PART 7

STREET LIGHTING AND TRAFFIC SIGNAL SYSTEMS

SECTION 700 – MATERIALS

ADD:

700 MATERIALS. DELETE Part 7 in its entirety and SUBSTITUTE with Caltrans Standard Specifications, 2014 Section 86. See 700-1.2 "Standards" in this City Supplement when The Greenbook refers to 700-3.3 "Standards."

1. Signal, lighting, and electrical system materials and installation work shall be done in accordance with Caltrans Standard Plans, except as herein amended.

2. References to Sections 10 through 95 of the Standard Specifications of the State of California shall apply where shown in Section 86. References in the State Standard Specifications to the State of California, its agencies, or agents shall be construed to refer to the City, its corresponding agencies, or agents.

3. These specifications shall be used in conjunction with 701 – CONSTRUCTION.

4. Section that start with "86" correspond to the same subsection in Section 86 of the Standard Specifications of Caltrans.

700-1 (86-2) MATERIALS AND INSTALLATION.

700-1.1 (86-2.03) Foundations. Spacers shall be inserted between the reinforcing steel cage and the form to ensure that the specified clearance is maintained.

700-1.2 (86-2.04) Standards, Poles, Steel Pedestals, and Posts.

700-1.2.1 General. Standards, regardless of diameter, shall be round unless otherwise noted. Steel standards shall be galvanized (whether or not they are painted). Aluminum 1-A poles, where indicated on the Plans, shall be fabricated of seamless tubing conforming to 6063-T6 wrought aluminum alloy specifications of the Aluminum Association. The base of the post shall be a minimum of 6 inches (150 mm) O.D. tapering to 4½ inches (115 mm) O.D. at the top. The wall thickness of the shaft shall be a minimum of 1/4 inch (6 mm). Ornamental anchor bolt nut covers shall be provided for all traffic signal and/or lighting standards and posts. Edges shall have minimum 1 inch (25 mm) radius.

Standards shall have an aluminum identification plate attached with stainless steel rivets or screws, as specified on the Plans. Each Standard shall have a handhole in the base and a handhole cover. The handholes shall conform to the details shown on the Plans or Standard Plans. The handhole cover shall be securely attached to

the Standard with tamper-resistant hardware or as detailed on the Plans or specified in the Special Provisions.

700-1.2.2 Straightness.

1. For street lighting and pedestrian Standards the maximum deviation shall not exceed the tolerance specified in Table 700-1.2.2 when measured with the Standard in the vertical position. For traffic signal standards the maximum deviation shall not exceed the tolerance specified in Table 700-1.2.2 when measured with the Standard in the horizontal position.

TABLE 700-1.2.2

Length of Standard – Excluding Base		Maximum Allowable Deviation From String Line*
Over	Equal to or Less	
---	21 feet (6.4 m)	½ inch (12mm)
21 feet (6.4 m)	25 feet (7.9 m)	¾ inch (19mm)
25 feet (7.9 m)	35 feet (10.7 m)	1 inch (25mm)
35 feet (10.7 m)	40 feet (12.2 m)	1-¼ inch (32mm)
40 feet (12.2 m)	---	As specified in the Special Provisions.

*The maximum deviation shall be measured from a string line on the face of the Standard, in a plane passing through the longitudinal axis.

2. Short deviations in the Standard shall not exceed 1/4 inch (6 mm) deviation from the centerline of the Standard for each 5 feet (1.5 m) of length.

3. Offsets or jogs due to mold extensions or joints shall not exceed 1/16 inch (1.6 mm) in thickness along the surface of the Standard.

700-1.2.3 (86-2.04B) Mast Arm Replacement or Modification.

1. The welding of mast arms and qualification of welders shall conform to AWS D1.1, "Structural Welding Code." Tenon shall be mechanically held in relation to the mast arm before welding tenon. The Welds and damaged galvanized surfaces of modified mast arms shall be painted with 2 applications of zinc-rich primer as provided in Section 75-1.05, "Galvanizing," of Caltrans Standard Specifications. The second application shall be applied at the installation site.

2. At each mast arm replacement location, a new or completely modified mast arm shall be on hand and ready for installation before closing traffic lanes or ramps. Luminaires installed on modified mast arms shall be adjusted to be tipped up 5 degrees from the horizontal, or as directed by the Engineer.

700-1.2.4 (86-2.04) Concrete Poles.

1. The ultimate strength shall be calculated in accordance with the latest revision of ACI-318 utilizing a load factor of 2. Under working load (including wind loading) the pole must not be stressed beyond the cracking strength. Wind loads shall be as specified in the latest edition of the AASHTO Standards.

2. Poles shall be tapered, centrifugally cast, and pre-stressed. They may be round or octagonal, black and white marble aggregate or natural exposed aggregate, direct burial or anchor base type. The minimum outside diameter or dimension of direct-burial poles shall be 5 inches (125 mm) at the top and 9 inches (225 mm) at the bottom. Pole shape and color shall be uniform for any one project. Replacement poles shall match existing. Aggregates shall conform to current requirements of ASTM C33, except that abrasion requirements therein shall not apply and that no more than 7% shall be smaller than 140 μm (pass a No. 100 mesh sieve). No dye or sealer shall be used without approval of the City.

3. The centrifugal casting process shall produce a center duct throughout the length of the pole. The duct shall be free from sharp projections or edges which might injure the wire or cable. It shall have a minimum diameter of 1-inch in 5-inch (25 mm in 125 mm) top diameter poles and 1 1/2 inches in 6-inch (38 mm in 150 mm) top diameter poles. All reinforcing steel shall have a minimum cover of 16 mm.

4. Four galvanized bar studs shall extend approximately 1 inch (25 mm) above top of standard for attachment of bracket arm. These studs shall be sufficiently embedded so as to provide sound anchorage for the mast arm and luminaire under working loads. Other methods of attachment may be used, with the Engineer’s approval.

5. After curing, the surface of the standard shall be treated to remove cement laitance and develop the surface texture. When finished, poles shall be without

cracks or brazing and shall have a uniform surface (without objectionable mold marks) and texture throughout the entire length. Maximum deviation from string line at any point shall not exceed 0.03-inch per foot (2.5 mm per meter) of length.

6. Direct burial poles furnished with sand and gravel aggregate shall have a concrete finish free from fins or other imperfections and shall have a finish equal to Class 1, see 303-1.9.3, "Class 1 Surface Finish." At the base of the concrete standard, the pre-stressing steel shall be cut off 1/8 inch (3 mm) minimum below the surface. The exposed ends of the pre-stressing steel and the base of the light standard shall be heavily coated with roofing asphalt or coal tar enamel.

7. Reinforcing steel, cables, deformed bars, base plates, anchor bolts, and stud bolts shall be electrically bonded together. Mast arms shall be positively bonded to stud bolts, reinforcing steel and cables, or both by welding or brazing of steel materials, or brazing or mechanically connecting copper strap to steel members. A 1/4 inch (6 mm) hot dip galvanized or stainless steel bolt, accessible through the access holes, or a copper strap brazed or mechanically connected to the reinforcing steel shall be provided to ground direct burial poles.

700-1.2.5 Metal Standards.

700-1.2.5.1 General.

1. The top of each Standard shall be equipped with an ornamental cap which shall be securely held in place by a 3/4 inch (19 mm) diameter hex head machine bolt. Provisions shall be made for substituting 3/4 inch (19 mm) diameter steel insulator pin. The cap and cap support surface shall have sufficient strength to transfer to the Standard, from a point 5 inches (125 mm) above the top of the cap, a 950 lbs (4,250 N) horizontal loading.

2. Metal standards shall withstand, without permanent deformation, a maximum horizontal load of 950 lbs (4,250 N) applied to the center of the cap that is attached to the Standard. In addition, metal standards shall withstand, without exceeding a deflection of 2-5/16 inches (60 mm) a normal horizontal load of 370 lbs (1,650 N) applied to the cap that is attached to the top of the Standard.

3. Exposed edges of plates that comprise the base assembly shall be finished smooth. Exposed corners shall be rounded unless otherwise shown on the Plans. Slots or drilled holes shall have a tolerance of 0 to + 1/8 inch (3 mm).

4. Metal standards shall be equipped with anchor bolt covers made of metal of the same type as that used for the shafts or as specified on the Plans or Standard Plans. Anchor bolt covers shall be equipped with all necessary fittings and hardware for securing the bolt covers to the Standard.

700-1.2.5.2 Steel Standards.

1. Unless otherwise specified in the Special Provisions, steel standards shall be fabricated from sheet steel of weldable grade having minimum yield strength, after fabrication, of 40,200 psi (276 MPa). When a single-ply 5/16 inch (8 mm) thick steel standard is specified, a 2-ply steel standard with an equivalent section modulus may be substituted unless otherwise specified in the Special Provisions. Certified test reports that verify conformance to this minimum yield strength shall be submitted to the Engineer in accordance with 2-5.3 Submittals.

2. Steel standards may be fabricated from full length sheets or shorter sections. Each section shall be fabricated from not more than 2 pieces of sheet steel. Where 2 pieces are used, the longitudinal welded seams shall be directly opposite each other. When the sections are butt welded together, the longitudinal welded seams on adjacent sections shall be placed to form continuous straight seams from the base to the top. In addition, butt welded sections shall be strengthened by inserting a welded sleeve at each joint. The sleeve shall be fabricated from steel 1/8 inch (3 mm) nominal thickness or thicker of the same composition as the steel used in the Standard. The sleeve shall have a minimum length of 1 inch (25 mm). The sleeve shall be centered at the joint and have the same taper as the Standard such that the outside of the sleeve is in full contact throughout its length and circumference. The weld metal at the transverse joint shall extend to the sleeve. No transverse joint shall occur within 3 inches (75 mm) of mast arm fittings.

3. All welds shall be continuous and conform to the requirements of 700-2. The welds joining the shafts of Standards to their base plates shall be as shown on the Plans or Standard Plans. However, alternative weld joint details may be approved by the Engineer. Approval of alternative weld joint details will be contingent upon the proposed weld joint passing both weld procedure and nondestructive testing as deemed necessary by the Engineer. All costs of the weld procedure and nondestructive testing shall be borne by you.

4. Longitudinal welds in steel tubular sections will be tested by the Agency in conformance with the requirements in California Test 664. The sampling frequency shall be as directed by the Engineer. The welds may be made by the electric resistance welding process. Exposed welds shall be ground flush with the base metal.

5. Steel standards shall be galvanized by the hot-dip process conforming to 210-3 Galvanizing, or cadmium plated with Type NS coating conforming to ASTM B766. If specified in the Special Provisions or shown on the Plans, steel standards shall be painted in accordance with 210-1 Paint. Painting shall conform to 310 Painting.

700-1.2.5.3 Aluminum Standards.

1. Aluminum standards shall be fabricated from seamless tubing conforming to "6063-T6 wrought aluminum alloy of the Specifications of the Aluminum Association" or the specifications in Table 700-1.2.5.3.

TABLE 700-1.2.5.3

ITEM	ASTM SPECIFICATION NO.
Castings	B26/B26M
Luminaire Arm	B490-90a
Spun Shaft	B241/B241M
Square Extruded Shaft	B429

2. The wall thickness of the shaft shall be a minimum of 1/4 inch (6 mm). Aluminum standards shall be supplied with a mill finish, and be uniform and commercially sound in conformance with ASTM B209M.

700-1.2.6 Fiberglass Standards.

1. Fiberglass standards shall consist of fiberglass-reinforced thermosetting plastic poles. Fiberglass standards shall be hollow, tapered or with tapered sections, be non-conductive and chemically inert. Fiberglass standards shall be in conformance with current AASHTO manual titled "Standard Specifications for Structural Supports for Signs, Luminaires, and Traffic Signals" (2013) and ANSI requirements. You shall submit to the Engineer a Certificate of Compliance from the manufacturer in accordance with 2-5.3 Submittals; the certificate shall include a copy of all applicable test reports. The test reports shall be signed and stamped by the licensed engineer who supervised the tests. The certificate shall also comply with 4-1.5 and certify that the Standards were manufactured in accordance with an Agency-approved testing and quality control program.

2. Fiberglass standards shall be constructed of continuous fiberglass filaments combined with thermosetting polyester and ultraviolet-resistant resin. The fiberglass and resin ratio shall contain at least 65 % glass and 35 %resin by weight. The resin shall be pigmented as required by the Standard Plans or Special Provisions and be of uniform color throughout the entire body of the Standard. The glass filament shall be helically wound under tension at angles to provide axial strength. The finish shall be smooth.

3. Fiberglass standards shall be flame resistant in accordance with ASTM D635. In addition fiberglass standards shall be reinforced in areas of handholes, conduit entrance openings, and mast arm connections.

4. Fiberglass standards shall be direct burial or have an anchor base as shown on the Plans or the Standard Plans. The base shall be bonded to the pole with an adhesive recommended by the manufacturer, and coated with an aliphatic-type acrylic-modified polyurethane finish. Each Fiberglass standard shall be equipped with a removable aluminum or galvanized steel pole top cap.

5. An aliphatic-type acrylic-modified polyurethane coating shall be applied to the exterior of each fiberglass standard. The coating shall be semi-gloss, weather resistant and match the color of the resin specified in the Special Provisions. The coating shall have a minimum of 3 mils (75μm) dry film thickness. A 1 quart (1 liter) can of the coating that matches the specified color shall be furnished as specified in the Special Provisions. The polyurethane coating shall be tested by the manufacturer for adhesion in accordance with the requirements of ASTM D3359, Method A and shall have a scale rating of 5A. The adhesion testing shall be conducted before and after the accelerated weathering evaluation by the manufacturer. You shall provide the Engineer with a copy of the test results from the manufacturer in accordance with 2-5.3 Submittals. The test reports shall be signed and stamped by the licensed engineer who supervised the tests.

6. Finished surfaces shall be capable of withstanding a minimum of 2,500 hours of accelerated weathering when tested by the Agency, in accordance with the requirements of ASTM G154. Testing lamps shall be UV-B (313nm wavelength). The testing cycle shall consist of 4 hours of ultraviolet (UV) exposure at 140°F (60°C), followed by 4 hours of condensate exposure at 100°F (40°C). After testing, the finished surface of fiberglass standards shall exhibit the following:

    a) Fiber Exposure - None

    b) Crazing - None

    c) Checking - None

    d) Chalking - Very slight

    e) Change in color - May dull slightly.

7. Each fiberglass standard shall be spiral-wrapped in its entirety with a weatherproof wrap for protection during shipping and storage.

700-1.2.6.1 (86-2.04) Fiberglass Lighting Standards.

1. Where indicated on the Plans, standards utilizing fiberglass-reinforced thermosetting plastic (FRP) poles may be substituted for steel lighting standards as provided below:

Table 700-1.2.6.1(A)

Steel Standard	FRP Equivalent
Type 15	Type 15F
Type 15 with Slip Base	Type 15F (Breakaway)
Type 21	Type 21F
Type 30	Type 21F
Type 30 with Slip Base	Type 21F (Breakaway)

2. Fiberglass lighting standards shall consist of round, fiberglass-reinforced thermosetting plastic poles with aluminum mast arms. FRP poles shall be hollow, tapered or with tapered sections, non-conductive and chemically inert.

3. FRP lighting standards shall conform to the details shown on the plans, and shall comply with requirements in the AASHTO manual titled "Standard Specifications for Structural Supports for Signs, Luminaires, and Traffic Signals" (2013) and ANSI Roadway Lighting Document C136.20, "Fiber-Reinforced Plastic (FRP) Lighting Poles."

4. FRP lighting standards specified as "Breakaway" types shall also comply with the requirements in the National Cooperative Highway Research Program Report 230, "Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances." Design wind velocity for lighting standard systems shall be 100 mph (160.9 Km/hr).

5. You shall provide the Engineer a Certificate of Compliance from the manufacturer in accordance with 4-1.5, "Certificates of Compliance," of the Standard Specifications. The certificate shall also include a copy of all applicable test reports on the lighting standards. The test reports shall be signed by the manufacturer's management person responsible for the tests. The certificate shall also certify that the lighting standards comply with the

requirements of the specifications and were manufactured in accordance with the approved testing and quality control program.

6. Each standard shall have an identification plate conforming to the provisions in the second paragraph of Section 86-2.04, "Standards, Poles, Steel Pedestals and Posts," of Caltrans Standard Specifications. The identification plate shall show the standard type, manufacturer's name, manufacturer's part number and the year of fabrication. If the lighting standard is a breakaway type, the identification plate shall include the word "BREAKAWAY". The plate shall be located either on the anchor base or just above the handhole.

7. The pole shall be constructed of continuous fiberglass filaments combined with thermosetting polyester, ultraviolet-resistant resin. The fiberglass and resin ratio shall contain at least 65% glass and 35% resin by weight. The glass filament shall be helically wound under tension at angles to provide axial strength. The pole shall be flame resistant in accordance with ASTM D635. The resin shall be pigmented light gray and be of uniform color throughout the entire body of the pole. The finish of the pole shall be smooth.

8. Each pole shall have a handhole and handhole cover, bearing the name of the manufacturer. The handhole cover shall be securely attached to the pole with tamper-resistant hardware. The handhole shall be located on the side away from the mast arm. The pole shall be reinforced in areas of hand holes, conduit entrance opening, and mast arm connection.

9. The pole shall be smooth, round and uniformly tapered above ground and anti-rotation shaped below ground. The pole shall be direct burial or anchor base as specified on the plans. Each standard shall be provided with a removable aluminum or galvanized steel pole top cap.

10. The base shall be bonded to the pole with a suitable adhesive, and coated with an aliphatic-type acrylic-modified polyurethane finish. For new installations, adaptor plates shall not be used to attach the standard to the foundation.

11. FRP lighting standards that are not specified as "Breakaway" types shall not have the machined groove inside the anchor base casting as shown in the "Aluminum Anchor Base Elevation" detail shown on the plans.

12. Direct burial poles shall have a 2-inch x 6-inch (50 mm x 150 mm), nominal size, grommetted conduit/conductor entrance located 600 mm ± 25 mm (2 feet ± 1 inch) below finished grade after installation. The entrance shall be located directly below the handhole. The butt end of the direct-burial pole shall be flared, or modified by some other acceptable means, to increase the resistance to rotation and pullout and provide additional ground bearing resistance.

13. The pole, with specified luminaire and mast arm installed, shall withstand the bending strength test load shown in the following table. The pole shall

withstand this load with the handhole in compression. The pole shall not exceed a maximum deflection of 13 % of the length of the pole above the ground line when subjected to the deflection test load shown in the following table:

700-1.2.6.1(B) Test Load Table

Standard Type	Bending Strength Test Load	Deflection Test Load
Type 15F, Type 15F (Breakaway)	2406 N (540 pounds)	1606 N (360 pounds)
Type 21F, Type 21F (Breakaway)	2562 N (575 pounds)	1708 N (385 pounds)

14. Test loads shall be applied according to Section 12, "Pole Deflection Measurements," of ANSI C136.20. Poles shall be loaded 12 inches (300 mm) below the tip.

15. In addition to the requirements stated above, aluminum mast arms shall comply with requirements in the Aluminum Association's Publication 30, "Specifications for Aluminum Structures." Length of mast arm shall be as shown. Outer end of the mast arm shall be provided with a 2 3/4 inch (70 mm) O.D. slipfitter, 6 inches (150 mm) long.

16. An aliphatic-type acrylic-modified polyurethane coating shall be applied to the exterior of the fiberglass pole. The coating shall be semi-gloss, highly weather resistant and light gray in color matching the color of the resin and shall have a minimum 0.075 mm (3 mils) dry film thickness. A one liter (1 quart) can of the coating to match the poles shall be supplied with each order of poles. The polyurethane coating shall be tested for adhesion to the pole surface in accordance with the requirements of ASTM D 3359, Method A and shall have a scale rating of 5A. The adhesion testing shall be conducted before and after the accelerated weathering evaluation.

17. The finished surface of the pole shall be capable of withstanding a minimum of 2,500 hours of accelerated weathering when tested in accordance with the requirements of ASTM G 154. Lamps shall be UV-B (313 nm wavelength). The testing cycle shall be 4 hours of ultraviolet (UV) exposure at 60 °C (140 °F) and then 4 hours of condensate exposure at 40 °C (100 °F).

18. After testing, the finished surface of the pole shall exhibit the following:

Table 700-1.2.3

Fiber exposure:	None
Crazing:	None
Checking:	None
Chalking:	Very slight
Change in color:	May dull slightly

19. Each pole shall be spiral wrapped in its entirety with a weatherproof wrap for protection during shipping and storage.

20. Installation and backfilling for direct burial poles shall be as provided for wood poles in Section 86-2.12, "Wood Poles," of Caltrans Standard Specifications. The pole butt end shall be embedded into the ground 5 feet (1.5 m) deep.

21. Each FRP lighting standard shall have its luminaire, mast arm, and anchor bolts effectively grounded as provided in Section 86-2.10, "Bonding and Grounding," of the Standard Specifications. A separate bonding connection to the mast arm will not be required provided there is non-insulated contact between the luminaire and the mast arm.

700-1.2.6.2 (86-2.04) Fiberglass Type 1-A Traffic Signal Standards.

1. Fiberglass Type 1-A standards shall conform to dimensions shown on Caltrans Standard Plan ES-7B.

2. The design of the pole assembly shall use latest edition of AASHTO "Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals" when calculating maximum expected wind loading. The pole shall be designed to not deflect more than 5% when loads are applied.

3. The pole shall be smooth, round and uniformly tapered. The pole shall be constructed of continuous fiberglass filaments combined with thermosetting polyester resin. The fiberglass and resin ratio shall contain at least 65% glass and 35% resin by weight. The glass filament shall be helically wound under tension at angles to provide axial strength. The pole shall be reinforced in

areas of hand holes. A coating shall be applied to the pole surface to maintain surface integrity against the effects of sunlight and extremes in the weather. The pole resin and surface coating shall be gray unless otherwise noted. The pole shall be flame-resistant in accordance with ASTM D635. A 2½-inch by 5-inch (6.5 mm x 13 mm) oval hand hole with cover plate shall be located in the pole a minimum of 12 inches (300 mm) above the base plate.

700-1.3 (86-2.05) Conduit.

1. When approved by the Engineer, conduit runs shown on the plans to be located behind curbs may be installed in the street, within 4 feet of and parallel to the curb, by narrow trenching. All pull boxes shall be located behind the curb or at locations shown on the plans. Narrow trenching shall be Type "A" or Type "E" as shown in the Standard Drawings, except that the top of the conduit shall be installed a minimum of 18 inch (45.7 cm) below the pavement surface or three 3" below the bottom of pavement, whichever is greater. Any changes in conduit location shall be approved in advance by the Engineer. All narrow trenching shall conform to the City of San Diego Standard Drawings and be inspected prior to backfill. Trenches behind sidewalks shall be compacted using compaction tools to ensure no sinking of trench will occur. Trenches wider than 6 inch (15.2 cm) shall conform to the City of San Diego Standard Drawings. A 3 inch (7.62) bed of fine soil or sand shall be placed in the trench.

2. Conduit to be installed underground shall be Type 3 unless otherwise specified. Detector termination conduits shall be Type 3.

3. The conduit in a foundation and between a foundation and the nearest pull box shall be Type 3.

4. After conductors have been installed, the ends of conduits terminating in pull boxes, and in service and controller cabinets shall be sealed with an approved type of sealing compound.

5. Pull ropes for use when installing cables in Type 3 conduit shall consist of a flat, woven, lubricated, soft-fiber polyester tape with a minimum tensile strength of 8,000 N (1,800 pounds) and shall have printed sequential measurement markings at least every 3 feet (0.91 m).

6. If you judge it appropriate, the final 2 feet (0.61 m) of conduit entering a pull box in a reinforced concrete structure may be Type 4.

700-1.4 (86-2.06) Pull Boxes.

1. Non-PCC pull boxes shall only be used where specifically shown on the plans. Pull boxes shall not be installed in surfaces subject to vehicular traffic unless approved by the Engineer.

2. A No. 3½ pull box shall be installed immediately adjacent to each street light pole. A No. 3½ pull box shall be installed at each end of a street lighting conduit run crossing a street.

3. A No. 6 pull box shall be installed immediately adjacent to each signal pole. Unless otherwise shown, ¾-inch gravel shall be placed in bottom of pull boxes.

4. The cover of the pull box shall be stamped with the words "TRAFFIC SIGNAL," STREET LIGHT," or "COMMUNICATIONS," as appropriate.

5. A 4 inch (10.2 cm) diameter white ceramic raised pavement marker shall be installed on the face of the curb or asphalt dike adjacent to pull box installed in soil.

700-1.4.1 (86-2.06) Type 15 Pull Boxes.

1. Type 15 pull boxes and extensions shall conform to the Western Underground Committee Recommended Guide No. 3.6, "Non-Concrete Enclosures." Type 15 pull boxes shall be 30 inch (0.76 m) wide x 48 inch (1.22 m) long x 18 inch (0.46 m) deep (nominal inside dimensions). Each pull box shall have one 200 mm (8-inch) or 400 mm (16-inch) extension.

2. Hold down bolts or cap screws and nuts shall be of brass, stainless steel or other non-corroding metal material. Cover marking shall be "COMMUNICATION." Enclosures, covers and extensions shall be concrete gray color.

3. Type 15 pull boxes shall be installed where shown on the Plans for communication system.

700-1.5 (86-2.08E) Fiber Optic Subsystems.

700-1.5.1 (86-2.08E) Trenching.

700-1.5.1.1 Warning Tape.

1. Warning tape shall be provided and placed in the trench over conduits containing fiber optic cable as shown on the plans. The warning tape shall be (4 inches (100 mm) wide with bold printed black letters of approximately 3/4 inch (18 mm) on bright orange color background, and contain the printed warning "CAUTION - BURIED FIBER OPTIC CABLE" repeated at approximately 750 mm (30-inch) intervals. The printed warning shall be non-erasable and shall be rated to last with the tape for a minimum of 40 years. The construction of the warning tape shall be such that it will not delaminate when it is wet. It shall be resistant to insects, acid, alkaline and other corrosive elements in the soil. It shall have a minimum of 120

pounds (530 N) tensile strength and shall have a minimum of 700% elongation before breakage.

2. The warning tape shall be the detectable type with a contiguous conductor in the form of a copper wire or aluminized foil, encased in a protective plastic jacket. The aluminized foil shall be 0.35 mil thick. Separate rolls of the warning tape shall be electrically connected by corrosion resistant clips or by soldering. The ends of warning tape shall extend into pull boxes and splice vaults a minimum of 24 inches for future connection to a warning signal device. The continuity and detectability of the warning tape, for the entire conduit run, shall be demonstrated prior to, and again after backfilling each trench, to the satisfaction of the Engineer.

3. Warning tape shall be Condux International, Inc.; Allen System, Inc.; Reff Industries, Inc.; or equal.

700-1.5.1.2 Trace Wire.

1. Except where a detectable warning tape will be installed, a separate trace wire shall be installed external and adjacent to the conduit along the entire fiber optic cable route for use in active cable location. The trace wire shall be a #8 AWG bare-copper solid wire.

2. No insulation or other coating material shall be on the trace wire. The trace wire shall be terminated by connecting to the ground rods at the pull boxes as noted in the Plans.

700-1.5.1.3 Colored Concrete Backfill.

1. The concrete backfill for the trenches with conduits that will contain fiber optic cable shall be a medium-to-dark red or orange color 2 pounds (1 kg) of color pigment per sack of cement) to clearly distinguish the concrete backfill from other concrete and soil. The concrete shall be pigmented by the addition of commercial quality cement pigment to the concrete mix. The red or orange concrete pigment shall be LM Scofield Company; Orange Chromix Colorant; Davis Colors, or equal.

2. For trenches in pavement areas, only the top 4 inches (100 mm) of concrete backfill will be required to be pigmented concrete. If your judge it appropriate, the full depth may have the pigment.

700-1.5.2 (86-2.08E) Fiber Optic Cables.

1. Single-mode optical fiber shall be Corning SMF-28^{TM}. Each optical fiber shall be glass and consist of a doped silica core surrounded by concentric silica cladding. All fibers shall be useable and shall be sufficiently free of surface

imperfections and inclusions. The coating shall be a dual layered, UV cured acrylate.

2. The coating shall be able to be stripped mechanically or chemically without damaging the fiber.

Parameters	SM
Core Mode Field Diameter (Petermann II)	
@1310 nm	9.3 ± 0.5 μm
@1550 nm	10.5 ± 1.0 μm
Core Diameter Variation	± 3 μm
Core-to-Cladding Offset	≥ 1.0 μm
Cladding Diameter	125 μm ± 2 μm
Cladding Non-circularity	≤ 1.0%
defined as: 1- (min. cladding dia.	□ max. cladding
@ 1310 nm	≤ 0.4 dB/km
@ 1550 nm	≤ 0.3 dB/km
Chromatic Dispersion	
Zero Dispersion Wavelength	1301.5 to 1321.5 nm
Zero Dispersion Slope	< 0.092 ps/(nm^2•km)
Maximum Dispersion	
@1300 nm - 1330 nm	< 2.5 ps/(nm•km)
@1550 nm	< 20 ps/(nm•km)
Cut-off Wavelength	< 1250 nm

700-1.5.3 Cable Fabrication.

700-1.5.3.1 Cable Certification.

1. The cable manufacturer shall certify that the cable is suitable for direct installation in 1 1/4 inch to 3-inch (30 mm to 75 mm) conduit in an underground environment. You shall submit a sample and its certification

submittal prior to installation. You shall submit laboratory test reports on representative samples of similar cable design to demonstrate compliance with the following requirements prior to cable installation:

a) Tensile Strength per EIA -455-33A and EIA-RS-455-28A

b) Jacket Shrinkage per EIA -455-86

c) Cable Twist per EIA -455-85

d) Environmental Temperature Cycling per EIA -455-3A

e) Flexing per EIA -455-104

f) Impact Resistance per EIA -455-25

g) Compressive Strength per EIA -455-41

h) Freezing Test per EIA -455-98A

i) Mechanical Bend Test per EIA -455-37

2. You shall provide the manufacturer's certification that the offered cable shall comply with all optical and mechanical requirements set forth in this specification. The cable manufacturer shall be ISO 9001 registered.

700-1.5.3.2 Applicable Documents.

1. The cable shall conform to the latest issue of the following standards documents which are incorporated by reference into this specification:

a)	EIA-455	Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
b)	EIA-359	Standard Colors for Color Identification and Coding.
c)	MIL-202	Test Methods for Electronic and Electrical Component Parts.
d)	MIL-454	Standard General Requirements for Electronic Equipment.
e)	MIL-810	Environmental Test Methods and Engineering Guidelines.
f)	EIA-598	Color Coding of Fiber Optic Cables

2. Fiber optical cables shall be constructed in accordance with EIA-455 and 100% of all optical fibers and jacketing shall meet or exceed the requirements contained in this specification.

700-1.5.4 Mechanical Performance.

700-1.5.4.1 Fiber Proof Test. Fibers shall be 100% subjected to a minimum proof stress of 100 kpsi prior to being drawn into fiber sub-cables.

700-1.5.4.2 Minimum Bend Radius. The cable shall be able to withstand bending to a minimum radius of 10 times the cable outer diameter without tensile load applied, and 20 times the cable outer diameter with maximum load applied (during installation only), without damage to the cable components or degradation of the optical fiber performance. The fiber optic cables shall withstand at least 20 cycles at a minimum bend radius without damage to the fiber optic cable components or degradation of the optical performance. The cyclic flexing test shall be in accordance with EIA-455.

700-1.5.4.3 Cyclic Flex Resistance. The cable shall withstand cyclic flexing 2,000 times per the requirements of EIA-455-104.

700-1.5.4.4 Environmental Performance. The fiber optic cable shall comply with the requirements specified herein when subjected to the following environmental conditions.

700-1.5.4.5 Temperature.

1. The cable shall comply with the optical and mechanical performance requirements specified herein up to 95% relative humidity (non-condensing) when subjected to moisture resistance conditioning according to Method 106B of MIL-202 except that the specimen shall not be vibrated.

2. The shipping and storage temperature of the cable shall be -40°C to 70°C (-40°F to 160°F), and the operating and installation temperature range of the cable shall be -40°C to 70°C (-40°F to 160°F).

700-1.5.4.6 Moisture Resistance. Optical and mechanical performance shall not be degraded and the cable shall not be damaged in any way by immersion in ground water.

700-1.5.4.7 Fungus Resistance. The outer jacket material used in construction of this cable shall be fungus inert as described in requirement 4 of MIL-454.

700-1.5.4.8 Sunlight/UV Resistance. The outer jacket material shall be suitable for long-term exposure to sunlight and weather, with a life expectancy in excess of 20 years. Suitability shall be determined in accordance with MIL-810, method 505.

700-1.5.4.9 Loose Tube Cables.

1. Optical fibers shall be placed inside loose buffer tubes. Each buffer tube shall contain between six and twelve single mode fibers. Each fiber shall be

numbered and color coded. The cable shall contain between one and 6 buffer tubes. The tubes shall be color coded.

2. Each fiber shall be distinguishable from other fibers in the same tube by means of color coding. Each tube shall be distinguishable from other tubes in the same cable by means of color coding. The colors shall be targeted in accordance with the Munsell color shades and shall meet EIA-598 "Color Coding of Fiber Optic Cables." The color formulation shall be compatible with the fiber coating and the buffer tube filling compound, and be heat stable. The colors shall not fade or smear or be susceptible to migration and it shall not affect the transmission characteristics of the optical fibers and shall not cause fibers to stick together.

1. Blue (BL)	5. Slate (SL)	9. Yellow (YL)
2. Orange (OR)	6. White (WT)	10. Violet (VL)
3. Green (GR)	7. Red (RD)	11. Rose (RS)
4. Brown (BR)	8. Black (BK)	12. Aqua (AQ)

700-1.5.4.10 Buffer Tubes.

1. Clearance shall be provided in the loose buffer tubes between the fibers and the inside of the tube to allow for expansion without constraining the fiber. The fibers shall be loose or suspended within the tubes. The fibers shall not adhere to the inside of the buffer tube.

2. The loose buffer tubes shall be extruded from a material having a coefficient of friction sufficiently low to allow free movement of the fibers. Buffer tubes shall be made of a tough abrasion resistant material to provide mechanical and environmental protection of the fibers, yet designed to permit safe intentional "scoring" and breakout, without damaging or degrading the internal fibers.

3. Buffer tube filling compound shall be a homogenous hydrocarbon-based gel with anti-oxidant additives and used to prevent water intrusion and migration. The filling compound shall be non-toxic and safe to exposed skin. The compound shall be chemically and mechanically compatible with all cable components, non-nutritive to fungus, non-hygroscopic, and electrically non-conductive. The filling compound shall be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

4. Buffer tubes shall be stranded around a central member by a method that will prevent stress on the fibers when the cable jacket is placed under strain, such as the reverse oscillation stranding process.

700-1.5.4.11 Central Member. The central member shall be a glass reinforced plastic rod with similar expansion and contraction characteristics as the optical fibers and buffer tubes. A linear overcoat of low density polyethylene shall be applied to the central member.

700-1.5.4.12 Filler Rods. Fillers shall be included in the cable, where needed, to lend symmetry to the cable cross-section. The sum of buffer tubes and filler rods shall be equal to six. Filler rods shall be solid medium or high density polyethylene. The diameter of filler rods shall be the same as the outer diameter of the buffer tubes.

700-1.5.4.13 Stranding. Completed buffer tubes shall be stranded around the overcoat central member using stranding methods, lay lengths, and positioning such that the cable shall meet mechanical, environmental, and performance specifications. A polyester binding shall be applied over the stranded buffer tubes to hold them in place. Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

700-1.5.4.14 Core and Cable Flooding. The cable core interstices shall be filled with a polyolefin-based flooding compound to prevent water ingress and migration. The flooding compound shall be homogeneous, non-hygroscopic, electrically non-conductive, and non-nutritive to fungus. The flooding compound shall also be nontoxic, safe, and compatible with all other cable components.

700-1.5.4.15 Tensile Strength Member. Tensile strength shall be provided by high tensile strength aramid yarns and fiberglass which shall be helically stranded evenly around the cable core.

700-1.5.4.16 Outer Jacket.

1. The jacket shall be smooth, free of holes, splits, blisters, and other surface flaws, and shall be medium density cross-linked polyethylene (PE) with minimum nominal jacket thickness of 1/16 inch (1.4 mm). Jacketing material shall be applied directly over the tensile strength members and flooding compound and shall not adhere to the aramid strength material. The polyethylene shall not promote the growth of fungus. The color of the cable outer jacket shall be solid yellow.

2. The jacket or sheath shall be marked with the manufacturer's name, the date of manufacture, a cable code to identify the number and type of fibers, and sequential measurement markings every meter. Additionally, the following shall be printed on the jacket at regular intervals: “CAUTION Fiber Optic Cables”.

700-1.5.5 Traffic Signal System Fiber Optic Cable.

1. The actual length of the cable shall be within -0/+1 % of the length marking. The color of the markings on the cable jacket shall be black. The height of the marking shall be approximately 1/8 inch (2.5 mm).

2. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

700-1.5.5.1 Fan-Out Termination.

1. Individual fibers within the loose tube cable require handling protection inside the termination cabinets. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Fan-out tubes or furcation kits shall not be used. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables.

2. The colors of the outer jackets of the tight-buffered pigtail cables shall match the colors of the individual fibers within the loose tubes. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall be employed on all splices to protect the splices. A wall-mountable splice center shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure.

3. The tight-buffered pigtails shall be terminated with ST connectors.

700-1.5.5.2 Fan-out Pigtail Cable Specifications. Single-mode fiber (Corning SMF-28) shall be used in the pigtails. Optical characteristics shall comply with the optical fiber performance specifications.

Buffer material:	Thermoplastic
Buffer O.D.:	900 μm
Strength Member:	Kevlar
Jacket Material:	Polyethylene
Jacket O.D.:	2.5 mm
Temperature Range:	-20 °C to + 70 °C (-5 °F to 160°F)

700-1.5.5.3 Mechanical Performance.

1. Fiber Strippability. The fiber optic jackets shall be easily removed with commercially available mechanical stripping tools. The cable shall contain at least one ripcord under the outer jacket layer to facilitate jacket removal.

2. Minimum Tensile Strength. The fiber optic cable shall be rated to withstand a maximum tensile load of 2,700 N (608 pounds force) during installation (short

term) with no damage and 890 N (200 pounds force) installed (long term). While these are rated tensile loads, you shall exercise every precaution in minimizing cable tension during installation.

3. Compressive Load. The fiber optic cable shall withstand a compressive load of 220 N/cm applied uniformly over the length of the cable. The average increase in attenuation for the fibers shall be < 0.10 dB/km at 1550 nm for a cable subjected to this load, and the cable shall not exhibit any measurable increase in attenuation after load removal. Testing shall be in accordance with EIA-455-41, Compressive Loading Resistance of Fiber Optic Cable.

4. Tight-buffered Cables. The fiber optic cable shall be of fiber optic sub-cables encased in an outer jacket. The cable shall contain 18 tight-buffered breakout-type riser-rated fiber optic sub-cables each comprised of one 9/125 µm (Corning SMF-28^{TM}) single-mode (SM) fiber.

700-1.5.5.4 Fiber Optic Cable Description.

1. General Description. Operating wavelengths shall be 1300 and 1550 nm for all fibers. A Polyethylene outer jacket shall be extruded under high pressure directly over the stranded fiber sub-cable core. This process results in the internal surface of the cable jacket interlocking with the cable substructure so that the cable cannot move axially within the cable jacket. The design shall allow the fully rated tensile load of the cable to be applied with wire mesh (Kellums-type) grips during installation. The cable shall be flame retardant UL-listed type ONFR for riser application.

2. Fiber Optic Sub-cables. Each fiber sub-cable shall consist of a central glass optical fiber surrounded by a 500 µm primary UV-cured acrylate buffer with a secondary hard elastomeric polymer buffer up to 900 µm. Non-elastomeric (PVC) materials shall not be used for the buffer materials.

   The tight-buffered fiber is surrounded by a synthetic yarn or aramid strength member (Kevlar or equal) and a color-coded elastomeric polymer jacket. Non-elastomeric (plastic) materials are not allowed. The strength member shall be composed of individually and precisely tensioned elements such that tensile loads are equally shared by each element. The sub-cable outside diameter shall be 1/8 inch (2.5 mm).

3. Cable Outer Jacket. The jacket shall be smooth, free of holes, splits, blisters, and other surface flaws, and shall be of flame-retardant Polyvinylchloride (PVC) with a nominal wall thickness of 3/64 inch (1.0 mm) and a minimum wall thickness of 1/32 inch (0.75 mm) at any point. The outer jacket shall be pressure extruded over the outer layer of the stranded cable core

4. Cable Marking. The completed cables shall have sequentially numbered length markers, in a contrasting color to the cable jacket, at regular intervals

of not more than one meter along the outside of the jacket. Printed on the jacket shall be the cable code to identify the number and type of fibers (for example: 18 Fiber - 18 x 9/125), the manufacturer's name, manufacturer's part number, the year of manufacture, and the sequential length markings. Additionally, the following shall be printed on the jacket at regular intervals **" CAUTION Fiber Optic Cables".**

700-1.5.6 Traffic Signal System Fiber Optic Cable. The actual length of the cable shall be within -0/+1% of the length marking. The marking shall be in a contrasting color to the cable jacket. The marking shall be 1/8 inch (2.5 mm) in height and must be permanent and weatherproof. The markings shall be repeated at one meter intervals.

700-1.5.6.1 Colors. The color of the cable outer jacket shall be solid yellow. The color of the markings on the cable jacket shall be black. The single-mode sub-cable outer jackets shall be color coded in accordance with EIA-598 and designated as shown below. The colors shall be targeted in accordance with the Munsell color shades. For all documentation, the individual sub-cables shall be identified by the fiber number.

700-1.5.6.2 Sub-cable Jacket Color Assignments for Fiber Type. Table 700-1.5.6.2 shall be used to apply the color of the sub-cable to the fiber type and sub-cable number.

Table 700-1.5.6.2

Sub-Cable Number	Sub-Cable Color	Sub-Cable Number	Sub-Cable Color
1	Blue	10	Orange/Yellow Dash
2	Orange	11	Green/Yellow Dash
3	Green	12	Brown/Yellow Dash
4	Brown	13	Slate/Yellow Dash
5	Slate	14	White/Yellow Dash

Sub-Cable Number	Sub-Cable Color	Sub-Cable Number	Sub-Cable Color
6	White	15	Red/Yellow Dash
7	Red	16	Black/Yellow Dash
8	Black	17	Yellow/Black Dash
9	Blue/Yellow Dash	18	Violet/Yellow Dash

700-1.5.6.3 Mechanical Performance.

1. Fiber Strippability. Both the primary and secondary fiber buffer layers, sub-cable jackets, and outer jacket shall be easily removed with commercially available mechanical stripping tools. The cable shall contain at least one ripcord under the outer jacket layer to facilitate jacket removal.

2. Minimum Tensile Strength. The fiber optic cable shall be rated to withstand a maximum tensile load of 5000 N (1,124 pounds force) during installation (short term) with no damage and 2000 N (451 pounds force) installed (long term).

3. Residual Strain. Optical measurements of fiber strain shall be made on two of the eighteen fiber sub-cables before, during, and after cable installations. To minimize stress corrosion and thereby insure optimum fiber lifetime performance, the measured optical fiber sub-cables shall not be allowed to exhibit more than 0.2 % residual strain after installation. Under no conditions, during installation or other handling procedures, shall any portion of the cable structure be allowed to strain more than 0.75 %

4. Impact Resistance. The cable shall withstand an impact of 500 times per the requirements of EIA-455-25.

5. Crush Resistance. The fiber optic cable shall withstand a compressive load of 1000 N/cm applied uniformly over the length of the cable. The average increase in attenuation for the fibers shall be < 0.20 dB/km for a cable subjected to this load, and the cable shall not exhibit any measurable increase in attenuation after load removal. Testing shall be in accordance with EIA-455-41, Compressive Loading Resistance of Fiber Optic Cable.

The minimum crush resistance of the fiber optic cable shall be greater than 2000 N/cm without damage to the cable components or degradation of the optical performance.

The fiber optic cable shall be capable of withstanding 2,500 impacts, at 5 N-m force without damage to the fiber optic cable components or degradation of the optical performance. The impact resistance test shall be in accordance with EIA-455-25.

6. Cable Core. All sub-cable elements shall be stranded together to maintain flexibility. Stiff central elements such as wire, tapes, separators, void fillers, or dielectric epoxy glass rods shall not be permitted.

700-2 CABLE INSTALLATION

700-2.1 Assistance and Technical Support. You shall seek the assistance and technical support of the supplier of the fiber optic cable in preparation for and during installation.

700-2.2 Cable Protection.

1. The cable shall be inspected for jacket defects as it is removed from the reel. If defects are found, the pulling operation shall be terminated immediately and the Engineer notified. Repair of cable jacket will not be permitted. To reduce the possibility of damage to the outer jacket of the fiber optic cable, the following protective measures are recommended.

2. A cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it off the reel and into the duct. A pulling eye shall be attached to the cable end and be used to pull the cable through the duct and conduit system. As the cable is pulled off the reel and into the cable feeder guide, it shall be lubricated with a water-based lubricant approved by the cable manufacturer. Dynamometers or breakaway pulling swings shall be used to ensure the pulling line tension does not exceed the installation tension values specified by the cable manufacturer. Maximum allowable cable strain during installation shall be 0.75 %. The pulling of the cable shall be hand assisted at each hand hole or pull box. The cable shall not be crushed, kinked, or forced around a sharp corner.

700-2.3 Installation Procedures.

1. Cables shall be installed in continuous lengths without intermediate splices throughout the project. Cable installation personnel shall be familiar with the cable manufacturer's recommended procedures including, but not limited to the following:

a) Proper attachment to the cable strength elements for pulling during installation. Depending on cable design this will involve direct attachment to internal strength members or attaching an external "Kellums" or split mesh grip.

b) Cable tensile limitations and tension monitoring procedures.

c) Cable bending radius limitations.

d) Cable twisting limitations.

2. You shall comply with the cable manufacturer's specifications at all times.

3. Cable installation procedures shall conform to Bellcore guidelines.

4. To accommodate long continuous installation lengths, bi-directional "center pull" techniques for pulling of the cable is acceptable and shall be implemented as follows:

   a) From the midpoint, pull the cable into the conduit from the shipping reel in accordance with the manufacturer's specifications.

   b) When this portion of the pull is complete, the remainder of the cable must be removed from the reel to make the inside end available for pulling in the opposite direction.

   c) This is accomplished by hand pulling the cable from the reel and laying into large "figure eight" loops on the ground. The purpose of the figure eight pattern is to avoid cable tangling and kinking. The loops shall be laid carefully one upon the other (to prevent subsequent tangling) and shall be in a protected area. The inside reel end of the cable is then available for installation.

   d) In some cases, it may be necessary to set up a winch at an intermediate cable vault. The required length of cable shall be pulled to that point, and brought out of the cable vault and coiled into a figure eight. The figure eight is then turned over to gain access to the free cable end. This can then be reinserted into the duct system for installation into the next section.

5. At locations noted on the plans, you shall provide 30 feet (9.14 m) of cable slack. The cable shall be coiled and secured with cable ties. You shall ensure that the minimum bending radius of the cable is not compromised when preparing this stored cable slack.

6. The pulling eye/sheath termination hardware on the cables shall not be pulled over any sheave blocks.

7. When power equipment is used to install cabling, the pulling speed shall not exceed 100 feet per minute (30 meters per minute). The pulling tension, bending radius and twist limitation for cable shall not be exceeded under any circumstances.

8. Large diameter wheels, pulling sheaves, and cable guides shall be used to maintain the appropriate bending radius. Tension monitoring shall be accomplished using commercial dynamometers or load cell instruments.

9. Sufficient slack shall be left at each end of the cable to allow proper cable termination.

700-2.4 Optical Fiber Termination.

1. Termination components shall meet or exceed the applicable provisions of EIA-455-5. Cables shall have all optical fibers terminated directly at the patch panel via connectors. All cables shall be routed in each equipment cabinet in a manner that prevents damage during regular operation and maintenance functions. All exposed cable and fiber sub-cables shall be secured every 12 inches (300 mm) to 500 mm (18 inches) to the equipment frame or cable tray with nylon ties, hand tighten only.

2. Connectors shall be field-installable and perfectly matched to the cable used. Optical fiber connectors shall satisfy all of the interface parameters of equipment components as may be defined by the transmission equipment specifications.

3. The connectors shall provide tight fitting termination to the cladding/buffer tubing and to the outer jacket. Epoxy-based or “hot melt “adhesives shall be used to bond the fiber and buffer to the connector ferrule and body prior to polishing the end face. No dry-termination or “quick crimp” connectors are allowed. When termination is authorized by the Engineer, termination shall be by trained, qualified persons only.

4. After termination with connectors, the fiber ends must be visually inspected at a magnification of not less than 100 power to check for cracks or pits in the end face of the fiber. If any irregularities found cannot be removed by further polishing, the entire process must be redone by cutting off and disposing the connector body.

5. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used, dry interfaces only. Single-mode connectors shall be capable of field installation on 9/125 μm fibers with 900 μm buffers (OD) and 1/8 inch (2.5 mm) outer jackets.

6. Each connector shall be of the industry standard SC™ type compatible, designed for single-mode tolerances, and shall meet or exceed the applicable provisions of EIA-455-5, 455-2A, and 455-34, and shall be capable of 100 repeated matings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a key-way design and shall have a zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials, such as nickel plated zinc, designed to operate in humid environments without degradation of surface finishes.

7. Each connector shall be labeled for ease of subsequent identification and testing. Each connector label shall be attached next to the connector strain relief boot in a manner that will ensure that the label remains permanently intact. The optical test diagram details the numbering system to be used. The system employs two numbers, separated by a decimal point. The first number refers to the sub-cable number. The second number refers to the relative connector position in the backbone ring.

8. Splicing of fiber optic cable shall not be permitted **unless otherwise specified** in the Special Provisions or shown on the Plans. When splicing is authorized by the Engineer, splicing shall be by trained, qualified persons only. Any allowed splicing of fiber optic cable shall be by fusion splice only, no mechanical splices are permitted.

9. Fusion splicing equipment shall be in good working order, properly calibrated, and meeting all industry standards and safety regulations. Cable preparation, closure installation and splicing shall be accomplished in accordance with accepted and approved industry standards.

10. The average splice loss shall be 0.1 dB or less per splice. The average splice loss is defined as one-half the summation of the losses as measured in each direction using an OTDR through the fusion splice. No individual splice loss measured in a single direction shall exceed 0.15 dB.

11. Upon completion of the splicing operation, all waste material shall be deposited in suitable containers, removed from the Work Site, and disposed of in an environmentally acceptable manner.

700-2.5 **Cable Testing.** You shall notify the Engineer in writing 10 Working Days prior to commencing tests. You shall provide information regarding what type test equipment will be utilized (manufacturer and model number) plus the equipment calibration procedures that will be utilized.

700-2.6 **Test Equipment.**

1. An Optical Time Domain Reflectometer (OTDR) with recording capability shall be utilized to test for the end-to-end transmission quality of each optical fiber. Quality tests shall consider both attenuation and localized loss

discontinuities. The OTDR shall be equipped with a switchable, dual-wavelength module with 1300 nm and 1550 nm light sources compatible with single-mode test fibers. The OTDR shall be capable of writing to a hard drive and configured with an X-Y plotter to provide a hard copy record of each test measurement. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of sufficient length to display the required cable section, or by using an OTDR with sufficient normalization to display the required cable section. A hard copy X-Y plot shall be provided to the City for all OTDR tests. The OTDR shall be calibrated for correct index of refraction to provide proper length measurement from a known length of reference fiber.

2. Testing light source: A laser diode (LD) light source with a 1300 nm wavelength shall be used. The LD shall be stable within 0.1 dB in output power over a time period sufficiently long to perform the measurement.

3. Power Meter: The detector in the power meter shall have an effective numerical aperture (NA) and active area that is larger than the fiber under test. The power meter shall have a sufficient measurement range to measure the insertion loss of the cable and connectors in the link. The power meter must be linear over the range of losses to be measured in the system and have sufficient resolution for the proposed measurements (0.05 dB). The power meter must be able to measure both absolute power in units of dBm and relative loss in units of dB. The power meter must also be able to change its calibration wavelength to match the system operation wavelength (1300 nm).

4. Launch Reference Cable: The patchcord used to connect the fiber optic cable to the multiplexer shall be used as the launch reference cable for the particular link under test.

700-2.7 Submittals.

1. Detailed shop drawings and specifications of proposed products shall be submitted in accordance with 2-5.3, “Submittals.” You shall submit the manufacturing data, pre-shipment test results, and a sample. Representative samples manufactured to the above specifications shall be submitted.

2. Submittals required by this item shall include, but not be limited to, the following:

   a) A material staging plan, if you propose City-owned property as a staging area.

   b) Manufacturer's complete specifications for all communication system cables, connectors, patch panels, fiber optic multiplexers, video encoders, and associated electronics and hardware components.

c) Manufacturer's complete specifications for optical fiber cable patch panels.

d) A detailed fiber optic cable and twisted-pair cable installation procedure including the following:

i. Fiber optic cable cutting lengths reflecting the cable order and reel allocations.

ii. Detailed installation procedures (cable pulling plan) which shall contain the manpower and equipment to be used, locations of the manpower and equipment for each pull, location of figure eights, and the estimated pulling tensions and which also identify the physical locations for equipment placement, proposed equipment setup at each location, and the pulling methodology for each type of cable. The cable pulling plan shall be submitted for approval 10 Working Days prior to pulling in each fiber optic segment.

iii. Manpower proposed for all equipment, safety, and manual assist operations.

700-2.8 **Test Documentation.** The results of insertion loss testing shall be recorded along with the test date, test wavelength, name of person performing the test, and the brand name, model number and serial number of the equipment used during the test. The measurements shall be recorded on a form identical to the test table provided in this specification. OTDR traces shall be generated into a hard copy and in electronic format for the purpose of developing historical "as-built" documentation regarding the cable's condition before and after it was installed. The hard-copy and electronic copy documentation, along with associated software to reproduce on paper via personal computer, shall be provided to the Engineer.

700-2.9 **OTDR Tests.** You shall use OTDR testing to insure that each fiber is one continuous length (contains no splices within the cable structure) and meets the attenuation (dB/km) specifications of the manufacturer and cognizant industry standards. In addition, OTDR tests shall be performed to measure connector and fiber loss on all terminated fiber links. OTDR measurements shall be made before the cable installation to provide baseline data for comparison to post-installation OTDR tests.

700-2.10 **Required OTDR Trace Information.**

1. Traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses, connector losses, or both). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km) as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers

are placed in the linear region of the trace: away from the front-end response and the far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal-to-noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length the fiber under test.

2. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). Connector losses shall be measured using the Least Squares Approximation (LSA) or 5-point splice loss measurement technique.

3. The OTDR trace shall also include the following information:

   a) The date and time of the test

   b) The cable ID number

   c) The cable segment ID number

   d) The fiber color or sub-cable number

   e) Launch point connector number

   f) The optical wavelength used for the test

   g) The refractive index setting of the OTDR

   h) The pulse width setting of the OTDR

   i) The averaging interval of the test

700-2.11 Pre-installation OTDR.

1. Prior to removal of each cable from the delivery reel, all optical fiber sub-cables within the cables shall be tested by you using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure. Cable sections failing this test shall be disqualified from subsequent use for installation.

2. Pre-installation, "on-reel" test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between you and the manufacturer.

700-2.12 Post-Installation OTDR.

1. You shall conduct insertion loss testing on all installed and terminated optical fiber elements. Insertion loss test measurements for each terminated fiber on each cable shall be documented by you and the results provided to the Engineer. Testing shall be conducted at 1300 nm for all terminated sub-cables. Total node-to-node insertion loss for each terminated sub-cable in each cable shall be within the fiber optic multiplexer manufacturer's allowable loss budget specifications. The total node-to-node insertion loss, between adjacent multiplexers, for the single-mode fiber links shall be less than 6 dB at 1300 nm. If it is not, you shall take corrective measures to bring the insertion loss into compliance with the manufacturer's specifications, including re-mating and re-termination of the connectors, and/or replacement of the cable.

2. Fiber links shall be measured in both directions in order to measure patch panel connector and link insertion losses accurately. The Insertion Loss Test Table shall be used to conduct the insertion loss measurements. The table calls for inserting light at various insertion points and measuring power out at other points. Once all of the powers have been measured, the insertion losses are then calculated and recorded in the table.

700-2.13 (86-2.08E) Node Equipment.

700-2.13.1 Termination Cabinet.

1. A Model 332 cabinet shall be installed at each location shown on the plans. You shall submit for review detailed drawings showing the proposed cabinet layout.

2. The cabinet shall be equipped with a standard ventilation fan and filter, shelves for shelf-mounted 404 modems, rack for mounting the fiber optic data network multiplexer and the fiber optic termination patch panel, 120 V AC power for operating equipment, and terminal blocks for copper cable termination.

700-2.13.2 Fiber Optic Termination Patch Panel.

1. The patch panel enclosure shall be rack-mounted in the cabinet. The enclosure shall have nominal dimensions of 3.5 inches high x 19 inches wide x 15 inches deep (90 mm high x 480 mm wide x 375 mm deep). The enclosure shall have doors to protect the fiber terminations inside the panel. The inner connector panel shall be mounted vertically in the enclosure and be approximately in the center of the enclosure to allow access to both cable sides. The cable ends shall enter the patch panel enclosure from the bottom. The patch panel enclosure shall provide cable strain reliefs at the entry ports. All enclosure hardware shall be stainless steel or aluminum.

2. The fiber optic cable shall terminate inside each of the communications cabinets on a termination patch panel. The patch panel shall be fitted with

"SC™" type bayonet couplings. All optical fibers within the cable shall be terminated with "SC™" compatible connectors. The patch panel shall have a 24-fiber capacity, and shall facilitate fiber optic cable cross-connection between outside plant cables and opto-electronic interface equipment. Unused couplings shall be fitted with protective dust covers. Factory-terminated, tight-buffered, aramid-reinforced fiber optic jumper assemblies or interconnect cables, standard 1 3/16 inch (3.0 mm) O.D., shall connect the optical fiber terminations to the multiplexer I/O ports via the patch panel couplings.

3. The termination patch panel shall be equipped with a suitable means for routing and securing of cables and shall provide a suitable means of protection for the mounted optical fiber connectors to prevent damage to optical fibers and connectors during all regular operation and maintenance functions. Bend diameters on cable, sub-cables, and jumpers must be greater than 4 inches (100 mm) at all times to ensure optical and mechanical integrity of the optical fibers.

700-2.13.3 Data Modems. Data modems for communicating with intersections shall be installed in the termination cabinets. Data Computer Equipment (DCE) EIA RS-232C interface shall be accomplished through a standard DB-9S (female) connector. The four wire modem-modem interface shall be provided by means of a color coded cable terminated with spade lugs. The maximum communicating distance shall be greater than 15 miles (24.1 Km).

700-2.13.4 Copper Cable Termination Blocks.

1. You shall provide and install 12-pair cable termination blocks in each cabinet where twisted-pair cable is installed. Termination blocks shall be capable of accepting #22 AWG insulated solid conductors and be rack mountable on a standard 19inch (480 mm) rack. Termination blocks shall be designed to operate in unheated outdoor cabinets, capable of resisting corrosion and oxidation, and capable of preventing open circuits caused by poor metal-to-metal contact.

2. Each quick connect terminal block and barrier terminal block shall be sprayed with a PIC restoration spray to retard corrosion. Three coats shall be applied prior to connecting the wires and three coats shall be applied after all the wire connectors have been completed. Each coat shall be allowed to dry thoroughly, as specified by the manufacturer, before the next coat is applied. You shall terminate all SIC cable on termination blocks in each cabinet where twisted-pair cable is installed.

700-2.14 (86-2.08E) Twisted-Pair Copper Subsystems

The interconnect cable shall contain the amount of twisted, #22 AWG solid, copper pairs as specified in the Plans. This cable shall be constructed for installation in an underground conduit environment with a sheath consisting of a

double coated aluminum shield over which a medium density polyethylene jacket is extruded, in accordance with REA Standard PE39. This cable shall be filled with a gel compound to resist water penetration and migration.

700-2.14.1 Cable Performance. The copper twisted-pair cable shall meet or exceed the following specifications:

1. 22 AWG, solid copper conductor, twisted pair
2. Insulation: Dual, semi-rigid PVC skin over foamed PE
3. Core wrap: Polypropylene film
4. Mutual capacitance of 94 nanofarads per mile, measured at 1 KHz
5. DC Resistance = 92 ohms per mile
6. Attenuation = 2.2 dB/1,000 ft. @ 150 KHz

700-2.14.2 Installation.

1. You shall install cables and the combination connector/protector block. The same pair assignment shall be maintained. Cables shall be installed at each location per the Master Interconnect Conductor Assignments shown on the plans. Cables shall be installed in continuous lengths from terminal block to terminal block. There shall be no splicing between terminal blocks.

2. You shall determine a suitable cable installation method to ensure that all cable installation requirements shall be met in all conduit sections. All work shall be carried out in accordance and consistent with the highest standards of quality and craftsmanship in the communication industry with regard to the electrical and mechanical integrity of the connections; the finished appearance of the installation; as well as the accuracy and completeness of the documentation.

3. You shall make a physical survey of the project site for the purpose of establishing the exact cable routing and cutting lengths prior to the commencement of any work or committing any materials.

4. When ordering cable, you shall ensure that the cable shall be of sufficient length to pull from terminal block of one traffic signal controller cabinet to the terminal block of the next traffic signal controller cabinet. A minimum of 3 feet (0.91 m) of cable shall be provided in each pull box.

5. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the Engineer notified. Precautions shall be taken during installation to prevent the cable from being kinked or crushed. Crushed or

kinked cable shall be replaced with new cable. As the cable is pulled into the conduit system, it shall be sufficiently lubricated with a lubricant that shall be the water based type and approved by the cable manufacturer. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched or exceeds manufacturer's specifications.

6. The pulling of the cable shall be hand assisted at each handhole or pullbox. When pulling through intermediate pullboxes, the cable shall be placed on the ground near the pullbox and care taken to prevent damage by vehicles or other objects. The cable shall not be crushed, kinked or forced around a sharp corner. A minimum of 3 feet (0.91 m) slack shall be left in each pullbox and enough left at each end of the cable to allow proper cable termination. All cable pairs shall be terminated on terminal block.

700-2.14.3 Cable Testing.

1. You shall perform field acceptance tests on the installed copper cable. The City shall observe the tests and the test results shall be documented as prescribed elsewhere in this specification. You shall replace any cable failing these tests at no additional expense to the City. You shall provide all test equipment necessary to perform the tests. All pairs of each copper cable shall be tested for continuity, polarity, shorts, grounds, longitudinal balance, and resistive loss consistent with the manufacturer's specifications and standard telecommunication industry requirements.

2. After installation each pair within the cable shall be tested with a Time Domain Reflectometer (TDR). TDR testing shall be for end-to-end transmission quality, splices, improper terminal termination, no bridge taps, or pairs that have no termination, open or shorted pairs. You shall certify that all individual wires have been terminated consistent with the wire insulation color to termination pin requirements.

3. You shall document the test results and provide a certification for each cable that the cable meets or exceeds the manufacturer's published specifications and otherwise complies with the requirements set forth in this specification. You shall provide the City with information regarding what type test equipment will be utilized (manufacturer and model number) plus the equipment calibration procedures that will be utilized by you prior to conducting all test routines.

4. Each underground cable shall be tested end-to-end from the termination block to the terminal block at each cabinet. You shall provide test readings for each of the following items to verify the cable performance:

    a) DC Resistance - The resistance of any conductor in any cable shall not exceed 92 ohms per mile.

b) DC Resistance Unbalance - The resistance unbalance between the two conductors of any pair shall not exceed 5%.

c) Mutual Capacitance - The mutual capacitance of any pair shall not exceed 94 nanofarads per mile at 1 KHz.

Capacitance Unbalance: Pair to Ground - The capacitance unbalance to ground at 1 KHz of any pair shall not exceed 800 picofarads per 1,000 feet.

d) Ambient Noise Measurements - You shall measure the ambient noise level in dBrn0 to determine the level of noise on each cable being tested. The distant end of the pair being tested shall be terminated with a 600-ohm resistor. At the near end, a HP3551 or equivalent transmission measuring set shall be configured for conducting a noise reading test. Cable pairs being sampled shall provide an ambient noise figure of 30 dBrn0 (-60 dBm) or better. You shall record all readings.

e) Attenuation - You shall test the attenuation of all twisted pairs in each cable at various frequencies. Attenuation shall not exceed 2.2 db per 1,000 feet (304.8 m), measured at 150 KHz.

f) Near-end Crosstalk - The near-end crosstalk (NEXT) coupling loss between worst pairs within a cable shall be equal to or less than 53 dB per 1,000 feet, (304.8 m), measured at 150 KHz.

g) Bit Error Rate - You shall conduct a dynamic data transmission test of each pair in each cable whose application in intended for data communication applications. The dynamic test shall verify that the transmission quality of each cable shall support a bit error rate of 1 x 10-6 or better at 1 Mb/s. The results of this test shall be documented for one pair in each cable.

h) Ground Resistance Measurements - Ground resistance of the single point ground system shall be measured before and after it is bonded to the electrical service ground or building earth ground. Resistance after the bond has been made to the electrical service ground (or building earth ground) shall not exceed 3 ohms. If the measured ground resistance exceeds 3 ohms, you shall provide additional grounding points until this maximum differential has been achieved.

5. TDR traces shall be generated into a hard copy and software file in electronic format for the purpose of developing historical "as-built" documentation regarding the cable's condition after it was installed. The hard-copy and electronic documentation shall be provided to the City.

700-2.15 **(86-2.08) Conductors.** Conductors of size #8 AWG and larger shall be stranded. Ends of cables entering the controller shall be marked the same as in the pull boxes adjacent to the pole the cables serve and shall include the pole served. The cables shall be identified with one or more wraps of 1/2 inch (13 mm) 7 mil vinyl electrical tape, conforming to the following color coding:

A	B	C	D	E	F	G	H	I
Blue	Orange	Green	Brown	Grey	White	Red	Yellow	Violet

700-2.16 **(86-2.09) Wiring.**

1. Where specified on the plans or at the direction of the Engineer, conductors shall be spliced by the use of "C" shaped compression connectors as shown on ES-13. A jumper wire with clips shall be provided for continuity of shielded cables. The completed splice shall be rated for direct burial application and capable of normal continuous operation at 600 V. Splices shall be insulated with heat-shrink tubing of the appropriate size.

2. Splices shall be insulated by "Method B" or, If you judge it appropriate, splices of conductors shall be insulated with heat-shrink tubing of the appropriate size after thoroughly painting the spliced conductors with electrical insulating coating.

3. The open end of cable jackets or tubing shall be sealed in a manner similar to the splicing requirements to prevent the entrance of water.

700-2.17 **(86-2.09F) Fused Splice Connectors.** A fused splice disconnect shall be installed in the pull box adjacent to the service point for a street light. Each street light shall have a fuse and fuseholder.

700-2.18 **(86-2.11A) Service.**

1. Install Type III service equipment enclosure for combined 120 V metered traffic signals and 120 V unmetered street lighting as noted on the plans. Maximum base size of service equipment enclosure shall not exceed 16 inches x 16 inches (400 mm x 400 mm) and service equipment shall meet all SDG&E requirements. Traffic signal service shall have 50 A, 1P, 120 V main circuit breaker, and street lighting service shall have 30 A, 1P, 120 V main circuit breaker, unless noted otherwise on the plans.

2. Continuous welding of exterior seams in service equipment enclosures is not required.

3. Type III service equipment enclosures shall be the aluminum type.

4. Circuit breakers shall be the cable-in/cable-out type, mounted on non-energized clips. All circuit breakers shall be mounted vertically with the up position of the handle being the "ON" position.

5. Dead front panel or panels, and corresponding exterior door, shall be hinged on one side and shall be openable without the use of tools.

6. A barrier-type terminal block rated for 40 A, minimum, shall be provided in each service equipment enclosure. The terminal block shall have a minimum of 12 positions with terminals rated at Size No. 8 or larger, to accept the field wires indicated on the plans. Field wires shall be terminated using crimped, insulated loop connectors.

700-2.19 (86-2.11A) Solar Electric Power System. Where shown on the plans, a solar electric power system shall be provided. The system shall consist of solar modules, batteries, a charge regulator, mounting hardware, and the necessary wiring.

700-2.19.1 Solar Electric Modules. Solar electric modules for school zone flashers shall use triple junction thin film technology. Twenty-four-hour systems may use the thin film or polycrystalline modules. Thin film module electrical characteristics shall be 16.5 V DC maximum power voltage and 23.8 V DC open circuit voltage under standard test conditions of 1000 W/m² at 25 °C. Polycrystalline module electrical characteristics shall be 16.9 V DC maximum and 21.5 V DC open circuit voltage under standard test conditions of 1000 W/m² at 25 °C. The cell shall be fabricated on a stainless steel back sheet. Cells shall include an integral bypass diode. Cells shall provide the required module wattage and be encapsulated under low-iron glass.

700-2.19.2 Batteries. Systems shall include between 1 and 4 sealed valve regulated lead-acid batteries depending on autonomy and load requirements. Battery size shall be group 27. Battery ratings shall be 12 V DC, 98–105 Amp-hours and the C/100 rate or similar. Plate chemical composition shall be of lead-calcium. The case and cover material shall be polypropylene. The terminal configuration shall be T881 designed for a 1/4-inch (6 mm) bolt. Batteries shall be filled with electrolyte suspended in a thixotropic gel or an absorbed glass mat which allows the battery to be placed upright or on its side. Batteries shall be designed for solar applications and shall come with a prorated warranty for such applications. A data sheet for the battery, showing lifetime versus cycle depth at 25 EC, shall be included.

700-2.19.3 Charge Regulator.

1. The unit shall be an integrated system control unit with the capability to control power and load management functions. Basic features shall include charging of the system batteries based on voltage and temperature, low

voltage disconnect to protect the batteries from over-discharge, and operation of the flasher circuit.

2. The unit shall have an external trigger input for system activation by external sources such as timers, detectors, and devices incorporating a switch/contact closure and shall include a select switch for this. The controller shall include a series switch-configured charge controller which controls the flow of array current to the battery.

3. The charging algorithm shall be a pulse type that features temperature-compensated charging. On-board short circuit protection shall be standard. The controller shall have two lamp outputs set for a 50 % duty cycle each and normally calibrated for 50–60 flashes per minute to meet ITE and MUTCD standards.

4. Outputs shall be complimentary—one on and the other off. Automatic intensity adjustment of the lamps shall be made by the controller for variance in light conditions. Dimming circuitry shall be integral to the controller. Electronics shall be potted or coated to protect against environmental damage.

5. The unit shall feature an integral heat sink and an 8-position terminal strip with all positions labeled for ease of servicing. Manual switches shall be provided on the controller to select the lamp activation source (on continuous or external activation) and the dimming circuit activation. Dimming shall be capable of being defeated for school zone systems.

700-2.19.4 Mounting Hardware.

1. Solar modules shall include an aluminum frame to allow for ease of mounting and rigidity. Solar modules shall be mounted to a fixed tilt mounting structure set to an angle of 45E–50E. The mount shall be constructed of galvanized steel (ASTM A-153 Class A) or clear anodized aluminum. The mount shall be suitable for use with a Type 1-A pole. The mount will include appropriate stainless steel hardware to secure the modules to the mounting structures.

2. The system shall be housed in a gasketed enclosure, constructed of 1/4 inch (3 mm) aluminum, and designed for mounting on a 14 feet (4.2 m) Type 1-A pole. The enclosure shall have room for a vertical aluminum mounting plate capable of holding the system controller and the timer module (school zone systems).

3. The battery section of the enclosure shall feature a minimum of 1/2 inch (12.5 mm) styrofoam insulation material around the battery compartment sides to minimize transfer of heat from the enclosure wall to the battery. Screen-covered louvered vents shall be included on each side of the enclosure to allow circulation of air in the enclosure.

4. The enclosure shall feature one or more PELCO police locks to secure the contents from unauthorized access. Enclosures shall be capable of holding either two or four batteries, depending on system requirements. The door shall have a lock cover plate attached to the door with a rivet. The door shall be attached to the main enclosure with hinges that are welded or sufficiently riveted to each piece. Enclosures for four batteries shall feature a continuous hinge. A mechanical stop shall be included to prevent the door from opening more than 115°.

700-2.19.5 **Wiring.** The system shall be provided complete with wiring necessary for installation on a Type 1-A pole. Cabinet and lamp wiring shall be color coded and include a seven-pin cannon plug in the harness to allow disconnect of the system. The plug shall be keyed with a locking mechanism to ensure proper connection. Array wiring shall be coated in UV resistant sheathing and come with cord grips for exiting the module and entry to the pole. Conductors shall be terminated with either a forked terminal or a spade terminal. Sealing lock rings or O-rings shall be used to minimize the entry of water or dust into the junction box. Module interconnect cables, if used, shall be constructed of #10 AWG with a UV resistant sheath. Cord grips shall be provided at entry and exit points to the module junction box. Conductors shall be terminated with forked terminals.

700-2.20 **(86-214) Testing.** Testing of control equipment and cabinet wiring, complete, will be accomplished at a facility by the City of San Diego. Testing of street lighting equipment will include a 3-day burn, by you, with the use of shorting caps.

700-2.21 **(86-2.16) Painting.**

1. **Where shown on the Plans or specified in the Special Provisions**, all light standards, mast arms, luminaire arms, signal heads, luminaires, and electrical service cabinets shall be painted the specified color. In the Centre City Community, the specified color is known as CCDC dark blue (Sherwin Williams F63TXL-1075-4365, Tnemec 75-J6179, or equal).

2. Steel surfaces shall be prepared either by Power Tool Cleaning per Section 310.2.4, or Commercial Blast Cleaning conforming to 310-2.5.1(d),"General." New ungalvanized ferrous and non-ferous metal surfaces shall to be prepared per section 310, "PAINTING." Coating system shall be Sherwin Williams (as listed below), Tnemec 75-J6179, or approved equal:

    - Wash Prime Coat: Sherwin Williams, Industrial Wash Primer, P60g2, 0.2-0.4 mil dry film thickness

    - Prime Coat: Sherwin Williams Tile-Clad II Hi-Build Primer, B62N 71/B60V 70, 4mils dry film thickness

    - First Finish Coat: Specified color, or Sherwin Williams F63TXL-1075-4365, 2 mils dry film thickness

- Second Finish Coat: Specified color, or Sherwin Williams F63TXL-1075-4365, 2 mils dry film thickness

3. You shall touch up marred or abraded areas with a matching paint.

700-3 CONTROLLER ASSEMBLIES.

700-3.1 (86-3.01) Controller Assemblies.

1. Traffic signal controllers shall conform with the latest edition of Standard Specifications, State of California, Department of Transportation," Section 86, and "Traffic Signal Control Equipment Specifications," State of California. Controller assemblies shall be on the current State of California Qualified Products List (QPL). Traffic Signal Control Equipment Specifications shall have precedence over Caltrans Standard Specifications.

Table700-3.1 Controller Assembly

Model 332 Cabinet	Model 336 Cabinet	Model 337 Cabinet	Description
1	1	1	Model 170E controller unit* with Model 412C system memory module and Power Distribution Assembly #2 (PDA #2)
1	1	1	Aluminum cabinet wired for and including the necessary accessories for full operation except as noted
1	1	1	Model 210 monitor unit
4	2	2	Model 242 two-channel isolator
12	12	6	Model 200 switch pack
1	1	1	Model 27256 programming chip (blank)

Model 332 Cabinet	Model 336 Cabinet	Model 337 Cabinet	Description
1	1	1	Model 404 Modem w/harness
16	8	4	Model 222 two-channel loop detector sensor unit

*When specified, use Model 170E Master Controller Unit with C2 connector and C20 connector.

2. The doors of the cabinets shall be hinged so that the doors swing away from the curb or street.

3. When the controller assembly is to be furnished in a Model 336 cabinet with base adaptor, the cabinet shall be constructed in accordance with the Controller specification for Model 332 aluminum cabinet but with the configuration shown in Figure 3.

4. Each cabinet shall be equipped with a single fluorescent fixture with front and rear door activating switches, and slide-out document drawer. Cabinet finish shall be anodized aluminum with clear anti-graffiti coating except when a paint finish is specified.

5. Front panel character display modules shall be socket mounted for easy replacement in the front panel assembly.

700-3.2 **(86-3.04E) Model 200 Switch Packs.** Model 200 switch packs shall be capable of operating Type "G" pedestrian signals without exceeding Model 210 conflict monitor threshold limits and shall be capable of switching a single L.E.D. head.

700-3.3 **(86-3.04E) Model 412C System Memory Module.** The module shall be designed so that persons inserting or removing the assembly shall not be required to insert hands or fingers within the controller unit housing this modular assembly. A handle or gripping device protruding no more than (1 1/4 inches) from the front panel shall be attached to the front of the assembly. The front panel shall be connected to equipment ground. The front panel of the module shall be labeled "SYSTEM MEMORY MODULE MODEL 412C". Socket for 27256 EPROM chip shall be marked on the board adjacent to each socket designating the following descriptive: MS and LS.

700-3.4 **(86-4.05) School Zone Flashing Beacon System Timer Module.** The system timer module shall have the following minimum standard features:

1. alphanumeric LCD display;
2. 48-hour capacitive backup;
3. 15 A SPDT relay output;
4. 16-key input keypad;
5. auto-leap year compensation;
6. auto-prompt for programming;
7. crystal clock source;
8. operating temperature range of -30°C to 74°C;
9. solid-state construction except for the relay;
10. auto-daylight savings time adjustment; and
11. compatible with nominal 12 V DC operation.

The unit shall be capable of exception periods when operation can be suspended or optional programs can be run for periods such as holidays or special events. Program steps shall allow the programming of a single day, weekend, or week days.

700-4 (Section 86-4) TRAFFIC SIGNAL FACES AND FITTINGS.

700-4.1 (86-4.01) Signal Faces and Signal Heads.

1. Signal head sections, except programmed visibility type heads, shall be metal with metal visors and metal back plates. Visors shall be tunnel-type, have ears and be attached to the signal heads with screws. Visors shall interchange with Econolite, Traffic Control Technologies, McCain, and Automatic Signal manufactured vehicle heads.

2. All new signal faces and all arrow indications shall be provided with 300 mm (12”) sections unless shown otherwise on the plans. Lenses shall interchange with Econolite, Traffic Control Technologies, Automatic Signal, and McCain manufactured vehicle heads.

3. Type SV-1-T mountings with 5 sections and SV-2-TD mountings shall be strapped to the standard using 1/2 inch (12.5 mm) stainless steel strapping material and a stainless steel standoff.

4. Except for programmed visibility heads, the red, yellow, and green indications shall be Type 1 Light Emitting Diode (LED) signal modules conforming to the latest Caltrans specifications. A maintenance period is not required. Replacement modules shall be provided promptly after receipt of modules that have failed at no cost to the City except cost of shipping of the failed modules. All warranty documentation shall be given to the Engineer prior to installation. The replacement modules shall be delivered to the City's Street Division-Electrical Section at Chollas Operations Station, 2781 Caminito Chollas, San Diego, CA 92105 within 5 Working Days after notification.

5. Where solar electric power is provided for a flashing beacon, the indication(s) shall be yellow or red Light Emitting Diode (LED) signal modules conforming to the latest Institute of Transportation Engineers specifications. A maintenance period is not required. Replacement modules shall be provided promptly after receipt of modules that have failed at no cost to the City except cost of shipping of the failed modules. All warranty documentation shall be given to the Engineer prior to installation. The replacement modules shall be delivered to the City's Street Division/Electrical Section at Chollas Operations Station, 2781 Caminito Chollas, San Diego, CA 92105 within 5 Working Days after notification.

6. Traffic signal heads shall be green with black doors unless otherwise specified in the plans or specifications.

700-4.2 **(86-4.02) Programmed Visibility Vehicle Signal Faces.** Lamps shall be furnished by you. You shall arrange to have a signal technician qualified to program the programmed visibility signal heads present at the time the signal heads are placed in operation. Lamps for the signal units shall be 150 W, 120 V, incandescent lamps with a minimum average rated life of 6,000 hours. The lamp and socket shall be the 3-prong type.

700-4.3 **(86-4.03) Types. Pedestrian signals shall be Type "G."**

1. Each pedestrian signal shall consist of a housing with front screen, a message plate, and two Light Emitting Diode (LED) modules, Pedestrian signal housings shall be metal with metal visors and shall conform to provision in Section 86-4.01. All pedestrian signals shall incorporate a pedestrian countdown timer indication.

2. The message plate shall be 1/8 inch (3 mm) nominal thickness ultra-violet-stabilized, prismatic-patterned polycarbonate plastic; 3/16 inch (5 mm) nominal thickness hammered wire glass; or 3/16 inch (5 mm) nominal thickness ultraviolet-stabilized, prismatic-patterned acrylic plastic. The message plates shall have a flat-black surface over the entire projected area except where the symbols are located. The material used to mask the message plate shall be hard and durable and shall bond in such a manner that it will not flake or peel when the message plate is in use or is washed. The symbols shall

be the only illuminated portion of the message plate. The message plate shall be sealed to a polycarbonate case to form a dust-tight and weather-proof module.

3. For crossings where the distance from the near curb to the pedestrian signal indication is 60 feet (18 m) or less, the luminance of the UPRAISED HAND symbol shall be 960 cd/m2 (280 footlamberts), minimum, and the luminance of the WALKING PERSON symbol shall be 3,400 cd/m2 (990 footlamberts) minimum.

700-4.4 (86-4.03) Audible Pedestrian Signals.

1. Audible pedestrian signals shall be installed in conjunction with each visual pedestrian signal head where shown on the plans.

2. The audible pedestrian signal shall consist of a weather-proof audio signal device operating continuously during the protected walk interval of the corresponding visual pedestrian signal when actuated by the corresponding pedestrian push button. The output volume of the audio signal shall automatically adjust to the ambient noise level in the intersection. East-west crosswalks shall be designated by a "Beep-Beep" electronic bird chirping; north-south crosswalks by a "Cuckoo" electronic bird chirping.

3. Audible signal device speaker shall be mounted facing down in location shown on the attached, "Audible Pedestrian Signal Details."

700-4.5 (86-4.03) Accessible Pedestrian Signals. Accessible pedestrian signal shall consist of an integrated push button assembly with vibrotactile button, programmable verbal message, locator tone with automatic volume adjustment to ambient noise.

700-4.6 (86-4.04) Signal Mounting Assemblies. Signal faces installed prior to signal operation shall be covered with shade cloth, canvas, or similar. Cardboard is not an acceptable cover material. Mast arm slip-fitters, post top slip-fitters, and terminal compartments shall be cast bronze.

700-4.7 (86-4.05) Flashing Beacons. Flashing beacons installed at school locations shall be equipped with a solid-state programmable timer with digital display as specified in 700-3.4 School Zone Flashing Beacon System Timer Module.

700-5 (Section 86-5) - DETECTORS

700-5.1 (86-5.01) Vehicle Detectors.

1. Loop wire shall be Type 1. Loop detector lead-in cable shall be Type "B". Slots shall be filled with elastomeric sealant, epoxy sealant, or hot-melt rubberized asphalt sealant, except asphaltic emulsion loop sealant and cold tar

loop sealant are acceptable if the pavement surface will receive an asphaltic concrete overlay.

2. Vehicle detector loops shall be Type E or Type E Modified as shown on the plans. Bicycle detector loops within bicycle lanes shall be Type Q. For Type E detector loops, sides of the slot shall be vertical and the minimum radius of the slot entering and leaving the circular part of the loop shall be 1 1/2 inches (40 mm). Slot width shall be a maximum of 3/4 inch (20 mm). Type E detector loops shall have three turns of conductor. Limit line vehicle detector loops (front loops) shall be Type E Modified loops. Type E Modified loops shall have four turns of conductor.

3. The sand mixed with the epoxy loop sealant shall be clean and dry silica sand and shall be smaller than 1,520 μm (pass a No. 12 sieve) and be no smaller than 860 μm (retained on a No. 20 sieve). The adhesive shall be a black, low viscosity material consisting of equal parts of modified coal tar epoxy resin and modified amine-bitumen hardening agent, equal to Epocast H-1136A and 1136B. Adhesive shall be mixed together mechanically on the Site and shall have 30- to 45-minute pot life.

4. Fill the slot with sand. Soak the sand with adhesive overflow. Cover the slot with additional sand. Before the adhesive sets, strike off excess material flush with pavement and remove from adjacent road surfaces.

700-5.2 (86-5.01A) Preformed Inductive Loops.

1. Preformed inductive loops shall be the type shown on the plans. The loop shall be 6 feet (1,8 m) square unless otherwise shown. The loop shall consist of 4 turns of No. 16, or larger, wire with Type THWN or TFFN insulation. The loop wires shall be encased in Size 10, minimum size, Schedule 40 or Schedule 80 PVC or polypropylene conduit. The conduit shall be sealed to prevent the entrance of water and the movement of wires within the conduit. The loop wires from the preformed loop to the adjacent pull box shall be twisted together into a pair (at least 7 turns per meter (2 turns per foot)) and encased in Schedule 40 or Schedule 80 PVC or polypropylene conduit between the preformed loop and the adjacent pull box or detector handhole. The lead-in conduit shall be sealed to prevent the entrance of water at the pull box or handhole end.

2. In new roadways, the preformed loops and lead-in conduits shall be placed in the base course, with top of conduit flush with top of base, and then covered with the asphalt concrete or PCC pavement. Preformed loops and lead-in conduits shall be protected from damage prior to and during pavement placement.

3. In new reinforced concrete structure decks the preformed loops shall be secured to the top of the uppermost layer of reinforcing steel using nylon wire

ties. The loop shall be held parallel to the structure deck by using PVC or polypropylene spacers where necessary. Conduit for lead-in conductors shall be placed between the uppermost 2 layers of reinforcing steel.

4. In existing pavement, preformed loop installation shall conform to the following:

5. "The preformed loops and lead-in conduits shall be placed in slots, 1/4 inch (6 mm) minimum width, cut into the existing pavement. The top of the conduit shall be 1 inch (25 mm), minimum, below the top of pavement."

6. Slots in asphalt concrete pavement shall be filled with elastomeric sealant, epoxy sealant, or hot-melt rubberized asphalt sealant.

7. Slots in portland cement concrete shall be filled with elastomeric sealant or hot-melt rubberized asphalt sealant, or shall be filled with epoxy sealant conforming to the requirements in Section 95-2.09, "Epoxy Sealant for Inductive Loops" of the Standard Specifications.

700-5.3 (86-5.02) Pedestrian Push Button Assemblies.

1. Pedestrian push buttons shall be Type "B." Actuator shall have a minimum diameter of 2 inches and an operating force of 2.5 to 3.6 N (9 to 13 ounces) and a release force of one N (3.5 ounces).

2. Pedestrian push button signs shall conform to the size shown on Standard Plan ES-5C. Signs shall display international "Walking Person" symbol and directional arrow. Pedestrian push button housing shall be mounted with the actuator button at 3 feet 3 inches +/- 1" (0.99 m +/- 25 mm) above the adjacent finished grade.

700-6 (Section 86-6) LIGHTING.

700-6.1 (86-6.03) Low Pressure Sodium Luminaires.

1. Low pressure sodium luminaires shall be completely assembled, furnished with a lamp and ballast, and shall comply with the following requirements.

2. Luminaires shall be the enclosed type with a horizontal burning lamp. Luminaires shall be cutoff type or semi-cutoff type (Illuminating Engineering Society Classification) as shown on the plans. Luminaire performance data shall be performed and certified by an independent and recognized testing laboratory and shall be submitted with material lists in conformance with Section 86-1.04, "Equipment List and Drawings," of the Standard Specifications.

3. Lux distribution shall be ANSI Type III, short, or Type IV, medium distribution, for cutoff or semi-cutoff luminaires. With a 34-feet 3-inch (10.4 m) mounting height, each type of luminaire shall maintain a minimum of 2.1 lux (0.2 footcandles) at least 90 feet (27.4 m) each side, along the longitudinal roadway line below the luminaire, and a minimum of 3.75 lux (0.35 footcandles) at a transverse roadway distance from the luminaire location equal to 1.5 times the luminaire mounting height.

4. Certified luminaire performance data shall be furnished as part of the Equipment List and Drawings as specified in Section 86-1.03 of the Standard Specifications. This data shall include complete photometric test data in the form of isolux (isofootcandle) charts at a scale of 1:240 (1 inch = 20 feet), for the luminaire and lamp sizes indicated on the plans.

5. Alternate data may be in the form of horizontal lux (horizontal footcandle) values recorded on a 15 foot x 15 foot (5 m x 5 m) grid extending 90 feet (27.4 m) longitudinally each side of the light source, and 15 feet (4.6 m) behind and 90 feet (27.4 m) in front of the light source, for the luminaire and lamp sizes and the mounting height indicated on the plans. The horizontal lux (horizontal footcandle) levels in the data submitted shall equal or exceed the levels specified in these special provisions. Failure to meet the referenced values will be justification for disapproval of the luminaires.

6. The photometric test shall be performed and certified by an independent and recognized testing laboratory. Subsequent to you installing any luminaires, field checks may be performed at random by the Engineer and calculated according to the Illuminating Engineering Society "Guide for Photometric Measurement of Roadway Lighting Installation (LM-50-99)" (1999). Failure to meet or exceed the referenced values during field checks will be justification for replacement by you.

7. The luminaire shall be completely assembled and furnished with a lamp. Each luminaire shall consist of a housing, a reflector, a refractor or a lens, a lamp socket, an integral ballast, a removable ballast tray, a lamp support, a terminal strip, a capacitor, a slipfitter, and shall be provided with an integral standard three-prong twist lock receptacle for photoelectric cell control in accordance with latest EEI-NEMA standards. The reflector may be an integral part of the housing.

700-6.1.1 Construction.

1. The luminaire housing shall be of corrosion-resistant die-cast aluminum, of 5/8 inch (1.6 mm) corrosion-resistant aluminum sheet and plate with concealed continuous welds, or of acrylonitrile-butadiene-styrene sheet material 3/32 inch (2.4 mm), minimum nominal wall thickness) on a cast aluminum frame that provides mounting for all electrical components and the slipfitter. Positioning and clamping of the luminaire to the pipe tenon shall be

accomplished by tightening mounting bolts. The housing shall be divided into optical and power compartments that are individually accessible for service and maintenance. A high temperature neoprene, or equal, sealing ring shall be installed in the pipe tenon opening to prevent entry of water and insects into the power and optical compartments. Access to the power unit shall be through a weather-tight hinged cover, secured with spring type latches or captive screws, to the luminaire housing. Hardware shall be stainless steel machine screws and/or bolts and shall be used to secure removable components. Sheet metal screws shall not be used.

2. The lamp socket shall be of high temperature, flame-retardant thermoset material with self-wiping contacts or may be of other equally durable material. The socket shall be rated for 660 W and 1000 V. Position of the lamp socket and the lamp support shall maintain the lamp in correct relationship with reflector and refractor for designed distribution pattern. Ballast shall be the autotransformer or high-reactance type and, when operated with the lamp, shall have the following characteristics and maintain the following lamp operation:

   a) The power factor shall be not less than 90% when the ballast is operated at nominal line voltage.

   b) Lamp wattage regulation spread, at any lamp voltage from nominal through life, shall not vary by more than ☐ 6% for ☐ variation.

   c) The lamp current crest factor shall not exceed 1.8 at nominal line voltage.

   d) Ballast losses shall not exceed 24% for 180 W ballasts at nominal line voltage.

3. A single multi-circuit connector shall be provided for quick disconnection of ballast tray.

4. Field wires connected to the luminaire shall terminate on a barrier type terminal block secured to the housing. The terminal screw shall be captive and equipped with wire grips for conductors. The terminal block shall accommodate stranded or solid wire sizes No. 16 to No. 8.

5. The slipfitter shall be capable of attaching to a 2 3/8 inches (70 mm () O.D. pipe tenon mounting bracket without the need for special mounting parts. Positioning and clamping of the luminaire to the pipe tenon shall be accomplished by tightening mounting bolts. The slipfitter shall have minimum 5 degree tilt adjustment.

6. Semi-cutoff luminaires and molded refractor style (drop lens) cutoff luminaires shall be provided with a refractor. Refractors shall be one-piece

injection molded polycarbonate 2.4 mm (3/32-inch) minimum thickness; or be made of a one-piece injection molded acrylic 1/8 inch (3 mm) minimum thickness. The refractor assembly and flat lens assembly shall be constructed to rigidly maintain its shape. The refractor assembly and the flat lens assembly shall be hinged and secured with spring-type latch(es) to the luminaire housing.

7. Cutoff-type luminaires shall be provided with a flat lens. Flat lens shall be one piece polycarbonate of 3/32 inch (2.4 mm), minimum thickness. The flat lens shall be mounted in a metal frame. Alternate methods of manufacturing refractor may be approved provided minimum specified thicknesses are maintained. A sample refractor for testing will be required for alternate method of manufacturing.

8. The optical system, consisting of the reflector, refractor or flat lens, lamp socket, and lamp shall be in a sealed chamber. Sealing shall be provided by a gasket between the refractor or flat lens frame and the luminaire housing shall form a weather-tight, dust-tight enclosure.

700-6.1.2 **Finish.** Painted exterior surfaces of the luminaire shall be finished with a fused coating of electrostatically applied polyester powder paint or other approved ultraviolet inhibiting film. Color shall be aluminum gray unless otherwise shown.

700-6.2 **(86-6.03) Low Pressure Sodium Lamps.**

1. Lamps shall be single ended, bayonet base, tubular gas discharge lamps suitable for use in outdoor lighting application. The lamps shall have a 93% lamp lumen depreciation factor rating, and comply with the minimum performance requirements in Table 700-6.2

Table 700-6.2

Nominal Watts	Rated Lumens	Average Watts Over Life	Operating Position
18	1,800	18.6	Base up ± 110°
35	4,800	37.5	Base up ± 110°
55	8,000	58.9	Base up ± 100°
90	13,500	96.3	Horizontal ± 20°
135	22,500	139.1	Horizontal ± 20°

Nominal Watts	Rated Lumens	Average Watts Over Life	Operating Position
180	33,000	189.9	Horizontal ± 20°

2. Lamps are to have an average rated life of 18,000 hours (at 10 hrs/start) except the 18 watt size which shall be 14,000 hours. Lamps shall be able to reach 80 percent of light output within 10 minutes and shall restrike within 1 minute after an outage due to power interruption or voltage drop at the lamp socket.

3. The base of the lamp shall have a device that will allow the installer to indicate the month and year of installation.

700-6.3 (86-6. 11) Photoelectric Controls.

1. The photoelectric control unit (PCU) shall be Type "IV".

2. Furnish an individual, stand-alone PCU with each fixture. An Adaptive Control Node shall be provided unless otherwise specified on the Plans or in the SSP The PCU shall have a silicon light sensor that complies with ANSI 136.10 – 2010, and have MOV surge protection. The PCU shall have a minimum ten year warranty. The PCU shall fail in the “on” control. It shall be capable of inverse ratio controls. It shall be suitable for roadway applications.

3. The PCU shall be American Electric Lighting model number DP 124-1.5-T-J-BK or approved equal.

4. Photoelectric units for illuminated signs shall have a "turn-on" level of between 215 and 323 lux (20 and 30 footcandles) (corresponds to a switching level of approximately 430 to 646 lux (40 to 60 footcandles) measured in the horizontal plane). "Turn-off" level shall not exceed 3 times "turn-on" level.

5. See 700-6.6 for Adaptive Control Node specification.

6. All components shall be long life with UV inhibitors

700-6.4 Induction Cobra Head Luminaire.

700-6.4.1 General.

1. Each luminaire shall consist of an assembly that utilizes induction light components as the light source subject to the following requirements:

   a) Operating Temperature: The luminaires shall be designed to operate at an

average nighttime temperature of 70°F (21°C) The ambient operating temperature range shall be 30°F to +130°F (-1°C to 54.4°C). The fixture shall be capable, for example, when a PCU fails, of operating without long term degradation at temperatures up to 150°F (65.6°C) without compromising the warranty.

b) UL Listing: Fixture shall include UL label. The fixtures shall be UL Listed, and UL listed for The City Locations. The UL listing shall include the pole mounting assembly.

c) Components: Induction components shall be interchangeable amongst similar wattages for common fixtures without requiring use of special tools. Troubleshooting components shall not require special diagnostic tools or individual energy usage metering systems.

700-6.4.2 Electrical Requirements.

1. Operating Voltage: The luminaire shall operate within one of two voltage categories (110 to 120 and 200 to 277) Volts AC (VAC). The fixtures shall be capable of operating in the range of voltages in each category. Fluctuations of line voltage within these categories shall have no visible effect on the luminous output. . External Transformers are not permissible as components for the luminaire input voltage.

2. Power Factor: Power supply shall have a minimum Power Factor of 0.90.

3. Harmonic Distortion: The total harmonic distortion shall not exceed 10%. An integral factory installed standard ballast is required that includes inherent thermal protection.

4. In-Rush Current: The in-rush current shall be limited to 16 amps for 60 – 90 Watt and 28 amps for 150 - 165 Watt for duration no longer than 170 µs. Leakage current shall not exceed 0.5 milliamps.

5. Ignition Time: The ignition time for the lamps shall be less than 1.0 seconds.

6. Surge Suppression: The luminaire on-board circuitry shall include Surge Suppression Devices (SSD) to withstand high repetition noise transients as a result of utility transients, and other interference. SSD shall conform to UL 1449 or UL 1283, depending on the components used in the design.

700-6.4.3 Controls.

1. Photocell Receptacle: Each luminaire shall have a rotatable (so the window can be adjusted to the north) prewired 3-prong (twist-lock) ANSI C136.10 photocell receptacle

2. Furnish a PCU with each fixture.

3. Refer to 700-6.3 for Photoelectric Controls

700-6.4.4 Interference Requirements.

Radio Frequency Interference (RFI) Requirements: Power supplies shall meet FCC 47 CFR Part 18.

700-6.4.5 Cooling System.

1. Thermal management of the heat generated by the induction components shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life of more than 100,000 hrs at specified operating temperature range and climate zone.

2. The light output variation shall not deviate greater than 15% over 40°F to +130°F (4.4°C to 54.4°C) operating temperature variation.

3. Thermal management shall be passive by design and shall consist of a heat sink with no moving mechanical parts or liquids.

700-6.4.6 Roadway Application Requirements and Optical Assembly.

1. Correlated Color Temperature (CCT): CCT shall be 3000 or 4000 Kelvin depending on location and as indicated on the Plans.

2. Color Rendering Index (CRI): Luminaires shall have a minimum CRI of 80.

3. Optics: The luminaire shall conform to the Illuminating Engineering Society (IES) definition of "cut-off", with no illumination above an angle of 90 degrees above the nadir. The fixtures shall be International Dark-Sky Association (IDA) compliant with RP-8, adapted 2005. Submittal documentation shall include "Dark Sky" compliance.

4. Reflector Assembly: The reflector shall be precision formed aluminum with heat/impact resistant tempered flat glass protecting the interior. The interior reflector shall have a chemically bonded lightweight non-breakable silicate coating and a nonporous surface that maintains a bright specula finish, inhibits the accumulation of dirt, and promotes ease of cleaning. Cleaning may be accomplished with the application of compressed air to remove foreign materials such as dust to restore the reflectance. The reflector assembly shall have a charcoal air filter with integral felt gasket, or equivalent air-quality filtering system, to inhibit entry of particulates into the interior reflector assembly to mitigate dirt depreciation. The reflector assembly shall confirm to ASTM B117-09 test procedure i.e., 50,000 hours of exposure to salt fog testing.

700-6.4.7 Physical/Mechanical Requirements.

1. Luminaire Fixture: The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.

2. Maximum Dimensions: 36inches long by 19 inches wide by 12inches tall (91 cm long by 48 cm wide by 30 cm tall).

3. Luminaire shall not weigh more than 35 pounds (15.9 Kg).

4. Assembly Housing: The housing shall be primarily constructed of die cast aluminum, or steel; corrosion resistant paint. Finish shall be gray in color, powder coated and rust resistant. The fixture openings and doors shall be sealed and gasketed. The components within the fixture assembly shall be easily accessible with a two-piece hinged door separable from the upper assembly. The lower door shall be removable. All screws shall be stainless steel. Captive screws are required on accessible components that require maintenance after installation. No parts shall be constructed of polycarbonate unless it is UV stabilized. Lens discoloration shall be considered a failure under warranty.

5. Generator Compartment Requirements: Provide a separate generator compartment, easily accessible with a "plug and receptacle" type conductor so that the generator can be easily removed from the fixture and remain attached to the fixture i.e., using a lanyard or restraining device to avoid having the generator falling out. The power door shall be hinged and secured to the luminaire housing separately from the optical chamber. The door shall be secured to the housing in a manner to prevent the door from accidentally opening. The power supply shall be electrically connected to the power door with a NEMA rated quick disconnect device.

6. Access: Provide easy access to internal components. Include an external latch capable of being operated with one hand. No internal components shall fall out when the lower door assembly is opened. Seams shall be CNC formed and TIG welded.

7. Lens Requirements: The lens shall be tempered glass ¼ inch (6 mm) thick lens, or approved equal with gasketed door.

8. Mast Arm Mounting Connection Requirements: Luminaires shall mount on min 1-5/8 inch (41.3 mm) OD to max 2-3/8 inch (60.3 mm) OD horizontal tenon with no more than four 9/16" hex bolts and a 2-piece clamp(s). Luminaire leveling capability shall be integral to the fixture. Multiple mounting angle adjustments shall be provided to adjust the level of the fixture +/- 4 degrees from the horizontal.

9. Mechanical Requirements: The assembly and manufacturing process for the induction luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration from winds.

10. Ingress Protection (IP) Rating: Optical assembly shall have a minimum rating of IP-65; the exterior shell shall have a minimum IP rating of 54.

11. Terminal Block: Field wires connected to the luminaire shall terminate on a barrier type terminal block secured to the housing. The terminal screws shall be captive and equipped with wire grips i.e., serrated strips on the terminal for conductors up to #6 AWG wire size. Each terminal position and conductor phase designation i.e., neutral, phase ground conductor shall be clearly identified.

12. Components: All components, including circuit boards, shall conform to Chapter 1, Section 6 of the "Transportation Electrical Equipment Specifications" (TEES) UL 1598, and ANSI C 136 requirements.

13. Painting: Powder coat painting of the housing shall conform to the requirements of the Caltrans Standard Specification and the Caltrans Standard Special Provisions. Applied coating shall be free of lead and mercury. Fixture components shall be modular in design and recyclable.

700-6.4.8 Luminaire Identification.

1. Identification: Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date of manufacture including month and year, and lot number as identification permanently marked inside each unit and the outside of each packaging box.

2. Identification: The wattage, voltage and CCT rating of the luminaire shall be able to be detected visibly from an observer standing at ground elevation at the base of the pole.

3. Identification of Operating Characteristics: The following operating characteristics shall be permanently marked inside each unit: rated voltage and rated power in Watts and Volt-Ampere, and Luminaire Efficiency Rating (LER).

4. Lamp Identification: Lamps shall be permanently marked with the correlated color temperature (CCT) rating in Kelvin, color rendering index (CRI), and wattage.

700-6.4.9 Photometric Documentation. IES Files: Submittals shall include an IES files for each fixture type. Submittals shall include photometric iso-foot candle diagram

for a 30’ mounting height for each fixture type, and a point to point diagram with uniformity calculations that identify maximum to minimum illumination ratio.

700-6.4.10 Quality Assurance. Luminaires shall be manufactured in accordance with ISO9001. Manufacturer’s Warranty Certificate:

1. Provide manufacturer’s Certification of Warranty for a minimum of 10 years. Warranty shall include all components of the luminaire and labor cost for replacement.

2. The Manufacturer shall provide documentation verifying that the induction luminaire model(s) being offered for this procurement are covered by the 10 year warranty.

700-6.5 LED Cobra Head Luminaire.

700-6.5.1 General.

1. Each luminaire shall consist of an assembly that utilizes LED components as the light source subject to the following requirements:

   a) Operating Temperature: The luminaire shall be designed to operate at an average nighttime temperature of 70°F (20°C). The ambient operating temperature range shall be 30°F to +130°F (-5°C to 55°C).

   b) UL Listing: The fixtures shall be UL Listed and shall include UL label. The UL listing shall include the pole mounting assembly.

   c) Components: LED components shall be interchangeable amongst similar wattages for common fixtures without requiring use of special tools. Troubleshooting components shall not require special diagnostic tools or individual energy usage metering systems.

700-6.5.2 Electrical Requirements.

1. Operating Voltage: The luminaire shall operate within one of two voltage categories (95 to 305 and 480) Volts AC (VAC). The fixtures shall be capable of operating in the range of voltages listed. Fluctuations of line voltage within these categories shall have no visible effect on the luminous output. . External Transformers are not permissible as components for the luminaire input voltage.

2. Power Factor: Power supply should have a minimum Power Factor of 0.90.

3. Harmonic Distortion: The total harmonic distortion shall not exceed 20%. An integral factory installed standard driver is required that includes inherent thermal protection.

4. Surge Suppression: The luminaire on-board circuitry shall include Surge Suppression Devices (SSD) to withstand high repetition noise transients as a result of utility transients, and other interference. SSD shall conform to UL 1449 or UL 1283, depending on the components used in the design.

700-6.5.3 Controls.

1. Photocell Receptacle: Each luminaire shall have a rotatable (so the window can be adjusted to the north) prewired 7-conductor (twist-lock) ANSI C136.41-2013 photocell receptacle.

2. Furnish an Adaptive Control Node for each luminaire. See 700-6.6 for Adaptive Control Node specification.

3. All components shall be long life with UV inhibitors

700-6.5.4 Cooling System.

1. Thermal management of the heat generated by the components shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life of more than 100,000 hrs at specified operating temperature range and climate zone.

2. The light output variation shall not deviate greater than 15% over 40°F to +130°F (0°C to 55°C) operating temperature variation.

3. Thermal management shall be passive by design and shall consist of a heat sink with no moving mechanical parts or liquids.

700-6.5.5 Roadway Application Requirements and Optical Assembly.

1. Correlated Color Temperature (CCT): CCT shall be 3000 or 4000 Kelvin depending on location and as indicated on the Plans.

2. Color Rendering Index (CRI): Luminaires shall have a minimum CRI of 70.

3. Optics: The luminaire shall conform to the Illuminating Engineering Society (IES) definition of “cut-off”, with no illumination above an angle of 90 degrees above the nadir. The fixtures shall be International Dark-Sky Association (IDA) compliant. Submittal documentation shall include “Dark Sky” compliance.

700-6.5.6 Physical/Mechanical Requirements.

1. Luminaire Fixture: The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.

2. Maximum Dimensions: 40 inch long by 16 inch wide by 8 inch tall (101.6 cm long by 40.6 cm wide by 20.3 inch tall).

3. Luminaire shall not weigh more than 40 pounds (18 Kg).

4. Assembly Housing: The housing shall be primarily constructed of die cast aluminum, or steel; corrosion resistant paint. Finish shall be gray in color, powder coated and rust resistant. The fixture openings and doors shall be sealed and gasketed. The components within the fixture assembly shall be easily accessible with a two-piece hinged door separable from the upper assembly. The lower door shall be removable. All screws shall be stainless steel. Captive screws are required on accessible components that require maintenance after installation. Lens discoloration shall be considered a failure under warranty.

5. Access: Provide easy access to internal components. Include an external latch capable of being operated with one hand. No internal components shall fall out when the lower door assembly is opened. Seams shall be CNC formed and TIG welded.

6. Lens Requirements: The lens shall be tempered glass 1/4 inch (6 mm) thick lens, or approved equal with gasketed door.

7. Mast Arm Mounting Connection Requirements: Luminaires shall mount on min 1-5/8 inch OD to max 2-3/8 inch OD horizontal tenon with no more than four 9/16 inch hex bolts and a 2-piece clamp(s). Luminaire leveling capability shall be integral to the fixture. Multiple mounting angle adjustments shall be provided to adjust the level of the fixture +/- 4 degrees from the horizontal.

8. Mechanical Requirements: The assembly and manufacturing process for the induction luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration from winds.

9. Ingress Protection (IP) Rating: Optical assembly shall have a minimum rating of IP-65; the exterior shell shall have a minimum IP rating of 54.

10. Terminal Block: Field wires connected to the luminaire shall terminate on a barrier type terminal block secured to the housing. The terminal screws shall be captive and equipped with wire grips i.e., serrated strips on the terminal for conductors up to #6 AWG wire size. Each terminal position and conductor phase designation shall be clearly identified.

11. Components: All components, including circuit boards, shall conform to Chapter 1, Section 6 of the "Transportation Electrical Equipment Specifications" (TEES) UL 1598, and ANSI C 136 requirements. Fixture components shall be modular in design and recyclable.

12. Painting: Powder coat painting of the housing shall conform to the requirements of the Caltrans Standard Specifications and the SSP. Applied coating shall be free of lead and mercury.

13. House Side Shield: The manufacturer shall offer a field installable house side shield.

700-6.5.7 Luminaire Identification.

1. Identification: Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date of manufacture including month and year, and lot number as identification permanently marked inside each unit and the outside of each packaging box.

2. Identification: The wattage and CCT rating of the luminaire shall be able to be detected visibly from an observer standing at ground elevation at the base of the pole.

3. Identification of Operating Characteristics: The following operating characteristics shall be permanently marked inside each unit: rated voltage and rated power in Watts and Volt-Ampere, and Luminaire Efficiency Rating (LER).

700-6.5.8 Photometric Documentation. IES Files: Submittals shall include IES files for each fixture type. Submittals shall include photometric iso-foot candle diagram for a 30' mounting height for each fixture type, and a point to point diagram with uniformity calculations that identify maximum to minimum illumination ratio. Photometric diagrams shall be in a scale of 1:20.

700-6.5.9 Quality Assurance. Luminaires shall be manufactured in accordance with ISO9001. Manufacturer's Warranty Certificate:

1. Provide manufacturer's Certification of Warranty for a minimum of 10 years. Warranty shall include all components of the luminaire and labor cost for replacement.

2. The Manufacturer shall provide documentation verifying that the LED luminaire model(s) being offered for this procurement are covered by the 10 year warranty.

700-6.6 Adaptive Control Node.

700-6.6.1 General.

1. The adaptive control node (controller) shall consist of an assembly with the following features and requirements:

700-6.6.2 Control System Interface:

1. The controller shall transmit to the system the following values on a system of at least 250,000 controllers:
   a. Voltage RMS
   b. Current RMS
   c. Power Factor
   d. Wattage
   e. Temperature
   f. Physical Location
   g. Controller Local Time GMT
   h. Network Address
   i. Network Parent
   j. RF Signal Strength
   k. Total Hours Controller
   l. Total Hours Load
   m. Active Schedule
   n. Next Scheduled Event Time
   o. Current Firmware Version
   p. Firmware Upload Version
2. The system shall support load identification via searchable fields that include:
   a. Physical address
   b. Unique Billing Identification Number
   c. Pole Material Type

d. Load Wattage

e. Installation Date

f. Pole Number

3. The system shall support SMTP or SMS user notifications for all measurement value reported outside of user defined limits

4. All measurement data will be automatically stored in the CMS data base at a user defined interval of 15 minutes to 24 hours

5. The System CMS shall be hosted by the customer or at his specified hosting partner location

6. The Gateways shall support both cabled (copper or fiber) and wireless backhaul connectivity (cellular or equivalent)

700-6.6.3 Asset Management:

1. All System controllers shall be equipped with an internal GPS receiver

2. GPS location reporting error will in all cases be less than 3 meters when satellite signals are not obstructed

3. All system components will automatically register and be displayed in the MAP view of the deployment area

4. A total of all Controllers registered will be prominently displayed on the MAP view of the Graphic user interface

5. A total of all Controllers in the error state will be prominently displayed on the MAP view of the Graphic user interface

700-6.6.4 Energy Metering and Billing Data Transfer:

1. All controllers shall contain a subsystem that complies to ANSI 12.20- 0.5% Metering Accuracy Class

2. The controller shall in all cases report the combined total of all energy consumed by both the controller and the load

3. Energy metering shall start within 3 seconds of power being applied to the controller

4. Power outage recovery events shall not result in more than 3 seconds of unmetered energy consumption

5. The system shall export energy consumption for each controller at a minimum of once every 24 hours

6. The system shall report the total energy consumption in 15 minute interval s that shall end on the 1/4 hour GMT (IE 00:15:30:45)

7. All Data shall be formatted and transferred in accordance to:ANSI-X12 formatting criteria and Transaction Set 867 Ver/Rel 004010, meter Interval and Historical Usage Reporting Version 1.1 • Jul 16, 2006

700-6.6.5 **Wireless Mesh:**

1. The Wireless Lighting Control system shall:

   a. Utilize license free 915 MHz spectrum

   b. In all cases provide a wireless connection to all other controllers or gateways within 1650 feet (503 m) free from obstacles

   c. Transmit using a randomly selected channel from a group of a minimum of 50 discrete channels to minimize interference

   d. Comply with all IEEE 802.154g PHY communication standard requirements

   e. Comply with all IETF 6LoWPAN communication standard requirements

   f. Utilize a self-forming and self-restoring mesh communications protocol

700-6.6.6 **Security:**

1. All System Components will be assigned a unique permanent serial number by the manufacture (MAC ADDRESS)

2. All System Components will only use a system wide unique IPV6 address reference, no dynamic address schemes

3. All Wireless Connections will utilize a unique 128 bit ECC encryption key 256 bit Certificate Authority registered authentication key

4. All Wired Connections will utilize a unique 256 bit encryption key and a 256 bit Certificate Authority registered authentication key

5. All encryption & authentication keys will be wirelessly revocable & updateable by the user should they be compromised

700-6.6.7 **Dimming (Power Trimming):**

1. All controllers shall continuously adjust the load consumption within 2% of the user defined target over the full temperature range

2. All controllers shall utilize a power change ramp rate of 1 second per 1% of total load wattage change

3. All controllers shall support Lumen Maintenance and Constant light output over the life of the load (default is LM70)

700-6.6.8 Mechanical:

1. All controller and gateway electronic components and printed circuit boards shall be conformal coated.

2. The controller housing shall be rated IP54 and allow any moisture to drain without affecting operation

3. The Gateway housing shall be rated IP66 and allow any moisture to drain without affecting operation

4. The total power consumption for the gateway shall not exceed 3W @120-240 VAC

5. The total power consumption for the controllers shall not exceed 2W @120-240 VAC

6. Controllers shall be integrated (mechanically and electrically connected) at the luminaires using a NEMA C136.41 standard polarized twist-lock receptacle or equivalent for both electrical and dimming control signal connectivity.

7. The rated life of all Field Devices shall be 15 years or more at an ambient temperature of 25 degrees Celsius.

8. All controllers shall be UL listed.

700-6.6.9 Warranty:

1. All Field devices shall be covered by a single-source written replacement warranty covering material and workmanship for a period of TEN (10) years.

2. All software and firmware shall be covered by a written replacement warranty covering material and workmanship for a period of TWO (2) years.

700-6.7 LED Post Top Luminaire.

700-6.7.1 General.

1. Each luminaire shall consist of an assembly that utilizes LED components as the light source subject to the following requirements:

    a) Operating Temperature: The luminaire shall be designed to operate at an average nighttime temperature of 70°F (20°C). The ambient operating temperature range shall be -40°F to +122°F (-40°C to 50°C).

2. UL Listing: The fixtures shall be UL Listed for wet locations and shall include UL label. The UL listing shall include the pole mounting assembly; see 700-6.7.6,10 for additional IP rating requirements.

700-6.7.2 Electrical Requirements.

1. Operating Voltage: The luminaire shall operate within a nominal voltage range of 120 to 277 Volts AC (VAC). The fixtures shall be capable of operating in the range of voltages listed. Fluctuations of line voltage within these categories shall have no visible effect on the luminous output. . External Transformers are not permissible as components for the luminaire input voltage.

2. Power Factor: Power supply should have a minimum Power Factor of 0.90.

3. Harmonic Distortion: The total harmonic distortion shall not exceed 20%. An integral factory installed standard driver is required that includes inherent thermal protection.

4. Surge Suppression: The luminaire on-board circuitry shall include Surge Suppression Devices (SSD) to withstand high repetition noise transients as a result of utility transients, and other interference. SSD shall conform to IEEE/ANSI C62.41.2-2002, 6kV/3kA, location category B.

5. All components shall be RoHS compliant.

700-6.7.3 Controls.

1. Photocell Receptacle: Each luminaire shall have a rotatable (so the window can be adjusted to the north) prewired 7-conductor (twist-lock) ANSI C136.41-2013 photocell receptacle.

2. Furnish an Adaptive Control Node for each luminaire. See 700-6.6 for Adaptive Control Node specification.

3. All components shall be long life with UV inhibitors

700-6.7.4 Cooling System.

1. Thermal management of the heat generated by the components shall be of sufficient capacity to assure proper operation of the luminaire over the

expected useful life of more than 100,000 hrs at specified operating temperature range and climate zone.

2. The light output variation shall not deviate greater than 15% over -40°F to +122°F (-40°C to 50°C) operating temperature variation.

3. Thermal management shall be passive by design and shall consist of a heat sink with no moving mechanical parts or liquids.

700-6.7.5 Roadway Application Requirements and Optical Assembly.

1. Correlated Color Temperature (CCT): CCT shall be 3000 or 4000 Kelvin depending on location as specified in the City of San Diego Street Design Manual.

2. Color Rendering Index (CRI): Luminaires shall have a minimum CRI of 65.

3. Optics: The luminaire shall not exceed the following Illuminating Engineering Society (IES) Uplight definitions per the BUG rating system:

    a. Traditional Acorn Style luminaires: U2

    b. Inverted Acorn (Teardrop) luminaires: U3

    c. Calculated BUG ratings shall be for initial (worst case) values, i.e.: Light Loss Factor (LLF) = 1.0.

4. For Traditional Acorn Style, frosted upper (interior) lens, below LEDs, shall be provided as part of the LED assembly to minimize direct glare from the LED's.

5. Provide IES Type III or Type V distribution as required for the application as specified in the City of San Diego Street Design Manual.

6. Initial lumen output shall be as required for the application as specified in the City of San Diego Street Design Manual.

700-6.7.6 Physical/Mechanical Requirements.

1. Luminaire Fixture: The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.

2. Maximum Dimensions: 40 inch tall by 18 inch diameter (102 cm long by 46 cm diameter).

3. Luminaire shall not weigh more than 45 pounds (20 Kg).

4. Assembly Housing: The housing shall be primarily constructed of die cast aluminum; corrosion resistant paint. Finish color shall be as required by application area, powder coated and rust resistant. The fixture openings and doors shall be sealed and gasketed. The components within the fixture assembly shall be easily accessible. All screws shall be stainless steel. Captive screws are required on accessible components that require maintenance after installation.

5. Shape:

    a. A1, A2, C, CE, CL: Unit shall be a traditional 'acorn' style. Lower housing shall resemble a GE Avery, Pod A shape. Upper housing shall resemble a GE Avery, Scroll top. Side shall be enclosed with clear acrylic.

    b. Type T: Unit shall be an inverted 'acorn' teardrop style with decorative upper housing that resembles a Spring City 'Columbia' series with ribbed lower glass lens.

    c. Type G (Gaslamp): Luminaire shall consist of five (5) lighting fixtures mounted together on a decorative cluster bracket, each such luminaire assembly suitable for mounting atop an existing or new pole and rigidly secured by four hex screws. Luminaires shall be as follows:

        i. Aluminum decorative globe holder with mounts for interior support structure.
        ii. The globe shall be injection-molded acrylic, with opal outer sphere, which shall have an aluminum-mounting ring. Nominal dimension shall be eighteen (18) inches in diameter.
        iii. Luminaire shall be U.L. listed for wet locations and of maximum 25 degrees C ambient temp.

        iv. The decorative cluster bracket shall be of one-piece cast aluminum or iron with nominal wall thickness of ½ inch and enclosing a ¼ inch diameter internal wireway to each of the five (5) lighting fixtures; each wireway shall be pre-wired with 90 C THHN/CU conductor, #10 AWG, from fixture base to pole top fitter and, in addition, an extra 15 feet of unspliced slack length of conductors shall be provided for drop down inside pole to remote splice compartment. All electrical components shall be U.L. listed and entire assembly shall be constructed as suitable for installation of outdoor wet locations

        v. Where mounted atop an existing pole, a new luminaire shall have a fitter (designed for slipover complete with four set screws).

6. Access: Provide easy access to internal components. No internal components shall fall out when the assembly is opened.

7. Lens Requirements: The lens shall be clear acrylic, or approved equal. Lens discoloration shall be considered a failure under warranty.

8. Pole Top Mounting Connection Requirements: Luminaires shall mount on a standard 3" OD vertical tenon and shall be held in place with a minimum of four screws.

9. Mechanical Requirements: The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration from winds. The luminaire shall meet 2G vibration standards per ANSI C136.31-2010.

10. Ingress Protection (IP) Rating: Optical assembly shall have a minimum rating of IP-65 per ANSI C136.25-2009. Also, the electrical compartment shall have a UL wet location listing.

11. Terminal Block: Field wires connected to the luminaire shall terminate on a barrier type terminal block secured to the housing. The terminal screws shall be captive and equipped with wire grips i.e., serrated strips on the terminal for conductors up to #6 AWG wire size. Each terminal position and conductor phase designation shall be clearly identified.

12. Components: All components, including circuit boards, shall conform to Chapter 1, Section 6 of the "Transportation Electrical Equipment Specifications" (TEES) UL 1598, and ANSI C 136 requirements. Fixture components shall be modular in design and recyclable.

13. Painting: Powder coat painting of the housing shall conform to the requirements of the Caltrans Standard Specifications and the SSP. Applied coating shall be free of lead and mercury. Color to be as required for the application as specified in the City of San Diego Street Design Manual.

700-6.7.7 Luminaire Identification.

1. Identification: Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date of manufacture including month and year, and lot number as identification permanently marked inside each unit and the outside of each packaging box.

2. Identification of Operating Characteristics: The following operating characteristics shall be permanently marked inside each unit: rated voltage and rated power in Watts and Volt-Ampere, and Luminaire Efficiency Rating (LER).

700-6.7.8 Photometric Documentation.

1. Contractor shall submit all street lighting documentation to the City of San Diego Construction Engineer for review and approval before ordering/installing new street lights in the public right of way.

2. IES Files: Submittals shall include IES files for each fixture type. Submittals shall include photometric iso-foot candle diagram for a mounting height appropriate per the pole type height for each fixture type, and a point to point diagram with uniformity calculations that identify maximum to minimum illumination ratio. Photometric diagrams shall be in a scale of 1:20.

700-6.7.9 Quality Assurance. Luminaires shall be manufactured in accordance with ISO9001. Manufacturer's Warranty Certificate:

1. Provide manufacturer's Certification of Warranty for a minimum of 10 years. Warranty shall include all components of the.

700-6.8 Decorative Poles for Post Top Luminaires.

700-6.8.1 General.

1. Each pole shall consist of up to three assemblies, the pole itself, a decorative sub-base assembly and additional top pieces such as supports, collars and arms depending on application type.

2. Dimensions for specific application types such as gauge (wall thickness), base diameter and height are shown on City of San Diego Standard drawings as referenced below.

3. Poles shall be tapered and shall taper at 0.14"/ft. from bottom to top. The pole assembly shall conform to ASTM A595, Grade A steel. The pole shall have uniform sharply defined flutes with the flutes running vertical and straight or octagonal as referenced below.

4. Base plate shall be of structural grade ASTM Grade A36 steel. The pole shaft will telescope the base plate and be circumferentially welded at top and bottom and shall have four slots at 90 degrees to each other. Actual base plane dimensions are shown on the City of San Diego Standard drawings as referenced below.

5. Anchor bolts shall be fabricated from a structural hot-rolled bar and shall conform to ASTM F1554 specifications. All anchor bolts shall have an L-bend at the bottom, the length of which shall not exceed four times the thickness of the bolt. All anchor bolts shall be hot dipped galvanized according to ASTM-153 galvanizing specifications. Each anchor bolt shall be

supplied with one hex nut for leveling, one hex nut for securing base, and two flat washers. Anchor bolt size to be as referenced below.

6. Hand hole shall be provided with locking cover located in the pole shaft. The hand hole shall be located below decorative base cover and aligned with base access door facing the street. A welded grounding lug shall be provided inside the hand hole, 180 degrees from handhole opening, for bonding of equipment ground conductors.

7. Refer to the City of San Diego Approved Materials List for current approved pole manufacturers.

700-6.8.2 Decorative Base Assembly.

1. The decorative base assembly is shall be constructed of ASTM A48-83, Class 30 Gray Iron and has multiple parts unless noted in Application section below.

2. A lower vertically split base section is designed to fit around the pole base plate and is octagonal in shape.

3. The upper section is vertically split and is designed to fit around the pole and match with the lower base section. This section has a removable access door that is positioned to line up with the handhole opening in the pole.

4. The base collar is designed to fit around the fluted or octagonal pole and has serrations to match the pole to form a tight fit to the pole.

5. The access door is secured to the base with two stainless steel tamper proof screws.

6. Each part must assemble together and be free of voids, porosity and casting fins and generally have a smooth sand cast finish.

700-6.8.3 Top Assembly.

1. See Application reference below for dimensions.

2. Provide a steel top cap plate conforming to ASTM A36 specifications for all pole welded to the top of the pole.

3. Some applications require a steel support plate conforming to the same specs to be welded to the cap plate.

4. A steel tenon is then welded to either the cap plate or the support plate.

700-6.8.4 Pole Characterized by Application Type.

1. Type P-A (Gateway)

a. Standard Drawing: SDE-105
b. Handhole: 4" x 6", 23" to top of handhole
c. Pole Style: Fluted, tapered with 16 flutes.
d. Base Style: Shall resemble Visco "C" base assembly. See City of San Diego Approved Material List for specific Visco part numbers.
e. Base Collar: Four Flowered decorative bezels.
f. Top Cap: ¼" x 8"
g. Steel Support Plate: 1" x 6-3/4"
h. Tenon: 3-1/2", Sched 40 pipe x 41-1/4" Tall with ¼"plate welded on top. Top plate to have 9/16" clearance hole with ½"x13 nut welded on the bottom of plate to accept finial bolt.
i. Provide 3' x 5" oval wireway opening located 28-1/4" to centerline of opening above support plate.

2. Type P-AP (Asian Pacific)

a. Standard Drawing: SDE-106
b. Handhole: 3" x 5", aligned with base cover door.
c. Pole Style: Fluted, tapered with 16 flutes.
d. Base Style: Shall resemble Visco "A" base assembly. See City of San Diego Approved Material List for specific Visco part numbers.
e. Base Collar: Four Flowered decorative bezels.
f. Top Cap: ¼"
g. Steel Support Plate: N/A
h. Tenon: 2-7/8" x 3" tall

3. Type P-C (Standard)
a. Standard Drawing: SDE-108
b. Handhole: 3" x 5", 17" to top of handhole
c. Pole Style: Fluted, tapered with 16 flutes.
d. .
e. Base Style: Shall resemble Visco "A" base assembly. See City of San Diego Approved Material List for specific Visco part numbers.
f. Base Collar: Four decorative bezels.
g. Top Cap: ¼" x 2-7/8"
h. Steel Support Plate: N/A
i. Tenon: 2-7/8" Dia x 3" tall.

4. Type P-CE (Enhanced)

a. Standard Drawing: SDE-109
b. Handhole: 4" x 6", 23" to top of handhole
c. Pole Style: Fluted, tapered with 16 flutes
d. Base Style: Shall resemble Visco "C" base assembly. See City of San Diego Approved Material List for specific Visco part numbers.

e. Base Collar: Four decorative bezels.
f. Top Cap: ¼" x 8"
g. Steel Support Plate: 1" x 6-3/4"
h. Tenon: 3-1/2", Sched 40 pipe x 25" Tall" with ¼"plate welded on top. Top plate to have a second 2-7/8 Dia x 3" tall tenon welded to it.

5. Type P-CL (Little Italy)

a. Standard Drawing: SDE-109
b. Handhole: 4" x 6", 23" to top of handhole
c. Pole Style: Fluted, tapered with 16 flutes
d. Base Style: Shall resemble Visco "C" base assembly. See City of San Diego Approved Material List for specific Visco part numbers.
e. Base Collar: Four decorative bezels.
f. Top Cap: ¼" x 8"
g. Steel Support Plate: 1" x 6-3/4"
h. Tenon: 3-1/2", Sched 40 pipe x 25" Tall" with ¼"plate welded on top. Top plate to have a second 2-7/8 Dia x 3" tall tenon welded to it.

6. Type P-G (Gaslamp)

a. Standard Drawing: SDE-110
b. Handhole: N/A
c. Pole Style: N/A
d. Base Style: N/A
e. Base Collar: N/A
f. Top Cap: N/A
g. Steel Support Plate: N/A
h. Tenon: N/A
i. See Luminaire Specification 700.6.7 for Top Assembly

7. Type P-T (Teardrop)

a. Standard Drawing: SDE-111
b. Handhole: 4" x 6", aligned with access in base
c. Pole Style: Octagonal, tapered with flat sides
d.
e. Base Style: Two piece split, octagonal to match pole with removable access door.
f. Base Collar: N/A
g. Top Cap: N/A
h. Steel Support Plate: N/A
i. Tenon: 4" x 6-1/2" tall, open top
j. Receptacle: Provide at top, 6" down from bottom of tenon. GFI type.
k. Cross-arm shall be cast aluminum (356.1 ingot alloy) construction and measure forty-eight (48) inches between luminaire centers and have a one and a half (1½) inch NPT fitting provided for luminaire mounting.

l. Banner arm shall be a three-quarter (¾) inch schedule 80 steel pipe construction with a half-sphere finial. The arm shall mount to a coupling welded to the shaft.

700-6.8.7 Finish.

1. Color shall be TGIC by Sherwin Williams or approved equal. For paint substitution, a paint chip shall be submitted to the City Engineer for approval. All parts shall be finish-coated to match the specified custom color. The coating shall be a premium TGIC polyester powder coat.

2. An acceptable alternative to powder coating shall be priming and painting. The light standard shall be factory primed. The finished paint shall be applied per the painting specifications either in the factory or after erected at the job site.

3. If the finished coat is applied at the factory, any scrapes, chips or other damage caused by installation must be sanded, feathered, primed and then touched up, with the specified paint after reinstallation to eliminate any noticeable patches

4. Application Color shall be as specified in the City of San Diego Street Design Manual.

700-6.8.8 Concrete Foundation.

1. Concrete foundation size shall be as shown on the City of San Diego Standard Drawings. Concrete shall be as specified in "Standard Specifications for Public Works Construction" (Latest Edition). Grounding shall consist of a copper wire installed per the City of San Diego requirements and the "Standard Specifications for Public Works Construction" (Latest Edition).

2. All foundations shall be reviewed by the project structural engineer for each project.

700-6.8.9 Quality Assurance. Poles shall be manufactured in accordance with ISO9001. Manufacturer's Warranty Certificate:

1. **Provide manufacturer's Certification of Warranty for a minimum of 10 years. Warranty shall** include all components of the pole.

700-7 (Section 86-7) - REMOVING, REINSTALLING, OR SALVAGING ELECTRICAL EQUIPMENT

700-7.1 (86-7.01) Removing Electrical Equipment. Salvaged equipment not reused on the Project shall be delivered to the General Services Transportation & Storm

Water Department, Street Division, Electrical Section at Chollas Operations Station, 2781 Caminito Chollas, San Diego, CA, and stockpiled. Delivery time and location shall be coordinated with the City at Telephone No. (619)527-8031, a minimum of 1 Working Day in advance of desired delivery date. You shall provide equipment, as necessary, to safely unload and stockpile the material. You shall obtain an appropriate receipt upon delivery. You shall tag each pole and mast arm with the size and type using an indelible ink marker.

700-7.2 **(86-7.02) Reinstalling Removed Electrical Equipment.** When removed electrical equipment is to be reinstalled on a new or different size pole, you shall furnish and install all new mounting equipment including all necessary signal mounting assemblies, anchor bolts, nuts, washers and concrete as required for completing the installation.

700-8 EMERGENCY VEHICLE PREEMPTION EQUIPMENT (EVPE)

700-8.1 General.

1. Each traffic signal, where shown on the plans, shall have a modulated light signal detection system which shall conform to the details shown on the plans and these special provisions. Each modulated light signal detection system shall consist of an optical detector/discriminator assembly or assemblies located at the traffic signal. Emitter assemblies are not required for this project.

2. Each system shall permit detection of two classes of authorized vehicles. Class I (mass transit) vehicles shall be capable of being detected at any range of up to 1,800 feet (550 m)from the optical detector. Class II (emergency) vehicles shall be capable of being detected at any range up to 2,500 feet (762 m) from the optical detector.

3. Class I signals (those emitted by Class I vehicles) shall be distinguished from Class II signals (those emitted by Class II vehicles) on the basis of the modulation frequency of the light from the respective emitter. The modulation frequency for Class I signal emitters shall be 9.63855 Hz.

4. A system shall establish a priority of Class II vehicle signals over Class I vehicle signals, and shall conform to the requirements in Section 25352, of the California Vehicle Code. Standard emitters for both classes of signals shall be available from the manufacturer of the system. Range measurements shall be taken with all range adjustments on the discriminator module set to "Maximum."

700-8.2 **Optical Detection/Discriminator Assembly.** Optical detection/discriminator assembly shall conform to the following.

700-8.2.1 General.

1. Each optical detection/discriminator assembly shall consist of one or more optical detectors, connecting cable(s), and discriminator module.

2. Each such assembly, when used with standard emitters, shall have a range of at least 1,800 feet (550 m) for Class I signals and 2,500 feet (750 m) for Class II signals. Standard emitters for both classes of signals shall be available from the manufacturer of the system. Range measurements shall be taken with all range adjustments on the discriminator module set to "maximum".

700-8.2.1.1 Optical Detector.

1. Each optical detector shall be a weatherproof unit capable of receiving optical energy from two separately aimable directions. The horizontal angle between the two directions shall be variable from 180° to 5°. The reception angle for each photocell assembly shall be a maximum of 8 degrees in all directions about the aiming axis of the assembly. Measurements of reception angle will be taken at a range of 1,800 feet (550 m) for a Type I emitter and at a range of 2,500 feet (750 m)) for a Type II emitter. Each optical detector shall be installed, wired, and aimed as specified by the manufacturer. Mast-arm mounted optical detectors shall utilize clamping hardware shown in the attached, "E.V.P.E. Detector Mounting Details."

2. Internal circuitry shall be solid state, and electrical power shall be provided by the associated discriminator module. Each optical detector shall be contained in a housing, which shall include two rotatable photocell assemblies, an electronic assembly, and a base. The base shall have an opening to permit its mounting on a mast arm or a vertical pipe nipple, or suspension from a span wire. The mounting opening shall have female threads for 3/4 inch (19 mm) conduit. A cable entrance shall be provided which shall have male threads and gasketing to permit a water-proof cable connection. Each detector shall have mass of less than 2 pounds (1.1 kg) and shall present a maximum wind load area of 36 in^2 (230 cm^2). The housing shall be provided with weep holes to permit drainage of condensed moisture.

700-8.2.1.2 Cable. Optical detector cable shall meet the requirements of IPCEA-S-61-492/NEMA WC 5, Section 7.4, 600 volt control cable, 75 EC (165 °F), Type B, and the following:

1. The cable shall contain 3 conductors, each of which shall be No. 20 (7 x 28) stranded, tinned copper with low-density polyethylene insulation. Minimum average insulation thickness shall be 25 mil (0.63 mm). Insulation of individual conductors shall be color-coded: 1-yellow, 1-blue, 1-orange.

2. The shield shall be either tinned copper braid or aluminized polyester film with a nominal 20 % overlap. Where the film is used, a No. 20 (7 x 28) stranded, tinned, bare drain wire shall be placed between the insulated

conductors and the shield and in contact with the conductive surface of the shield.

3. The jacket shall be black polyvinyl chloride with minimum ratings of 600 V and 80 EC (175 EF) and a minimum average thickness of 45 mils (1.1 mm)). The jacket shall be marked as required by IPCEA/NEMA.

4. The finished outside diameter of the cable shall not exceed 0.35 inch (8.9 mm).

5. The capacitance, as measured between any conductor and the other conductors and the shield, shall not exceed 157 pf per meter (48 picofarads per foot) at 1,000 Hz.

6. The cable run between each detector and the controller cabinet shall be continuous without splices or shall be spliced only as directed by the detector manufacturer. Provide 20 feet (6 m) of slack lead-in cable for each detector. Coil cable in pull box adjacent to pole on which detector is installed.

700-8.2.1.3 Discriminator Module.

1. Each discriminator module shall be designed to be compatible and usable with a Model 170 controller unit and to be mounted in the input file of a Model 332 or Model 336 controller cabinet, and shall conform to the requirements of Chapter I of the State of California, Department of Transportation, "Traffic Signal Control Equipment Specifications," dated April, 1978, and all addenda thereto, current at the time of project advertising.

2. Each discriminator module shall be capable of operating 2-4 channels, each of which shall provide an independent output for each separate unit. Each discriminator module, when used with its associated detectors, shall be capable of:

   a) Receiving Class I signals at a range of up to 1,000 feet (300 m) and Class II signals at a range of up to 1,800 feet (550 m).

   b) Decoding the signals, on the basis of frequency, at 9.639 Hz ☐ 0.119 Hz
   for Class I signals and 14.035 Hz ☐ 0.255 Hz for Class II

   c) Establishing the validity of received signals on the basis of frequency and length of time received. A signal shall be considered valid only when received for more than 0.50 second. No combination of Class I signals shall be recognized as a Class II signal regardless of the number of signals being received, up to a minimum of ten signals. Once a valid signal has been recognized, its effect shall be held by the module in the event of temporary loss of the signal for a period adjustable from 4.5 seconds to 11

seconds in at least 2 steps at 5 seconds ☐ 0.5 second
seconds.

d) Providing an output for each channel that will result in a "low" or grounded condition of the appropriate input of a Model 170 controller unit. For Class I signals, the output shall be a 6.25 Hz ☒ rectangular waveform with a 50 % duty cycle. For Class II signals, the output shall be steady.

3. Each discriminator module shall receive electric power from the controller cabinet at either 24 V DC or 120 V AC.

4. Each channel, together with its associated detectors, shall draw not more than 100 mA at 24 V DC nor more than 100 mA at 120 V AC. Electric power, one detector input for each channel and one output for each channel, shall terminate at the printed circuit board edge connector pins listed below:

Table 700-8.2.1.3 (A) Board Edge Connector Pin Assignment

A	DC ground		
B	+24 V DC	P	(NC)
C	(NC)		
D	Detector input, Channel A	R	(NC)
E	+24 V DC to detectors	S	(NC)
F	Channel A output (C)	T	(NC)
		U	(NC)
H	Channel A output (E)	V	(NC)
J	Detector input, Channel B	W	Channel B Output (C)
K	DC Ground to detectors	X	Channel B Output (E)
L	Chassis ground	Y	(NC)
M	AC-	Z	(NC)
N	AC+		

(C) Collector, Slotted for Keying

(E) Emitter, Slotted for Keying

(NC) Not connected, cannot be used by manufacturer for any purpose.

5. Two auxiliary inputs for each channel shall enter each module through the front panel connector. Pin assignment for the connector shall be as follows:

   a) Auxiliary detector 1 input, Channel A

   b) Auxiliary detector 2 input, Channel A

   c) Auxiliary detector 1 input, Channel B

   d) Auxiliary detector 2 input, Channel B

6. Each channel output shall be an optically isolated NPN open collector transistor capable of sinking 50 mA at 30 V and shall be compatible with the Model 170 controller unit inputs.

7. Each discriminator module shall be provided with means of preventing transients received by the detector from affecting the Model 170 controller assembly.

8. Each discriminator module shall have a single connector board and shall occupy 1 slot width of the input file. The front panel of each module shall have a handle, to facilitate withdrawal, and the following controls and indicators for each channel:

   a) Three separate range adjustments each for both Class I and Class II signals.

   b) A 3-position, center-off, momentary contact switch, one position (down) labeled for test operation of Class I signals, and one position (up) labeled for test operation of Class II signals.

   c) A "signal" indication and a "call" indication each for Class I and for Class II signals. The "signal" indication denotes that a signal above the threshold level has been received. A "call" indication denotes that a steady, validly coded signal has been received. These two indications may be accomplished with a single indication lamp; "signal" being denoted by a flashing indication and "call" with a steady indication.

9. In addition, the front panel shall be provided with a single circular, bayonet-captured, multi-pin connector for two auxiliary detector inputs for each channel. Connector shall be a mechanical configuration equivalent to a MIL-C-26482 with 10-4 inserts arrangement, such as Burndy Trim Trio Bantamate Series, consisting of:

a) Wall mounting receptacle, G0B10-4PNE with SM 20M-1S6 gold-plated pins.

b) Plug, G6L10-4NE with SC20M-1S6 gold-plated sockets, cable clamp, and strainer relief that shall provide for a right-angle turn with 2 1/2 inch (65 mm) maximum from the front panel surface of the discriminator module.

700-8.2.1.4 Cabinet Wiring.

1. The Model 332 cabinet has provisions for connections between the optical detectors, the discriminator module, and the Model 170 controller unit.

2. Wiring the Model 332 cabinet shall conform to the following:

   a) Slots 12 and 13 of input file "J" have each been wired to accept a 2-channel module.

   b) Field wiring for the primary detectors, except 24 V DC power, shall terminate on either terminal board TB-9 in the controller cabinet or on the rear of input file "J", depending on cabinet configuration. Where TB-9 is used, position assignments shall be as follows:

Position	Assignment
4	Channel A detector input, 1st module (Slot J-12)
5	Channel B detector input, 1st module (Slot J-12)
7	Channel A detector input, 2nd module (Slot J-13)
8	Channel B detector input, 2nd module (Slot J-13)

   c) The 24 V DC cabinet power will be available at Position 1 of terminal board TB-1 in the controller cabinet.

   d) Field wiring for the auxiliary detectors shall terminate on terminal board TB-0 in the controller cabinet. Position assignments are as follows:

FOR MODULE 1 (J-12)	FOR MODULE 2 (J-13)

Position	Assignment	Position	Assignment
1	+24 V DC from (J-12E)	7	+24 V DC from (J-13E)
2	Detector ground From (J-12K)	8	Detector ground from (J-13K)
3	Channel A auxiliary detector input 1	9	Channel A auxiliary detector input 1
4	Channel A auxiliary detector input 2	10	Channel A auxiliary detector input 2
5	Channel B auxiliary detector input 1	11	Channel B auxiliary detector input 1
6	Channel B auxiliary detector input 2	12	Channel B auxiliary detector input 2

700-8.2.1.5 System Operation. You shall demonstrate that all of the components of each system are compatible and will perform satisfactorily as a system.

700-9 RELATED CONSTRUCTION

700-9.1 Pedestrian Barricade. Pedestrian barricades shall be constructed in accordance with attached City of San Diego Standard Drawing SDE-103 (Modified). Assembly shall be commercial quality galvanized material.

700-9.2 Traffic Signs and Components. Traffic signing shall conform to latest version of the California Manual on Uniform Traffic Control Devices (CA MUTCD). Sign panels shall be 0.080 inch (2 mm) aluminum alloy 5052 mill-produced stable H38 hardness. All aluminum shall be anodized. The sheeting on the signs shall be 3M™ Scotchlite™ High Intensity Grade Reflective Sheeting Series 2870/3870, Stimsonite Series 6200, or equal.

700-9.3 Traffic Striping and Marking Removal.

1. Removal of traffic striping and marking shall conform to Section 15, "Existing Facilities."

2. You shall neatly and thoroughly remove all striping and marking from pavement surfaces at those locations shown. Removal shall be by wet sandblast cleaning method. You shall furnish all materials, labor, tools, equipment and incidentals as required for completing the removal of traffic striping and marking. Abrasive used for sandblast cleaning shall be either clean dry sand or mineral grit, at your discretion , and shall be of a grading suitable to produce satisfactory results. The use of abrasives other than those specified herein will not be permitted unless approved, in writing, by the Engineer. Grinding of thermoplastic marking material or paint or tape will be permitted.

3. When sandblast cleaning is being performed in areas adjacent to traffic, people, or property, you shall provide suitable devices and take appropriate actions to prevent damage or injury. Prior to starting work, you shall furnish for approval of the Engineer, a description of all equipment which is to be utilized in the performance of the work. Traffic striping and marking shall be removed regardless of the condition and thickness of the paint, per measurements made by the Engineer prior to removal. Pavement legends shall be removed by grinding or sandblasting a rectangular-bounded area. The pavement shall be restored by slurry seal or asphaltic concrete patch.

700-9.4 Traffic Striping and Pavement Markings.

1. Traffic striping and pavement markings shall conform to Section 84, and to the Standard Plans, State of California, Drawing No. A20A, B, C and D; and to A24A, B, C, D, and E.

2. The paint shall be rapid dry water-borne (State Spec. No. 8010-91D-30). Pedestrian crosswalks, limit lines, pavement arrows, and pavement legends (except within a bike lane) shall be installed utilizing thermoplastic marking material.

3. You shall contact Construction Management and Field Services Division for approval prior to striping installation.

4. Continental Crosswalks shall be installed no earlier than 48 hours in advance of Signal Turn-On.

5. All median noses shall be painted yellow.

700-9.5 Raised Reflective Pavement Markers.

1. Raised Reflective pavement markers shall conform to Section 85 of the California Standard Specifications.

2. Pavement markers shall be installed on all lane lines and centerline striping on all new streets, as well as on existing streets where replacement of pavement

markers is necessary. The minimum height of the pavement markers shall be 0.70 inch (18 mm).

SECTION 701 - CONSTRUCTION

ADD:

701 CONSTRUCTION. DELETE IN ITS ENTIRETY AND SUBSTITUTE with the following:

SECTION 701 - CONSTRUCTION

701 CONSTRUCTION shall be used in conjunction with Section 86 of the Standard Specifications of the Caltrans, May, 2010 edition and Section 700 of these specifications.

701-1 INSTALLATION.

701-1.1 GENERAL.

1. You shall determine the quantities required to complete the Work. The quantities and values shall be included in the Schedule of Values in accordance with 9-2.1, "Schedule of Values (SOV)" submitted to the Engineer for approval per 2-5.3, "Submittals" within 10 Working Days after Award of the Contract.

2. No adjustment in compensation will be made in the Contract lump sum prices paid for the various electrical Work items due to differences between the quantities shown in the SOV and the quantities required to complete the Work.

3. The SOV shall include the following items:

    a) Foundations - Each Type

    b) Standards And Poles - List By Each Type

    c) Conduit - List By Each Size And Installation Method

    d) Pull Boxes - Each Type

    e) Conductors - Each Size And Type

    f) Service Equipment Enclosures

    g) Signal Heads And Hardware - Each Type

    h) Pedestrian Signal Heads And Hardware - Each Type

i) Pedestrian Push Buttons

j) Loop Detectors - Each Type

k) Luminaires - Each Type

701-1.2 **Maintaining Existing and Temporary Electrical Systems.** Traffic signal system shutdowns shall be limited to periods allowed for lane closures listed or described under "Maintaining Traffic," in the **Special Provisions**.

701-1.23 **Scheduling of Work.** No material or equipment shall be stored at the Site until receipt of notification by the Engineer. Signal poles shall not be installed more than 3 weeks prior to the scheduled traffic Signal Turn-On date without prior approval of the electrical inspector. Obtain Electrical Service Orders (ESO) from the Street Lighting coordinator at 619-527-8088 to validate plan locations of all poles and the total quantity required. This document shall be attached to a copy of the Street Lighting As-Built Drawings for requesting street lights to be energized.

701-2 **Payment. Unless otherwise specified**, payment for the STREET LIGHTING AND TRAFFIC SIGNAL SYSTEMS shall be as follows:

1. If a separate Bid item has not been provided for an item of the Work related to STREET LIGHTING AND TRAFFIC SIGNAL SYSTEMS as described or shown in the Contract Documents, the payment shall be included in the Contract Price.

2. Street Lighting and Traffic Signal System components, which are required by the City, not included as separate Bid items, are included in the Contract Price.

3. Payment for the trenching and pavement restoration is included in the payment for the associated Work.

4. Payment for warning tape, trace wire, and the cement pigment to achieve the color required shall be included in the Bid item for the conduit.

5. When included in the Bid proposal, the following traffic control devices will be measured and paid separately:

6. Payment for electrical equipment pedestals shall be paid for in the Bid item for “Pedestal for Electrical Equipment”.

7. Payment for Type III meter pedestal and wiring shall be paid for in the Bid item for “Type III Meter Pedestal”.

8. Payment for costs associated with SDG&E service orders shall be paid as a lump sum in the Bid item for “SDG&E Service Orders” or “SDG&E Fee Allowance”.

9. Payment for the 2 inch (50 mm) electrical service conduit to SDG&E service connections and wires shall be paid for in the Bid item " 2" PVC Conduit Per SDG&E Standards".

10. Payment for 2 inch (50 mm) PVC conduit and wires shall be paid for in the bid item form "2" PVC Conduit Per City Standards".

11. Payment for grounding shall be paid in the Bid item for:

    a. "30 AMO Fuses, Cartridges, & Grounding Rod",

    b. "10 AMP Fuses & Cartridges at Street Light".

12. Payment for the installation of the electrical conduit and wires shall be included in the Bid item for "Electrical Conduit".

13. Payment for pull boxes and lids shall be included in the Bid item for:

    a. "Pull Box".

    b. "#3 Pull Box"

    c. "#6 Pull box".

14. Payment for pull box lids shall be included in the Bid Item for "Electrical Pull Box Lid".

15. Payment for pole base foundations shall be paid for as part of the pole unless a Bid item for "Pole Base Foundation" is provided.

16. Removal of existing poles and metal structures shall be included in the Bid item for the new pole unless a Bid item for removal has been provided:

    a. "Remove Existing Wood Pool",

    b. "Remove Existing Wayfinding Pole",

    c. "Remove Existing Metal Structure",

    d. "Remove Existing Street Light",

17. Bid items for removing or removing and reinstalling equipment shall include surface restoration, pole base foundation and wiring in the payment for the Bid item:

    a. "Remove Existing Street Light",

    b. "Remove & Reinstall Traffic Signs",

c. “Remove & Reinstall Existing Post Top Street Light Pole”,

d. “Remove & Reinstall Existing Light Pole”.

18. Payment for the pole foundation base, pole, mounting hardware, the sign, and any electrical wiring components for traffic signs on posts shall be included in the Bid item for:

    a. “Install Traffic Sign on Post”

    b. “Install Type K Traffic Sign on Post”.

19. Payment for new or modified street lighting systems shall include all components and Work to provide a functioning system shall be included in the Bid item for:

    a. “Street Lighting”,

    b. “Street Lighting Electrical System”.

    c. “Standard Light Pole Type A”,

    d. “Standard Light Pole Type C”,

    e. “Type 15 Fixture with pole”,

    f. “Type 15 Luminaire and Ballast With Connection”,

    g. “Ameron #21CT13 #37 Pole or Equal”

    h. “Type A Visco V1-A-W2-F/16-150HPS-424-III-22P HSS-CR-RECP-PEC Street Light or Equal”,

    i. “Holophane #WA15HP12LA6NSA TR 150W HPS Fixture or Equal w/Lamp & Photocell”

    j. “150 HPS Luminaire”

    k. “250 HPS Luminaire”,

    l. “Capital and Acrylic Assembly and Luminaire”,

    m. “Remove & Replace Capital Assembly and Luminaire”.

20. Payment for new or modified traffic signal systems shall include all components and Work to provide a functioning system.

    a. “Traffic Signal”,

    b. “Traffic Signal Modifications”,

    c. “Type 15 Pole with Mast Arm”,

    d. “Wiring Existing Traffic Signal to New Service”.

    e. “Upgrade Street Light on the Traffic Signal Pole”.

    f. “Traffic Signal Street Light Circuit Wire & Connect to New Service”.

21. Payment for traffic signal system restoration shall be paid for in the Bid item for “Traffic Signal System Restoration”.

22. Payment for street light system restoration shall be paid for in the Bid item for “Street Light System Restoration”.

23. Payment for Cobra Head Luminaires shall be included in the bid price for street lights unless a separate Bid item unit cost has been provided for “Cobra Head Luminaire.”