation to the streets and adjacent properties, with a north arrow, and a bar scale at a minimum scale of one inch (1") equals fifty feet (50'), unless a larger scale is specified by the City Engineer.
- B. All existing and proposed utilities such as power, gas, water, telephone, cable, sanitary sewer, storm sewer, and other items shall be accurately shown according to the best available information in the records of the owner of the facility, or field location, and shall be identified as to type, size, material, etc., as may be applicable. Existing utilities should be shown in gray.
- C. The base plans shall show all existing and proposed easements and right-of-way information. All existing and known proposed improvements within fifty feet (50') each side of the right-of-way and one hundred feet (100') beyond the project limits shall be shown at their proper locations unless otherwise approved or required by the City Project Engineer. These improvements shall include items such as street pavement, curbs and gutters, sidewalks and driveways, storm and sanitary sewers, water mains and fire hydrants, utility poles and pedestals, trees and shrubs, fences and walls, buildings, and similar items, and shall be identified as to type, size, material, etc., as may be applicable. Irrelevant items may be omitted for new developments. Existing items should be shown in gray. New non-street lighting items may be shown with a thin black line. Future non-street light items may be shown with a dashed line.
- D. Street lighting equipment should be identified by station and offset. Street centerline stations should be shown and marked at one hundred-foot (100') intervals. If station and offset are not indicated, the locations of

proposed street lighting equipment should be referenced from existing features that appear on the base plans, such as the back of curb, edge of pavement, utility poles, etc.

- E. Each item to be constructed or installed for the project should be legibly noted. Minimum font size shall be 0.125 inch on a 22" x 34" sheet size. Each power supply should be labeled with the identification number assigned by the City. Street light poles should also be labeled with the power supply identification number, circuit number and pole number as described in Section 103.5.
- F. There should be a table listing the pole number, station, offset, and luminaire arm lengths for all proposed poles. There should also be a table listing the box number, station, offset and type of box for all proposed junction and pull boxes. All proposed equipment shall be listed in the order in which it is located in the plans.

**104.5.4 Wiring Diagram Sheet(s):** This sheet should contain wiring diagrams (overall schematics of the street lighting system) for each power supply. The center to center distance between street light equipment should be indicated on the diagram. A summary table for each circuit should also be included on this sheet indicating the conductor size, circuit length, input amperage, percent voltage drop, circuit assignment at the power supply, and circuit breaker trip rating.

## **105 PRE-CONSTRUCTION REQUIREMENTS AND STEPS**

**105.1 Meter Locations:** Developer and or contractor to coordinate the Meter Location(s) with Xcel Energy.

**105.2 Builders Call Line:** Developer and or contractor to submit a Builders Call Line (BCL) applications with Xcel Energy. The City billing address for the BCL application is: Finance Department, City of Westminster, 4800 W. 92<sup>nd</sup> Ave, Westminster, CO 80031.

**105.3 Meter Address:** Prior to submission of the BCL application, contact the City of Westminster Engineering Division at 303-658-2120 for the meter address before pulling an electrical permit.

**105.4 Staking Approval:** Prior to installation, contact the City's engineering division to inspect the street light location stakes.

**105.5 Material Submittals:** Prior to ordering equipment contact the City's engineering division for submittal of all the materials required in the project. The City will not be responsible for the purchase of non-approved materials associated with the street lighting project. Only approved submitted materials will be accepted.



**SECTION 200**  
**CITY OF WESTMINSTER**  
**STANDARD SPECIFICATIONS**

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## **201 GENERAL**

### **201.1 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.

### **201.2 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.

### **201.3 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.

### **201.4 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.

### **201.5 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 Westminster 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.

### **201.6 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.

### **201.7 Permits and Inspections**

The Contractor shall contact the Department of Community Development 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.

#### **201.7.1 Owner's Building Permit**

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

### **201.8 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.

### **201.9 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.

## **202 MATERIALS AND EQUIPMENT**

### **202.1 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.

### **202.2 Street Light Poles**

The type of pole and length of luminaire arm shall be as specified on the Plans. This specification is in addition to the City of Westminster "Pole and Luminaire Details" Standard Drawing, which describes the Specifications and pertinent design details for various equipment. The equipment specified in the standard details and drawings are only a sample of the type of equipment that may be used and that other types of poles and fixtures may be specified for specific projects. 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 base shall be cast with four (4) 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 the standard 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.

### **202.3 Luminaire Arms**

The luminaire arm assembly for arterials and major collectors shall be a one piece arm and shall be either and 3 bolt simplex mount plate, a slipfit davit ("goose neck" type) or a slipfit arm as show in the standard drawings.

### **202.4 Screw-In Anchor Bases**

Screw-in anchor bases are not allowed.

### **202.5 Flowable Backfill**

All flowable backfill shall be mix design as described in the City of Westminster Design and Construction Manual.

### **202.6 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.

### **202.7 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. 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.

### **202.8 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. 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.

## **202.9 Luminaires**

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

### **202.9.1 Cobra Head Luminaires**

Cobra Head style LED luminaires shall be a power door or drop driver 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 quickconnect electrical hookup for easy installation of the electrical system and easy access to the driver 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, if used, shall be natural unpainted alzak aluminum and shall be secured to the top housing. The luminaire shall 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.

### **202.9.2 Post-Top Luminaire**

The post-top luminaire fixture housing shall be as specified by the City.

## **202.10 LED Lamps**

Luminaires shall be LED type with wattage and lumens rating as specified by the City.

## **202.11 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.

### **202.11.1 Polyvinyl Chloride (PVC)**

Rigid non-metallic conduit shall be polyvinyl chloride (PVC), 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.

### **202.11.2 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.

### **202.11.3 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.

### **202.11.4 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 202.11.2. 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 202.13.

### **202.12 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. At a minimum, pull boxes shall be required adjacent to each street light pole and at each power supply. 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".

### **202.13 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.

#### **202.13.1 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.

#### **202.13.2 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.

### **202.14 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.

### **202.15 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.

#### **202.15.1 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.

### **202.16 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, four or eight-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.

#### **202.16.1 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. 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.

#### **202.16.2 Photoelectric Cells**

Normally a "Control Node" or a "Telecell" equipped with wireless technology for remote control capability shall be required with a 7-pin receptacle for each luminaire fixture. When specifically authorized, 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. When a system photoelectric cell is specifically authorized, 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. When a system photo cell is specifically authorized, 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.

#### **202.16.3 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.

#### **202.16.4 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.

#### **202.16.5 Lightning Arrestors**

Lightning arrestors shall be rated at 650 volts alternating current.

#### **202.17 Spare Equipment**

If spare equipment is required in the project, 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.

### **203 CONSTRUCTION REQUIREMENTS**

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

#### **203.2 Screw-in Anchor Base Installation**

The City does not allow screw-in type anchor bases.

#### **203.3 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 and final location of all equipment is at the sole discretion of the City. 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. 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.

### **203.4 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 but is typically 2 inch in diameter. 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. 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.

#### **203.4.1 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.

#### **203.4.2 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. 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.

#### **203.4.3 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 unreel 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.

#### **203.4.4 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.

#### **203.5 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 (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 202.6. 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 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.

### **203.6 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.

### **203.7 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 handhole base of 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. 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.

### **203.8 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.

### **203.9 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 concrete bases 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 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.

#### **203.9.1 Luminaire Arm Installation**

Luminaire arms 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 arm. Cables shall not be pinched when arms are attached to poles. 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.

#### **203.9.2 Cover Skirt**

If directed by the City Engineer, an aluminum cover skirt must be installed around all four (4) sides of the base plate 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 taping screws.

#### **203.9.3 Luminaire Installation and Adjustment**

Cobra head luminaires shall be installed on the slipfitter at the end of the luminaire 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.

#### **203.9.4 LED Lamp Installation**

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

### **203.10 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.

### **203.11 Grounding**

At each concrete base a ground rod shall be driven in the pull box adjacent to the pole. At each power supply base a ground rod shall be driven in the same trench as the 3" conduit, or if approved in the adjacent pull box, for the secondary service connection. The completed ground rod installation and connection to the ground wire shall not be

backfilled until the power supply passes inspection by the City's Building Division Electrical Inspector. 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.

### **203.12 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.

#### **203.12.1 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.

### **203.13 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.

### **203.14 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.

### **203.15 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 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.