

SECTION 16500

SIGNALS, LIGHTING AND ELECTRICAL SYSTEMS

PART I - GENERAL

1.01 WORK INCLUDED

- A. Installation of electroliers and appurtenances.
- B. Installation of traffic signal standards, posts, cabinets, and foundations.
- C. Traffic signal heads, push button assemblies, luminaries, hardware and appurtenances.
- D. Conduit, circuits, and appurtenances.
- E. Trenching for conduits and appurtenances, and backfill.
- F. Traffic Signal controller assembly.
- G. Installation of electrical service, service cabinet, circuits and connections to existing circuits.
- H. Battery Backup System.
- I. Dust alleviation and control.
- J. Cleanup and restoration of surface in improved areas, including pavement markings and signage.
- K. Supplying all labor, materials, equipment and apparatus not specifically mentioned herein or noted on the plans, but which are incidental and necessary to complete the work specified.

1.02 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the general designation only.
 - 1. The State of California, Department of Transportation Standard Specifications, Standard Plans, and Manual on Uniform Traffic Control Devices (MUTCD).
 - 2. NEC – The National Electric Code.
 - 3. California Division of Industrial Safety Electrical Orders (Title 8).
 - 4. I.E.S. – Illumination Engineering Society of Standards.

5. NEMA – National Electrical Manufacturers Association Standards.
6. IMSA – International Municipal Signal Standards and Specifications.
7. SPUC Electrical Safety Orders (i.e., General Order No. 95)
8. American Society for Testing and Materials (ASTM) Publications:
 - A – 123 Zinc Coatings, Rolled, Pressed Forged Mat.
 - A - 307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - B - 3 Specification for Soft or Annealed Copper Wire.
 - B - 8 Cubic Conduit Hard Medium Soft.
 - D – 1785 Pipe, Poly Vinyl Chloride (PVC) Plastic, Schedules 40, 80 & 120.

1.03 SUBMITTALS

- A. Contractor shall submit shop drawings on all electroliers, fixtures, and signal system equipment components, and catalogue cuts of conduits, conductors, pull boxes, and other equipment for approval prior to ordering material and equipment.
- B. Traffic Control Plan: When work will occur on or adjacent to the right-of-way, submit a Traffic Control Plan in accordance with Section 01550 72 hours in advance for approval prior to starting work.

1.04 QUALITY ASSURANCE

- A. All work shall be done under the supervision of, and to the satisfaction of the City Engineer.
- B. Installation shall be in conformance with the NEC.
- C. All material for signals and safety lighting shall require the Underwriters' Laboratories label, except material for which U. L. does not provide label service listing.
- D. All material shall be new, packed in original containers, installed or turned over to the City free of rust, corrosion, or any other defects.
- E. To the extent possible, all equipment or materials for any one system shall be furnished by the same manufacturer. Such items as conduit, conduit fittings and appurtenances supplied for any one system shall be the same throughout the project.
- F. Compaction, Compression, and Tests:

1. The percentage of compaction or the compressive strength specified shall be the minimum allowable.
2. Compressive strength of concrete shall be determined utilizing test cylinders taken during the pour at such times and frequencies as designated by the City Engineer. Sampling shall be in accordance with the requirements of ASTM C172 and the specimens shall be made and cured in accordance with the requirements of ASTM C31. Compression testing shall conform to the requirements of ASTM C39.

G. Certification of Materials:

1. Portland Cement Concrete: When requested, provide City Engineer with two (2) copies of mill test reports of aggregate, cement, and reinforcement supplied, showing compliance with the respective Specifications.
2. Provide City Engineer with copies of certified plant load-out slips showing volume of concrete delivered and time of mixing for each load.

1.05 JOB CONDITIONS

- A.** Contractor shall conduct operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians and any adjacent property owners and tenants.
- B.** Contractor shall protect open excavations and trenches with covers, railings and fences as required, together with signs, lights and other warning devices sufficient to protect and maintain safe pedestrian, bicycle, and vehicular traffic through the work area to the satisfaction of the City Engineer.
- C.** Contractor shall conduct operations in such a manner that existing facilities and utilities which are to remain in place will not be damaged. Excavation, trenching, and other work under or adjacent to existing pipelines, conduit runs, or structures of any kind, shall be protected in such a manner as not to interfere with the safe operation and use of such facilities. Should any damage be incurred to existing facilities or structures during the operations, the Contractor shall immediately notify the proper owners or authorities, and shall arrange for the immediate repair of the facilities at the Contractor's expense.
- D.** The location of proposed signal and electroliner standards, pull boxes, conduits, cabinets, and other equipment shown on the plans is approximate only and the exact location of such shall be as established in the field by the City Engineer.
- E.** Construction area shall be left in a clean, neat, and workmanlike condition. All construction waste, rubbish, and debris remaining upon completion of the work shall become the property of the Contractor unless otherwise specified herein or noted on the plans and shall be removed from the work-site by the Contractor and disposed of off-site in a lawful manner to the satisfaction of the City Engineer.

- F. Comply and conform to conditions and requirements indicated herein and specified under all other sections of these Specifications.

1.06 MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

- A. Traffic signal and street lighting system shutdowns shall be limited to periods between the hours of 9:00 AM and 3:00 PM.
- B. Existing street lighting and signal communication systems shall be maintained during construction operations. Maintain existing safety lighting on streets to the minimum required by the Special Provisions, or as required by the City Engineer. Maintenance of existing street light and traffic signal systems shall be considered as included in the contract lump sum prices for the work item involved and no additional compensation will be allowed therefore.
- C. The contractor shall place "Stop Ahead" and "Stop" signs to direct vehicle and pedestrian traffic through the intersection during traffic signal system shutdown. Temporary "Stop Ahead" and "Stop" signs shall be either covered or removed when the system is turned on.
- D. "Stop Ahead" and "Stop" signs shall be furnished by the contractor and shall conform to the provisions in the California MUTCD and Section 12-3.06, "Construction Area Signs", of the Standard Specifications, except that the base material for the signs shall not be plywood.
- E. One "Stop Ahead" sign and two "Stop" signs shall be placed for each direction of traffic. Location of the signs shall be as directed by the City Engineer.
- F. Full compensation for furnishing, installing, maintaining and removing temporary "Stop Ahead" and "Stop" signs and for covering signs not in use shall be considered as included in the contract lump sum price paid for the work item involved and no additional compensation will be allowed therefore.

PART 2-PRODUCTS

2.01 PORTLAND CEMENT CONCRETE

- A. Concrete shall be Class "A" conforming to the requirements of Section 02550 of these Specifications.
- B. Portland Cement Concrete for foundations shall conform to Section 90-10, "Minor Concrete", of the Standard Specifications and shall contain not less than 470 pounds of cement per cubic yard, except concrete for reinforced pile foundations shall contain not less than 564 pounds of cement per cubic yard.
- C. Hand mixing of concrete shall not be permitted.

2.02 PAINTING

- A. Painting shall conform to the provisions of Section 86-2.16 "Painting" of the Standard Specifications, and these provisions.

- B. All electroliers, standards, pedestals, posts, cabinets, and luminaire housings shall be coated with two part recoatable epoxy primer and two coats of Hi-solids polyurethane paint, Sherman Williams color RWC 6687 or approved equal:

Epoxy primer:	Part A: B67R5
	Part B: B67V5
Hi-solids polyurethane:	B65T304
Hardener:	B60V30
- C. All signal head mountings, brackets, fittings, outside of vehicle signal heads, and pedestrian signal head housings shall be finished with two coats of enamel, low-luster Pervo paint #2836, Oxford Brown or approved equal.
- D. Front of backplates and inside of visors of traffic signal heads shall be painted lusterless black.
- E. Contractor shall submit color chips for approval by City Engineer.
- F. Painting shall be considered to be included in the contract lump sum price for the work item involved and no additional compensation will be allowed therefore.
- G. Touch-up painting shall be provided where required by the City Engineer.
- H. Poles in downtown shall be black. See Precise Plan.

2.03 FOUNDATIONS

- A. Foundations shall consist of Portland Cement Concrete conforming to the requirements of Section 2.01 of these specifications and be constructed to conform to the details shown or called for on the plans.
- B. Anchor bolts, nuts and washers shall be fabricated from steel conforming to the requirements of ASTM Designation A307. Size and shape of anchor bolts shall conform to the details shown on the plans. Bolts, nut and washers shall be galvanized after fabrication in conformance with the requirements of ASTM Designation A123. All bolts and threads shall be lightly greased prior to acceptance.
- C. Reinforcement for foundations shall be deformed steel bars conforming to the requirements of Section 02550 of the Specifications. Size and shape for bar reinforcement shall conform to the details shown or called for on the plans.

2.04 ELECTROLIERS

- A. Electrolier masts, arms, fixtures, luminaires and appurtenances shall conform to the details shown on the plans.

2.05 CONTROLLER ASSEMBLIES

- A. Controller assemblies shall be a Type 90 NEMA Controller Assembly compatible with the City's designated controller system, conforming to Section 86-3.02 "Type 90 Controller Assemblies" of the Standard Specifications including

controller unit, completely wired controller cabinet, inductive loop sensor units, conflict monitor, and load switches.

- B.** Cabinets shall be Type P as shown on Standard Plan ES-3A. Cabinet shall be prime coated and finished in accordance with Section 2.02 "Painting". A graffiti coating acceptable to the City shall then be applied.
- C.** Contractor shall furnish and install battery backup systems in conformance with paragraph 2.21 these Specifications.

2.06 PULL BOXES

- A.** Pull boxes shall be precast reinforced concrete of the size noted or called for on the plans and shall conform to the applicable provisions of Section 86-2.06 "Pull Boxes" of the State Standard Specifications with the following exceptions:
 1. Grout in the bottom of pull boxes will not be permitted, Contractor shall use drain rock at box sump.
 2. Covers of pull boxes shall be Christy "Fibrelyte" secured by means of either stainless steel bolts and nuts, or studs and nuts conforming to the requirements of said Section 86-2.06A of the State Standard Specifications.
 3. All ferrous metal parts shall be galvanized after fabrication in conformance with the requirements of Section 75-1.05 "Galvanizing" of the Standard Specifications.
 4. Covers for lighting pull boxes shall be marked "Street Lighting" in conformance with the requirements of Section 86-2.06B "Cover Marking" of the Standard Specifications.

2.07 CONDUIT

- A.** Conduit shall conform to the provisions in Section 86-2.05 "Conduit" of the Standard Specifications.
- B.** Conduit for underground electrical circuits shall be Poly Vinyl Chloride (PVC) type 1120, Schedule 40 with solvent weld joints, conforming to ASTM D-1785 and the requirements in the UL Standard for Rigid Non-Metallic Conduit (Publication UL 651). Minimum size conduit shall be 2" diameter.
- B.** Fittings and couplings for underground electrical conduit shall be Poly Vinyl Chloride (PVC), Schedule 40 specifically manufactured for the conduit used.
- C.** Conduit joints shall be solvent weld made by means of "Weld-On" P-70 primer and "Weld-On" cement, or approved equal.
- D.** All empty conduit or conduit for future circuits shall be installed with a 3/16 inch diameter nylon pull rope for future conductor extensions.

2.08 CONDUCTORS

- A.** Conductors shall conform to the provisions in Section 86-2.08 "Conductors" of the Standard Specifications and these provisions.
- B.** Conductors shall be copper of the type and size shown or called for on the plans. Copper wire shall conform to the applicable provisions of ASTM Designations B3 and B8.
- C.** Minimum conductor size is No. 8 AWG and shall be stranded. Wire size shall be based on American Wire Gage (AWG) and conductor diameter shall not be less than 98 percent of the specified AWG diameter.
- D.** Conductors shall be UL listed and rated for 600 volt operation.
- E.** Conductors shall be spliced by the use of "C" shaped compression connectors as shown on the Standard Plans.
- F.** Traffic Signal Cable, 12 Conductor No. 14 AWG stranded (600 volt class) and meeting IMSA Specification 20-1-1984, may be used in lieu of individual wires.
- G.** Insulation for conductors shall be one of the following:
 - 1. Type RHH or RHW cross-linked polyethylene.
 - 2. Type THW OR THWN Poly Vinyl chloride.
 - 3. At any point, the minimum thickness of any Type THWN insulation shall be 13 mils for conductor sizes No. 14 and No. 12, 18 mils for conductor size No. 10, 27 mils for conductor sizes No. 8 and No. 6, and 36 mils for conductor sizes No. 4 and No. 2. At any point, the minimum thickness of the nylon jacket shall be 4 mils for conductor sizes No. 14 to No. 10, inclusive, 5 mils for conductor sizes No. 8 and No. 6, and 6 mils for conductor sizes No. 4 and No. 2.

2.09 LUMINAIRES AND BALLASTS

- A.** Luminaires shall be high pressure sodium vapor luminaries of the voltage, type and wattage shown on the plans, and shall be in conformance with all requirements in Section 86-6.01 "High-Pressure Sodium Luminaries" of the Standard Specifications, and these provisions.
- B.** Ballasts shall conform to all of the provisions in Section 86-6.01 "High-Pressure Sodium Lamp Ballasts", of the Standard Specifications, and these provisions.
- C.** Hardware shall be stainless steel or cadmium plated. Machine screws or bolts shall be used to secure removable components. Sheet metal screws shall not be used.
- D.** 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 watts and 1,000 volts.

- E.** Ballasts for luminaries to be mounted on mast arms, brackets or lowering assemblies shall be located within the luminaire housing. The ballast for each horizontally mounted luminaire shall consist of components mounted on the luminaire housing, components mounted on a metal plate secured to the house, or components mounted on a down opening door. The door shall be hinged and secured to the luminaire housing separately from the refractor of flat lens frame. The door shall be easily removable and replaceable. The door shall be secured to the housing in a manner to prevent its accidental opening when the refractor of flat lens frame is opened.
- F.** Ballasts for luminaries to be mounted on mast arms, brackets, or lowering assemblies shall be the regulator, non-regulating reactor, autotransformer, or high reactance type.
- G.** Section 86-6.01A (1), "Regular Type Ballasts", shall be lag-type regulator type ballasts.
- H.** The 12th paragraph in Section 86-6.10, "High-Intensity-Discharge Lamp Ballasts" of the Standard Specifications is amended to read:

"Ballasts for luminaires shall be located within the luminaire housing. The ballast for each vertically mounted luminaire shall consist of components mounted in the luminaire housing and components mounted on a metal plate secured to the pole."
- I.** Luminaries shall be the semi-cutoff type with a Type IV distribution.
- J.** Fused splice connectors shall conform to the provisions in Section 86-2.095 "Fused Splice Connectors" of the Standard Specifications, and these provisions.
- K.** Each street light shall have an individual spliced fused connector located in the pull box adjacent to the pole.
- L.** All fixture housings shall be painted in accordance with section 2.02 "Painting" of these specifications.
- M.** The terminal strips shall have protective barriers between each terminal. The terminal screws shall be captive and equipped with wire grips for wire up to No. 8. All components shall be pre-wired to a single strip assuring that field connections are made to clearly identified line terminals.
- N.** Prior to energizing luminaries, the lamp socket should be checked to assure that it is set in the proper location for the required light distribution in accordance with the manufacturer's instructions, and the luminaries shall be tilted five degrees (5°) above the horizontal.
- O.** The supplier shall submit copies of certified tests to substantiate the satisfactory performance of the luminaries under 100 mph winds.

- P. A fused disconnect shall be furnished inside the luminaries so that when the door is opened the ballast primary circuit is broken, thereby allowing the fixture to be serviced without shock hazard.
- Q. Door frame shall be extruded aluminum construction hinged with stainless steel pins and be removable by means of quick release safety latch.
- R. Lens shall be of clear, thermal, and impact tempered glass of 0.156" minimum thickness, sealed with a gasket of heat resistant polypropylene.
- S. Ballast shall be open core-coil capacitor and starter type, high power factor type, suitable for starting lamp to -20°F.
- T. Ballast shall be mounted within the luminaries on a separate extruded aluminum panel having fins for heat dissipation with quick-release fasteners so that ballast assembly may be removed and replaced as a unit.
- U. Lamp holder shall be the mogul base ceramic type 5 KV pulse rated, having nickel-plated screw shell and contacts, reflector seal shall be airtight.
- V. All electrical components shall be rated for 240 volt single-phase two wire with insulation rated at 600 volts.

2.10 STANDARDS, STEEL PEDESTALS AND POSTS

- A. Standards for traffic signals and lighting, and steel pedestals for cabinets and other similar equipment shall be located as shown on the plans, and shall conform to the provisions of Section 86-2.04 "Standards, Steel Pedestals, and Posts" of the Standard Specifications and these specifications.
- B. Reference is made to Section 86-7 "Removing, Reinstalling or Salvaging Electrical Equipment" of the Standard Specifications. Salvaged material not reused shall be delivered to the Redwood City Municipal Services Center located at 1400 Broadway, Redwood City, California. The cost of this shall be considered in the lump sum of the work item involved and no addition compensation will be allowed therefore.
- C. All anchor bolts shall be galvanized steel and lightly greased prior to installation of the pole.
- D. All required drilling of poles shall be done in the field after the pole is mounted.
- E. Where the plans refer to the side tenon detail at the end of the signal mast arm, the applicable tip tenon detail may be substituted.
- F. The contractor shall either install a 3/16 inch or larger brass bolt on each existing standard for bonding, or preferably be provided by pole manufacturer on the side of pole adjacent to hand-hole. The bolt shall be installed on the outside of

the shaft near the baseplate where it is to be covered by the bolt cover. The shaft of the standard shall be drilled for no larger than a 1/4 inch hole near the baseplate to provide passage for the bonding conductor.

2.11 SERVICE PEDESTALS

- A.** Type III CF service equipment enclosures shall be fabricated from aluminum and shall conform to the fabrication requirements in Section 86-2.11, "Service", of the Standard Specifications except as follows:
 - 1. All exterior seams for enclosure and doors shall be continuously welded by the gas tungsten arc (TIG) process.
 - 2. Sealing of the anodic coating shall be in a five (5) percent aqueous solution of nickel acetate (PH 5.0 to 6.5) for 15 minutes at 210°F.
- B.** The anchor bolts for Type III CF service equipment cabinets shall be 5/8 inch diameter, minimum.
- C.** One (1) each Type III CF service equipment cabinets shall have one 200-amp meter socket. See the construction plans for wiring schematic.
- D.** Cabinets shall be prime coated and finished in accordance with Section 2.02 "Painting". A graffiti coating acceptable to the City shall then be applied.
- E.** Circuit breakers used as service disconnect equipment shall have a minimum interrupting capacity of 42,000 amperes, RMS, for 120/240-volt services and 30,000 amperes, RMS, for 480-volt services.
- F.** Minimum amperage for sub-circuit breakers shall be as shown on plans.
- G.** Circuit breakers shall be mounted on non-energized clips. All circuit breakers shall be mounted vertically with the up position of the handle being the "ON" position.
- H.** Dead front panel or panels, and corresponding exterior door, shall be hinged on one side and shall be able to open without the use of tools.

2.12 HEAT SHRINK TUBING

- A.** Heat shrink tubing shall be dual wall, irradiated polyethylene tubing containing an adhesive inner wall. When heated, the inner wall shall melt and fill all crevices and interstices of the object being covered while the outer wall shrinks. Each end of the heat shrink tube or the open end of the open end of the end clamp of heat shrink material shall, after contraction, overlap the conductor insulation at least 1-1/2 inches.
- B.** All heat shrink tubing shall also meet the following requirements:
 - 1. Shrinkage Ratio: 33 percent, maximum, of supplied diameter when heated to 125°C. and allowed to cool to 25°C.

2. Dielectric Strength: 350 kilovolts per inch, minimum.
3. Resistivity: 1014 ohms per centimeter, minimum.
4. Tensile Strength: 2,500 lbs. per square inch, minimum.
5. Operating Temperature: -5 °C. to 135°C.
6. Water Absorption: 0.5 percent, maximum.

2.13 DUCT SEAL

- A.** Sealant for duct seal shall consist of "Duct Seal Compound" as manufactured by Johns-Mansville Industries, Appleton Electric Company and Killark Products, or approved equal.

2.14 PHOTOELECTRIC CONTROLS

- A.** Photoelectric controls shall conform to the provisions in section 86-6.07 "Photoelectric Controls" of the Standard Specifications and these specifications.
- B.** Unmetered street lights or lighting circuits shall use Type IV photoelectric controls. Each luminaire shall be equipped with an individual photoelectric unit conforming to Section 86-6.07B(1) of the State Standard Specifications with the following additional requirement:
 1. The photoelectric unit receptacle shall be adjustable to allow for positioning to the satisfaction of the City Engineer.
- C.** Metered street lighting circuits serviced from an electrical service equipment enclosure shall use Type V photoelectric controls. Each Type III-BF or Type III-CF service equipment enclosure shall be equipped with a central photoelectric unit capable of switching multiple lighting circuits. Each luminaire shall be supplied with a shorting cap when a Type V photoelectric control is used.

2.15 SIGNAL INTERCONNECT CABLE

- A.** Signal Interconnect Cable (SIC) shall be six-pair No. 19, AWG solid bare copper conductors. Conductors shall be in twisted pairs. Color coding shall distinguish each pair. SIC cable shall conform to IMSA Specification 20-2-1984.
- B.** The cable jacket shall be IMSA 20-2 black, high-density polyethylene, rated for a minimum of 600 volts and shall have a nominal wall thickness of 60 mils, minimum. The cable jacket or the moisture resistant tape directly under the outer jacket shall be marked with the manufacturer's name, insulation type designation, number of conductors and conductor size and voltage and temperature rating.
- C.** No splices shall be allowed. Connections will be at the designated terminals in controller cabinets. A minimum of three (3) feet of slack shall be provided at each pull box and six (6) feet at each controller cabinet.

- D. Cable shall be provided with an overall copper shield which shall be grounded at each end.

2.16 VEHICULAR TRAFFIC SIGNAL ASSEMBLIES

- A. Vehicular Traffic Signal Assemblies shall conform to the provisions of Section 86-4 "Traffic Signal Faces and Fittings" of the Standard Specifications and these specifications.
- B. Painting shall be in conformance with paragraph 2.02 "Painting" of these specifications.
- C. All vehicular traffic signal assemblies shall include a backplate. Backplates for traffic signal heads mounted on mast-arms shall be louvered.
- D. All signal sections shall be 12-inch units.
- E. The first paragraph of Section 86-4.08 "Signal Mounting Assemblies" of the Standard Specifications is amended to read:

"Signal mounting assemblies shall consist of 1-1/2 inch standard steel pipe or galvanized conduit, necessary fittings, slip-fittings and terminal compartments. Pipe fittings shall be ductile iron, galvanized steel, copper, brass, or bronze. Mast arm slip-fittings shall be cast bronze or hot-dip galvanized ductile iron. Post top slip-fittings and terminal compartments shall be cast bronze, Type-356-T6 aluminum or hot-dip galvanized ductile iron."

- F. All signals shall be tightened and aligned properly at time of mounting to the satisfaction of the City Engineer.
- G. After installation, all signal lenses must be covered until signal turn-on for final inspection, and then recovered until acceptance of the work by the City at which time the Contractor shall uncover all lenses.

2.17 LIGHT EMITTING DIODE SIGNAL MODULE

- A. Light Emitting Diode (LED) Signal Modules shall conform to the provisions in Section 86-4.02, "Light Emitting Diode Signal Module" in the Standard Specifications and to the provisions in Standard Special Provision 86-385 "Light Emitting Diode Signal Modules."
- B. References contained in these Specifications and Provisions to "State," "Department," or similar references meant to refer to the Department of Transportation shall be amended to refer to the City or the City Engineer as appropriate.

2.18 PEDESTRIAN PUSH-BUTTONS

- A. All pedestrian push-buttons shall be "accessible" type push buttons, and shall conform to the requirements in Section 86-5.02 "Pedestrian Push Button

Assemblies” of the Standard Specifications and to Sections 4E.08 “Pedestrian Detectors” and 4E.09, “Accessible Pedestrian Signal Detectors” in the California Manual on Uniform Traffic Control Devices, latest edition.

- B.** All pedestrian push buttons shall be the Navigator Accessible Pedestrian Signal type, by Polara Engineering Inc., or approved equal.
- C.** Push button system shall be installed per the manufacturer specifications and details. Contractor shall be responsible for all required system components, including but not limited to, push button assemblies, control units, wiring circuits, and configuration devices.
- D.** Accessible Pedestrian Signals shall include the following custom and sound options:
 - 1. Custom Locate Sound – Plays a sound at a selectable interval to assist a blind pedestrian in locating the Push Button Station.
 - 2. Custom Location Message(s) – Typically message states street being crossed and cross street names, and other vital information to help pedestrian with location and direction.
 - 3. Custom Walk Message(s) – Typically alerts pedestrians that the walk interval has begun and name of street being crossed.
 - 4. Custom Clearance Sounds/Countdown – Plays a sound to let pedestrians know they should clear intersection crosswalk. This option tone typically would sound similar to the locate tone but is played at a faster rate or counts down the number of seconds in the clearance phase.

2.19 PEDESTRIAN SIGNALS

- A.** Pedestrian signals shall be the Light Emitting Diode (LED) type pedestrian signal, conforming to the provisions of Standard Special Provision 86-405 “Light Emitting Diode Pedestrian Signal Modules” and Section 4E of the California Manual on Uniform Traffic Control Devices.
- B.** Pedestrian signals shall be the “Countdown” type pedestrian signals conforming to the provisions in Section 4E.07, “Countdown Pedestrian Signals” of the California Manual on Uniform Traffic Control Devices, latest edition.
- C.** Pedestrian Signal Faces shall be a single section with the “Upraised Hand” and “Walking Person” overlain on the left of the pedestrian signal face, and the “Countdown” on the right of the pedestrian signal face.

2.20 BATTERY BACK-UP SYSTEM FOR TRAFFIC SIGNALS

- A.** Battery Back-up Systems for Traffic Signals shall be in conformance with “Specification for Battery Back-up System For Traffic Signals Utilizing Light Emitting Diodes (LED) Traffic Signal Modules” by the Department of Transportation dated July 2004, as amended below:

1. References to “State,” “Department,” or similar references meant to refer to the Department of Transportation shall be amended to refer to the City or the City Engineer as appropriate.
2. References to Caltrans Model 332A Cabinets, Model 170E Controllers, and Model 2070 Controllers shall be amended to refer to Caltrans Type P Cabinets and NEMA Type 90 Controllers as appropriate.
3. The following sections, paragraphs and figures are deleted in their entirety:
 - a. Paragraph 2.1.1 & 2.1.2;
 - b. Paragraph 2.1.5 & 2.1.6;
 - c. Section 2.2;
 - d. Paragraph 2.3.5 through paragraph 2.3.7;
 - e. Paragraph 2.3.14 through paragraph 2.3.16;
 - f. Section 5.6;
 - g. Figure 2.
4. The following sections and paragraphs are amended as follows:
 - a. Paragraph 2.1.7 – delete option (1) Internal Mounted Option;
 - b. Paragraph 2.3.3 line 3 shall read – “The specific finish of the external cabinet shall be in conformance with Section 2.02 “Painting” of these Specifications. A graffiti coating acceptable to the City shall then be applied.”
5. The following paragraph is added to Section 5:
 - a. Paragraph 5.0: The Contractor shall provide a Certificate of Compliance to the City Engineer certifying that the battery back-up system meets or exceeds these specifications.

2.21 LUBRICATING COMPOUND

- A.** Contractor shall apply high-pressure, high-temperature anti-seize and lubricating compound on all threaded nuts and bolts, including anchor bolts and components of signal mounting hardware assemblies.
- B.** Contractor shall use THREADEASE of approved equal.

PART 3 - EXECUTION

3.01 TRENCHING, BACKFILL AND SHORING

- A.** Trenching shall conform to Section 02202 of these Specifications.
- B.** Depth of trenches for conduit or conductors in areas to be covered by street paving shall be such as to provide thirty (30) inches of cover for conduits or conductors. Trench depth under sidewalks shall be such as to provide eighteen (18) inches of cover over the conduit or conductor to the paving subgrade, or as indicated on the plans.

3.02 CONDUIT JACKING

- A.** Placement of conduit beneath existing pavement and sidewalk may be by jacking methods when approved by the City Engineer.
- B.** Where conduit is to be installed by jacking or drilling longitudinally along the curb line, installation shall conform to the provisions in Section 86-2.05C, "Installation" of the Standard Specifications.
- C.** Pavement shall not be disturbed without written permission of the City Engineer.
- D.** Jacking pits shall be kept two (2) feet clear of the edge of any type of pavement.
- E.** Excessive use of water, such that pavement might be undermined or subgrade softened, will not be permitted.

3.03 FOUNDATIONS

- A.** Concrete for foundations of standards and cabinets shall be installed in conformance with section 2.01, "Portland Cement Concrete," of these specifications.
- B.** Top of foundations for electroliers shall be (2) inches above the surrounding finish grade in unpaved areas or shall be flush with top of curb when adjacent to curbs. The top two (2) inches of foundations for street electroliers shall be placed after the electrolier is in proper position.
- C.** Top of foundations for service pedestals shall be to the dimension or elevation shown or noted on the plans.
- D.** Excavation for electrolier foundations shall be done with an auger to the diameter called for on the plans and the top portion of the foundation above the surrounding subgrade shall be formed.
- E.** Foundations for electroliers adjacent to curbs shall be set to provide a minimum of twenty-four (24) inches clear from face of curb to center of electrolier mast.
- F.** Controller cabinet foundation shall be constructed to extend 5-1/2" above the surrounding grade, and shall be installed with a cast in ground rod.
- G.** In unpaved areas, a four (4) inch thick Portland Cement Concrete pad shall be constructed in front of cabinets. Pad dimension shall be as directed by the City Engineer.
- H.** The fifth paragraph in Section 86-2.03, "Foundations," of the Standard Specifications is amended to read:

Cast-in-drilled hole concrete pile foundations for traffic signal and lighting standards shall conform to the provisions in Section 49, "Piling," with the added requirements that standards shall not be erected until seven days have elapsed after placing the concrete, and except that material resulting from drilled holes

shall be disposed as provided in Section 86-2.01, "Excavating and Backfilling," of the Standard Specifications.

3.04 CONDUIT

- A.** Install conduits in the locations shown on the plans. Additional conduit not shown on the plans, but required to serve signal system shown on plans, shall be installed as directed by the City Engineer.
- B.** After conductors have been installed, the ends of conduits terminating in controller cabinets and pull boxes shall be sealed with an approved type of sealing compound.
- C.** All empty conduits shall be installed with 3/16" diameter nylon pull rope for future use.

3.05 PULL BOXES

- A.** Pull boxes of the size and type specified shall be installed at the locations shown on the plans. Additional pull boxes required for construction and not shown on the plans shall be installed by the Contractor at the direction of the City Engineer.
- B.** Top of pull boxes shall be set flush with surrounding finish grade land in curbed areas shall be set flush with top of curb.
- C.** Where the sump of an existing pull box is disturbed by the Contractor's operations, the sump shall be reconstructed.

3.06 CONDUCTORS

- A.** Conductors shall be pulled through rigid non-metallic conduit by hand only using nylon or polypropylene pull rope with a minimum tensile strength of 500 pounds. Nylon or polypropylene pull rope shall be installed in all conduits which are to receive future conductors.
- B.** All splices of conductors shall use Type "C" shaped compression connectors and shall be insulated by means of Method "B" as set forth in Section 86-2.09E "Splice Insulation" of the State Standard Specifications.
- C.** Splices shall be made in pull boxes, or terminal compartments only. All signal conductors may be spliced, in pull boxes, where circuits branch except where duplicate parallel conductors are shown in the conductor schedule.
- D.** All splices for connection to electroliers shall have fused disconnect splice connectors installed in the pull box adjacent to the electrolier. Fused splice connectors shall be installed in conformance with the requirements of Section 86-2.095 "Fused Splice Connectors" of the State Standard Specifications.
- E.** Provide at least three (3) feet of slack within each pull box.

- F. After conductors have been installed, the end of conduits terminating in service cabinets, standards, electroliers and pull boxes shall be sealed with Duct Seal Compound.
- G. Cables shall be permanently identified as to circuit or phase. Identification shall be placed on each cable in each pull box and near the end of terminated cable.
- H. When three or more conductors are to be enclosed within a single splice using heat shrink material, mastic shall be placed around each conductor prior to being placed inside the heat shrink material. The mastic shall be the type recommended by the manufacturer of the heat shrink material.

3.07 SERVICE

- A. Electrical services for street and safety lighting shall be installed in conformance with the applicable requirements of Section 86-2.11 "Service" of the State Standard Specifications and shall meet the requirements of the serving utility.
- B. The twelfth paragraph in Section 86-2.11 "Service" of the Standard Specifications is amended to read:

Except for power for the contractor's operations, upon written request by the contractor, the City Engineer will arrange with the serving utility to complete service connections for both temporary and permanent installations and the City will pay all costs and fees required by the utility. Such request shall be submitted not less than 15 days before service connections are required.

- C. Service conduit and pull boxes shall be installed as soon as possible to enable the utility company to schedule work well in advance of completion of the project.
- D. To facilitate the utility company in providing underground service connections, a conduit with conductors shall be run to the service point designated on the plans. Two No. 5 pull boxes shall be installed adjacent to the service point and an elbow to the face of the utility pole. The utility company shall then install the conductors through the elbow from the pull box.

3.08 LUMINAIRES

- A. Prior to energizing a luminaire, the lamp socket shall be set in the proper location for the required light distribution in accordance with the manufacturer's instructions for the type of distribution called for on the plans.
- B. Set fixtures level and flush with the roadway surface.

3.09 PHOTOELECTRIC CONTROLS

- A. Photoelectric controls shall be installed as per the detail shown on the plans, and adjusted to point in the north direction.

3.10 STANDARDS AND PEDESTALS

- A.** All poles shall be installed as shown, leveled and cleared of all concrete.
- B.** Salvaged material not reused shall be delivered to the Redwood City Municipal Services Center located at 1400 Broadway, Redwood City, California. The cost of this shall be considered in the contract price paid under the work item involved and no additional compensation will be allowed therefore.
- C.** All required drilling on poles, masts, mast arms and fixtures shall be done in the field after the pole (mast) has been satisfactorily installed, plumbed and cleaned.
- D.** For bonding existing intersectional street lighting standards the contractor shall either install a 3/16 inch or larger brass bolt, or preferably a means to be provided by pole manufacturer on side of pole adjacent to hand-hole. The bolt shall be installed on the outside of the shaft near the base plate where it will be covered by the bolt cover. The shaft of the standard shall be drilled for no larger than a 1/4 inch hole near the base plate to provide passage for the bonding conductor.
- E.** Payment for modifications for touch-up painting and bonding of existing standards shall be considered as included in the contract lump sum price paid for street lighting.

3.11 BONDING AND GROUNDING

- A.** Bonding and grounding shall conform to the provisions in Section 86-2.10 "Bonding and Grounding" of the Standard Specifications, these special provisions, the latest issue of the National Electric Code, Section 250-91(c), and to Sections 2395.91(b) and (c)l of the State of California Low Voltage Electrical Safety Orders, Title 8.
- B.** Grounding jumper shall be attached by means provided by pole manufacturer, if possible. If not, contractor shall provide a 3/16 inch or larger brass bolt in the standard or pedestal and shall be run through conduit to the ground rod or bonding wire in adjacent pull box.
- C.** Grounding jumper shall be visible after cap has been poured on foundation.

3.12 REMOVING, REINSTALLING OR SALVAGING ELECTRICAL EQUIPMENT

- A.** Salvaged electrical materials shall be hauled to the Redwood City Municipal Services Center located at 1400 Broadway, Redwood City, and stockpiled.
- B.** Full compensation for hauling and stockpiling electrical materials shall be considered as included in the contract price paid for the item requiring the material to be salvaged and no additional compensation will be allowed therefore.

3.13 EXCAVATION AND BACKFILLING

- A.** Excavation and backfilling for trenches, foundations and other appurtenance shall conform to the provisions in Section 86-2.01, "Excavating and Backfilling" of the State Standard Specifications and Section 02202 of the Specifications.

3.14 DISPOSAL OF LOW SODIUM LAMPS

- A.** All unserviceable, sodium lamps recovered from the existing street lights shall be brought to the Redwood City Municipal Services Center for disposal.
- B.** Sodium can generate a high degree of heat when exposed to small amounts of water; therefore the following precautions must be taken while handling the lamps.
 - 1. Prevent the bulb from being scratched.
 - 2. Be sure the power supply is off before installing or removing the lamp.
 - 3. In case the outer bulb is broken, avoid making contact with metal parts to prevent electrical shock.
- C.** The City of Redwood City has a disposal permit from SBSA. The lamps must be deactivated prior to disposal in the following manner:
 - 1. In a designated container located at the Service Yard, the contractor must break the lamps into small pieces.
 - 2. Goggles should be worn to prevent the possibility of injury from flying glass.
 - 3. The broken parts should then be covered with water with the aid of a hose.
 - 4. The contractor should maintain a safe distance away from the container until the chemical reaction has stopped and the sodium is rendered harmless.
 - 5. The contents of the container should be disposed of as directed by the City Engineer.

3.15 INDUCTIVE LOOP DETECTORS

- A.** Loop detectors shall conform to the provisions in Section 86-5.01A "Inductive Loop Detectors" of the Standard Specifications, details and notes shown on the Standard Plans, and these specifications.
- B.** Loop detector sensor units and asphaltic emulsion sealant for inductive detector loop installation shall be furnished by the contractor.
- C.** Loop detectors to be installed in an area that is to receive new asphalt concrete shall be installed prior to the final overlay of asphalt concrete.
- D.** Where the inductive loop detector conductors are to be installed in an area that is to be resurfaced with asphalt concrete, the loop detector conductor shall be

placed in slots cut in the existing pavement. The conductors shall be installed as shown on the plans in the existing pavement.

- E.** Loops shall be centered within traffic lanes unless otherwise specified.
- F.** Contractor shall position loops so that no portion of any loop lies over conduit.
- G.** Contractor shall make tentative layouts of all loops as shown on plans, then arrange for confirmation of layouts by the City Engineer prior to sawcutting.
- H.** All loops shall be brought to pull box individually through a chase and conductors shall have two turns of twist per foot and spliced in pull box.
- I.** Wire shall be installed in a slot sawcut in the pavement. Residue resulting from slot cutting operations shall not be permitted to flow across shoulders or lanes occupied by public traffic and shall be removed from the pavement surface by vacuuming or other approved method before any residue flows off of the pavement surface. Residue from sawcutting operations shall be disposed of outside the highway right of way in conformance with the provisions in Section 7-1.13 of the Standard Specifications.
- J.** Slots cut in the pavement shall be smooth, washed clean, blown out and thoroughly dried before installing conductors.
- K.** Loop wire shall be Type 1, Type RHW-USE neoprene-jacketed or Type USE cross-linked polyethylene insulated, No. 12, stranded copper wire, the minimum insulation thickness at any point shall be 40 mils, in accordance with Section 86-5.01 A of the Standard Specifications. One continuous, unbroken length shall be used to form a loop of the number of turns required and the lead-in from loop to junction box.
- L.** The lead-ins from the detector shall be Type B, lead-in cable shall be insulated with 20 mils of high-density polyethylene. The conductors shall be twisted together with at least 2 turns per foot and the twisted pair shall be protected with a copper or aluminum polyester shield. A No. 20, minimum, copper drain wire shall be provided and connected to the equipment ground within the cabinet. The cable shall be provided with a high-density polyethylene or high-density polypropylene outer jacket with a nominal thickness of 32 mils. An amorphous interior moisture penetration barrier of nonhydroscopic polyethylene or polypropylene fillers shall be provided in accordance with Section 86-5.01A. The lead-in shall be spliced, soldered and taped to the loop at the junction box. The shield shall be connected to the controller cabinet ground bus. Where spade terminals are used to secure the lead-in wire to field terminal blocks, the spade terminals shall be soldered as well as crimped to the UF wire. All detector lead-in cable shall be continuous - no splicing is permitted.
- M.** After the loop conductors are installed in the pavement, the slots shall be filled to within 1/8" of the pavement surface with the appropriate sealant. All excess shall be removed.

- N. Detector loop lead-ins shall be installed in conduit from the gutter to the splice box. After installation of loop wires, gutter end of conduit is to be sealed with duct seal and excavation is to be filled with sand to within 1-1/2" of road surface and capped with asphalt.
- O. All splices shall be soldered to ensure constant low resistance and must be insulated in such a manner that the installation maintains resistance to ground of not less than 100 megaohms. To ensure that the loop installation is correct, a continuity check of the loop wiring and a resistance check of this loop-to-ground shall be performed using a "megger" or other suitable insulation tester, with a representative of the City Engineer present. Loop readings that decrease below 20 megaohms during the guarantee period shall be considered below minimum limits and shall require replacement.
- P. The contractor shall test the detectors with a motor-driven cycle, as defined in the California Vehicle Code, that is licensed for street use by the Department of Motor Vehicles of the State of California. The unladen weight of the vehicle shall not exceed 200 pounds and the engine displacement shall not exceed 100 cubic centimeters. Special features, components or vehicles designed to activate the detector will not be permitted. The contractor shall provide an operator who shall drive the motor-driven cycle through the response or detection area of the detector at not less than three (3) miles per hour nor more than seven (7) miles per hour. The detector shall provide an indication in response to this test.
- Q. Chevron asphalt loop sealant or equal shall be used.
- R. Adjacent loops shall be tied to the same four-channel detector.
- S. The number of lead-in-cable required to achieve the specified detection shall be installed.
- T. Where Type "A" loops are indicated on the plans, except for speed monitoring installation, a six-foot diameter circular loop may be installed in lieu of the shape shown on the plans. The 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.
- U. If any part of the loop conductor, including the portion leading to the adjacent pull box, is damaged by the contractor's operations, the entire detector loop shall be replaced. If any adjacent loop is damaged during such replacement, that loop shall also be replaced.

3.16 RESTORATION OF EXISTING IMPROVEMENTS

- A. Existing pavement or other improvements removed or damaged due to the installation of work items shall be replaced in kind to the satisfaction of the City Engineer, at the Contractor's expense.
- B. Existing landscaping, irrigations, or plantings removed, damaged or disturbed due to the work items shall be replaced in kind to the satisfaction of the City Engineer, at the Contractor's expense.

- C. All construction areas shall be left in a clean, neat and workmanlike condition. All construction waste, rubbish and debris remaining upon completion of the work shall become the property of the contractor unless otherwise specified herein or noted on the plans and shall be removed from the worksite by contractor and disposed of off-site in a lawful manner to the satisfaction of the City Engineer.

3.17 ACCEPTANCE TEST AND TURN ON

- A. The work item will not be considered acceptable until it has been energized and visually inspected by the City Engineer. Prior to acceptance testing, all equipment as shown on the Plans shall be installed and operable, including but not limited to, pedestrian signals, pedestrian push buttons, vehicle detectors, lighting, signs, and pavement delineation.
- B. All louvers, visors, and signal faces shall be directed to provide maximum visibility.
- C. Contractor shall pay all energy costs until the street light system has successfully passed the acceptance test and initial turn on.
- D. Initial turn on of signal systems shall be made between 9 a.m. and 2 p.m., unless specified otherwise.
- E. Contractor shall notify the City Engineer seven (7) days prior to intended date of initial turn on. City will arrange for presence of the Police Department at the time of initial turn-on.
- F. Turn-on procedures must be approved by the City Engineer. Contractor shall be responsible for all required traffic control measures required for the turn-on, to the satisfaction of the City Engineer.

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