

712.34 Cables, Conductors and Wires.**(A) Cables and Wires for Roadway Lighting System.**

(1) **Series Circuit Cable.** The cable for the 6.6 ampere series circuits shall be No. 8 AWG, single conductor six thousand (6000) to seven thousand (7000) volt insulation eleven-sixty-fourth (11/64) inch thick, with metallic shielding and non-conducting neoprene sheath eleven-sixty-fourth (11/64) inch thick suitable for direct burial.

(2) **Multiple Circuit Cable.** The cable for the two hundred forty (240) volt multiple circuits feeding the roadway lighting circuits shall be single conductor, six hundred (600) volt, AWG sizes according to the contract, copper, stranded, type XHHW suitable for use at seventy-five (75) degrees Centigrade. The rubber insulation shall be two thirty-secondth (2/32) inch thick. The neoprene jacket shall be three sixty-fourth (3/64) inch thick. The rubber insulation and the neoprene jacket shall be according to the National Electric Code RHW/USE standards and IPCEA Designation S-19-81. *| *| *|

(3) Pole Fixture Cable.

(a) **Series Circuit.** Pole fixture cable for wiring from the isolating transformer to the roadway lighting luminaire shall be a two (2) conductor, No. 10 AWG, Type RHW, with six hundred (600) volt insulation between conductors and five thousand (5,000) volt to ground.

(b) **Multiple Circuit.** The connection of multiple circuit cables from base of lamp post to luminaires shall be single conductor, six hundred (600) volt, No. 10 AWG, solid copper, Type THW. Grounding wires in conduit system shall be single conductor, six hundred (600) volt, No. 6 AWG, stranded copper, Type XHHW or RHW.

Multiple circuit aerial cable shall be No. 1/0 AWG copper, pre-assembled, RINJ-insulation, including copper-clad messenger.

(B) Conductors and Cables for Traffic Signal System.

(1) **Solid No. 8, Single Conductor (Ground Wire).** The conductor shall be No. 8 AWG, solid electrolytic base copper, medium-hard-drawn, and suitable for grounding wire. The conductor shall conform to ASTM B 2. The wire shall weigh approximately 49.9 pounds per one thousand (1,000) feet.

(2) Solid No. 6, Three (3) Conductor, Six Hundred (600) Volt, General Purpose, Synthetic Rubber Insulated Neoprene Cable (Power Source to Controller).

(a) **Conductor.** The conductor shall be No. 6 AWG, three (3) conductor, soft-drawn, solid copper wire conforming to ASTM B 3.

(b) **Insulation.** The Contractor shall apply a concentric wall *| of long-lived, heat and moisture resistant synthetic rubber *| insulation over each conductor according to ASTM D 754. The *| insulation thickness shall be one-sixteenth (1/16) inch. |

(c) **Tape.** The Contractor shall provide a tape or braid over *| the insulation for identification. |

(d) **Sheath.** The Contractor shall wrap the synthetic rubber *| insulation and tape with a fibrous filler. The Contractor shall *| shall then apply a mold-cured neoprene sheath. The neoprene *| sheath shall be three thirty-secondth (3/32) inch thick and *| conform to ASTM D 752.

(3) Stranded No. 14, Single Conductor, Six Hundred (600) Volt, Type TW Machine Tool And Control Wire (Local Loop System To Signal Head).

(a) **Conductor.** The conductor shall be No. 14 AWG single conductor, soft-drawn, nineteen (19) strand copper wire conforming to ASTM B 8.

(b) **Insulation.** The Contractor shall apply a concentric wall *| of flame-retardant thermoplastic vinyl chloride insulation *| having no fibrous covering over the conductor. The thickness of *| the insulation shall be one thirty-secondth (1/32) inch. The | insulation shall conform to ASTM D 1047 and shall meet the | physical and electrical characteristics of the contract. |

(4) Stranded No. 14, Multi-conductor, Shielded, Six Hundred (600) volt, Traffic Control Cable.

(a) **Conductor.** The conductor shall be No. 14 AWG, stranded, soft-drawn, copper wire and shall conform to ASTM B 3. The number of conductors shall be according to the contract. *|

(b) **Insulation.** The Contractor shall cover the conductors with *| an extruded polyethylene insulation conforming to ASTM D 1248. *| The nominal thickness of insulation shall be 0.020 inch. The *| Contractor shall code each conductor with a different color *| and/or with an identifying colored spiral tracer. The *| Contractor shall cable the insulated conductors together and *| cover the insulated conductors with a neoprene bedding tape. *|

(c) **Inner Jacket.** The Contractor shall cover the tape core *| with extruded polyethylene jacket conforming to ASTM D 1248. The nominal thickness of jacket shall be 0.063 inch.

(d) **Metallic Tape.** The Contractor shall spiral a 0.002-inch *| metallic tape over the inner jacket to give complete coverage. *|

(e) **Outer Jacket.** The outer jacket shall be a high and low temperature, and water resistant thermoplastic conforming to ASTM D 2219. The nominal thickness shall be 0.078 inch. The outside diameter of the cable shall be approximately one (1) inch.

(5) Stranded No. 14, 2 Conductor, Shielded, Loop Detector Lead In And Pedestrian Pushbutton Circuit Cable.

(a) **Conductor.** The conductor shall be No. 14 AWG, 2 conductor, stranded (19 by 27), copper wire.

(b) **Insulation.** The Contractor shall cover the conductors *| with polyethylene insulation. The nominal thickness shall be *| 0.032 inch. The Contractor shall cable and shield the *| insulated conductors with aluminum -polyester. *|

(c) **Drain Wire.** The drain wire shall be No. 16 AWG, stranded, tin-coated copper wire.

(d) **Outer Jacket.** The outer jacket shall be of chrome-vinyl with nominal thickness of 0.032 inch. The outside diameter of the cable shall be approximately 0.340 inch. Capacity measured between conductors shall be twenty-four (24) micro-micro farad per foot and forty-seven (47) micro-micro farad per foot nominal with one (1) conductor connected to the shield.

(e) The Contractor shall fill the interior of the cable with *| an amorphous material that prevents water penetration. *|

(6) Solid No. 12 Single Conductor, Six Hundred (600) Volt, General Purpose Cable For Sensor Loops.

(a) **Conductor.** Conductor shall be No. 12 AWG, solid copper conductor.

(b) **Insulation.** Insulation shall be of moisture and heat resistant rubber with a minimum thickness of three sixty-fourth (3/64) inch. The outside diameter of the conductor shall be approximately 0.205 inch.

(7) Solid No. 20, 24 Conductor, (12 pair) Six Hundred (600) Volt Interconnect Cable.

(a) **Conductor.** The conductor shall be No. 20 AWG, twenty-four (24) conductor solid copper wire.

(b) **Insulation.** The Contractor shall cover the conductors *| with color coded polyethylene insulation with minimum thickness *| of 0.025 inch. The Contractor shall cable the insulated *| conductors in pairs and bound with a suitable tape. The *| Contractor shall shield each pair with copper tape more than *| 0.003 inch in thickness spiraled over the paired conductors. *| The Contractor shall bound the shielded pairs with a spiral *| wrapping of moisture resistant tape.

(c) **Outer Jacket.** The outer jacket shall be of tightly fitting PVC conforming to ASTM D 1047, latest issue, when tested. The outside diameter shall be approximately one (1) inch.

(8) Overhead Construction.

(a) Messenger for overhead intertie system shall be of three-eighths (3/8) inch, seven (7) wire strand conforming to ASTM A 475 and shall be extra zinc-coated. |

(b) The conductors shall be according to the contract. *|

(c) Messenger Hanger shall be of the universal type suitable for three-eighths (3/8) inch strand, including clamp bolts, lag screw and through bolts.

(d) Lashing wire shall be of 0.045-inch diameter stainless steel wire.

(9) **No. 19, Six (6) Pair Three Hundred (300) Volts Communications Cable.** Communications cable shall be No. 19 AWG shielded, twisted pair, according to IMSA Specification No. 39-2. |

(C) Cables, Conductors and Wires for Irrigation System.

(1) **General.** Wire and cable shall be single conductor, copper. Copper conductors shall be of annealed, uncoated wire conforming to ASTM B 3. Conductor sizes No. 6 and larger shall be stranded, Class B, conforming to ASTM B 8. Bare conductors shall be soft drawn.

(2) **Conductors in Conduit.** The Contractor shall insulate the *| circuit conductors and grounding conductors for installation in the *| conduits. Conductors shall be color coded as follows: |

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Grounding Conductors	Green
Control Conductors	No identical codes in same conduit

(a) Primary service conductors shall be fifteen thousand (15,000) volt insulation class. Insulation shall be: *

1. rubber with polychloroprene jacket or *

2. cross linked polyethylene with polyvinyl or polyethylene jacket. *

The Contractor shall strand the conductors. The Contractor shall install the cables unspliced, terminus-to-terminus. *

(b) Secondary voltage conductors shall be six hundred (600) volt insulation class. Conductors No. 6 and larger shall have insulation of cross linked polyethylene with polyvinyl or polyethylene jacket. Sizes smaller than No. 6 shall be NEC type RHW or THW insulation.

(3) **Conductors Directly Buried.** The Contractor shall insulate the circuit conductors for installation directly in earth. Insulation shall be six hundred (600) volt insulator class. Conductors shall be NEC type UF, seven (7) strand or solid. The Contractor shall color code the circuit conductors. The Contractor shall use white (with tracer) for common. Grounding conductors for installation directly in earth shall be bare. *

712.35 Disconnect and Protective Devices.

(A) **General.** The Contractor shall hold splices and taps to a minimum number. The Contractor shall make conductor-to-conductor connections with hydraulically-indented lugs. *

(B) **Taps.** The Contractor shall make taps from feeders to highway lighting luminaires at lighting standards with standard connector kits that provide a quicki-disconnect, fused branch connection to the feeder conductors. Taps shall be waterproof and of dielectric value equal to that of the insulation of the conductors joined. Fuses shall be standard midget, ferrule type ampere rating shown in the contract. *

(C) **Splicing.** The Contractor shall splice the feeders with standard splicing kits of the type recommended by the cable manufacturer. Splices shall be waterproof and of dielectric value equal to the insulation of the conductors joined. *

712.36 Photo Control. The photo control unit shall have an inrush current rating of one hundred twenty (120) amperes. The photo control shall withstand surge current up to one thousand (1,000) amperes. Chassis shall withstand hi-pot test of five thousand (5,000) volts. Cadmium-sulfide cells shall have three hundred (300) to five hundred (500) milliwatts maximum dissipation, operating voltage range between one hundred and five (105) volt to two hundred eighty-five (285) volt, and mounting features shall conform to EEI Publication No. 148, NEMA Publication No. SH18-1959.

The light level setting shall be adjustable from 0.5 to 3.0 footcandles. The Contractor shall adjust the light level setting for turn on at 0.7 ± 0.2 footcandles.

712.37 Controller Equipment.

(A) General. Model 170 controller assemblies shall conform to the latest provisions in the California Model 170 Traffic Signal Control Equipment (TSCE) Specifications. Controller assemblies supplied under this contract shall be of a make and model previously accepted by the Department of Transportation (DOT), State of California for service in the State of California.

(B) Controller Unit. The Contractor shall supply each Model 170 controller unit with one (1) system memory module, Model 41264. The Contractor shall provide a full compliment of EPROMS and RAM memory chips for each system memory module. The Contractor shall provide sockets for RAM and EPROM units on the system memory module. The Contractor shall install RAM memory in the system memory module before delivery.

The Contractor shall furnish each Model 170 controller unit furnished as on-street master with two (2) serial communications ports. The Contractor shall use one port with the internal Model 400 modem for communications to the local controllers. The Contractor shall use the second serial port with an external modem for communications with a computer.

Each controller assembly supplied includes the following auxiliary equipment:

- (1) Controller Cabinet
- (2) Model 200 Switch Packs
- (3) Model 204 Flasher Unit
- (4) 41264 Memory Module
- (5) Model 210 Monitor Unit
- (6) Loop Detector Sensor Units (channels to suit intersection)

(7) Model 400 Modem set for 1299 Baud

(8) Model 242 Two-Channel Isolators

(9) Associated Input/Output Files and Power Distribution Assembly

The Contractor shall furnish and install exact quantities of switch packs, DC isolators, and detectors according to each local intersection shown in the contract.

The 170 software shall be the latest version of BI Trans Systems, Inc.'s 200H Traffic Signal Program and shall be Contractor furnish. The Contractor shall program the EPROM chops and install the chips in the controllers.

(C) Cabinet.

(1) Model 332 Cabinet and Model 336 Cabinet shall conform to the latest TSCE Specification of the State of California.

The Contractor shall equip each cabinet with a phone jack installed in the back of the cabinet. The phone jack shall be compatible for voice communication utilizing one (1) pair of the interconnect cable used on the system.

(2) The Contractor shall make cabinets of anodized aluminum.

(3) **Subsystem Display.** The Contractor shall furnish a subsystem display panel with each cabinet in which an on-street master is called for. The panel shall be of aluminum construction with LED's at each local intersection on the subsystem.

(4) **Telephone System.** The Contractor shall furnish a portable field voice communications system at each local controller, utilizing the model 400 modem. The handsets provided shall have push-to-talk and ring switches. Depression of the ring switch shall result in the generation of a tone at connection local controller locations. The Contractor shall furnish two (2) handsets for the system.

(D) Qualified Products List (QPL). The Department will consider only manufacturers listed on the current State of California Qpl for Controller Assemblies for Model 170 Traffic Controller to furnish the controller assemblies. If the contract includes the traffic signal system, the QPL are applicable to this project and incorporated by reference. A copy of the latest QPL is available for review at the DOT, Highways Division, Traffic Branch.

(E) Supplemental Requirements. The manufacturer shall provide:

(1) Ground Fault Interrupter (GFI) type receptacles.

- (2) silk screen or phenolic/engraved labeling. |
- (3) circuit breakers with the rating engraved into the handle. |
- (4) integral Dual ACIA's to the controller unit. |
- (5) an eighteen (18) inch flourescent light in the cabinet. |
- (6) "vertical mount" type for type 170 Controller boards. |
Horizontal mount boards are NOT ACCEPTABLE. |

(F) **Quality Control.** The contract references Chapter I, Section VII, Quality Control of the State of California TSCC Specifications. The supplier shall submit a certificate stating that the State of California accepted the equipment supplier's quality control procedure according to paragraph 6 of Section VII. *

(G) **Warranty.** The warranty on the equipment furnished shall conform to Section 623 - Traffic Signal System. |

712.38 Traffic Signal Standards.

(A) **Type I Traffic Signal Standards.** The manufacturer shall make type I traffic signal standard of steel. The signal standard includes an anchor base about ten and a half (10-1/2) inches square, a uniform, continuously tapered steel shaft, anchor bolts and nuts, hand hole and hand hole cover and other necessary hardware needed to make the standard a complete unit. The Contractor shall construct the entire assembly according to the contract with no rough edges or surfaces, depressions, or other defects. *

(1) **Shaft.** The shaft shall be a minimum of eleven (11) gage steel and one (1) piece construction. The Contractor shall make the shaft from open hearth, hot rolled steel or high tensile low alloy steel. Length for shaft shall provide for a ten (10) foot mounting height. *

The Contractor shall provide a bolt on the shaft so that the Contractor may attach a ground wire conveniently. *

(2) **Hand Hole.** The shaft shall have a reinforced opening for a hand hole. The Contractor shall locate the opening on the side of the shaft about nine (9) inches above the bottom surface of the anchor base. The reinforced opening shall be complete with gasket, cover plate and non-slip fastener. The opening shall have a three (3) inch by five (5) inch inside minimum measurement. The Contractor shall weld a quarter (1/4) inch bolt approximately one (1) inch long inside the pole opposite the hand hole. The Contractor shall provide a nut for this bolt. *

(3) **Anchor Base.** The anchor base shall be an integral part of the standard. The anchor base shall be of steel casting, steel forging *|
or steel plate. The anchor base shall be of sufficient strength to *|
support the standard. The Contractor shall provide the base with *|
four (4) holes on an eighth and a half (8-1/2) inch diameter bolt
circle (6 inches square) to receive the anchor bolts.

(4) **Anchor Bolts.** The manufacturer shall recommend the size and *|
length of the anchor bolts. Anchor bolts shall have "L" bends or *|
plate washers at the bottom. The Contractor shall supply four (4) *|
anchor bolts. Each pole and each anchor bolt shall have a leveling *|
nut and a top nut. The Contractor shall zinc-coat the anchor *|
bolts, washers and nuts. *|

(5) **Finish.** The Contractor shall hot-dip zinc-coat the complete *|
standard and other ferrous material after fabrication, internally *|
and externally to comply with ASTM A 153 and ASTM A 123. |

(6) **Alternate Designs.** The Engineer will allow an accepted *|
alternate designs. *|

(B) **Type II and Type III Traffic Signal Standards.** The Contractor shall *|
use Type II and Type III traffic signal standards for mast arm mounting *|
of traffic signals with or without bracket-mounted traffic signals.

(1) **Description.** The traffic signal standards shall have a single
tapered tube mast arm and includes the following: |

(a) A tapered steel shaft complete with anchor base, anchor
bolts, hand hole, ground nut, cast pole top, and a flange
plate near the top of the pole for mounting the mast arm;

(b) A tapered steel arm complete with a mounting flange
plate, hanger clamp, and outlet having a one inch I.D. rubber
grommet for wiring each signal, and a removable end cap; and

(c) Steel castings conforming to ASTM A 27, grade 65-35, and
gray iron castings conforming to ASTM A 126, Class A. Steel *|
castings shall be clean and smooth with details well defined *|
and true to pattern. *|

(2) **Design.** The manufacturer shall design the traffic signal *|
standards to support the traffic signals mounted on the mast arm. *|
The mounting height of the signals shall be twenty-five (20) feet.

(3) **Shaft.** The manufacturer shall make the shaft of hot-rolled *|
sheet steel of more than No. 10 conforming to ASTM A 570 or ASTM A *|
595. Silicon shall less than 0.06 percent. The Contractor shall *|
not add boron. Transverse seams shall be perpendicular to the axis. *|
The Contractor shall reinforce the transverse seams with internal *|
sleeves welded in place. Size of shaft shall be more than nine and *|

three-eighths (9-3/8) inches outside diameter by five and a quarter *|
 (5-1/4) inches outside diameter by twenty (20) feet long. *|

The Contractor shall weld a four (4) inch by six and a half *|
 (6-1/2) inch reinforced hand hole frame, complete with cover, into *|
 the shaft a short distance above the base to ease the wiring. The *|
 Contractor shall tap the reinforced hand hole frame for a grounding *|
 bolt. *|

The Contractor shall weld a flange plate of a thickness *|
 recommended by the manufacturer to the pole near the top. The *|
 Contractor shall support the flange plate with side plates tangent *|
 to the pole and gusset plates both top and bottom. The flange plates *|
 shall have a deburred two and a half (2-1/2) inch diameter wiring *|
 hole and four (4) tapped holes for bolts. *|

The Contractor shall weld a J-hook wire support near the top of *|
 the shaft. The Contractor shall cap the top of the shaft with a cash *|
 pole top, secured in place with set screws. *|

(4) Anchor Base. The Contractor shall secure a one (1) piece steel *|
 anchor base of adequate strength, shape and size to the lower end of *|
 the shaft by two (2) continuous electric arc welds. The base shall *|
 telescope the shaft. One weld shall be on the inner portion of the *|
 base at the end of the shaft. The other weld shall be on the outside *|
 at the top of the base. The two (2) welds shall be about two (2) *|
 inches apart. *|

The Contractor shall provide the base with four (4) holes to *|
 receive the anchor bolts. *|

(5) Tapered Mast Arm. The manufacturer shall make the mast arm of *|
 only one (1) length of hot rolled sheet steel of more than No. 10 *|
 gage conforming to ASTM A 570 or ASTM A 595. Silicon shall be less *|
 than 0.06 percent. The Contractor shall not add boron. *|

A flange plate of a thickness recommended by the manufacturer *|
 shall telescope the large end of the arm. The Contractor shall weld *|
 the flange plate by two (2) continuous electric arc welds. One weld *|
 shall be on the outer portion of the plate next to the shaft. The *|
 other weld shall be on the inner portion at the end of the *|
 tubular cross section. This flange plate shall have four (4) holes *|
 that shall match the four (4) tapped holes in the mounting plate on *|
 the pole. *|

(6) Anchor Bolts. The Contractor shall furnish four (4) steel *|
 anchor bolts with each pole. The Contractor shall fit each bolt with *|
 two (2) hex or heavy hex nuts. Each anchor bolt shall have an "L" *|
 bend or plate washer welded to the bottom. The Contractor shall *|
 thread the anchor bolts at the top end. The bolts shall be of the *|
 strength size and length recommended by the manufacturer to support *|
 the mast-arm and mounted signal heads. *|

(7) **Zinc-coating.** The Contractor shall zinc-coat the steel and iron parts of the base, shaft and mast arm according to ASTM A 153. The Contractor may hot-dip zinc-coat or electro-zinc-coat the washers and nuts.

(8) **Alternate Designs.** The Engineer will allow accepted alternate designs.

(C) **Standard Specifications.** Traffic signal standards and appurtenances shall conform to the latest AASHTO publication, "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals". The Contractor shall base them on a wind speed fifty (50) year mean recurrence interval of eighty (80) miles per hour. The wind pressure shall be more than thirty (30) pounds per square foot.

(D) **Certification and Mill Test Reports.** The Contractor shall require Certification and Mill Test Reports. The Contractor shall submit the following information:

(1) A list of component parts showing:

(a) the description of each part,

(b) where the material were made (including ASTM number where applicable), and

(c) a statement certifying compliance to the contract.

(2) Shop drawings accompanied by complete and detailed engineering computations that justify the selection of dimensions and material. A registered Professional Structural Engineer shall certify the computations.

(3) A copy of the Mill Test Report for structural members (posts and beams) including the physical and chemical descriptions of material incorporated.

712.39 Traffic Signals and Appurtenances.

(A) **Standard Traffic Signal Heads.** Each signal head shall:

(1) be of the adjustable, colored light, vertical type with the number and type of sections shown in the contract;

(2) provide indications in one (1) direction only; and

(3) be adjustable through three hundred sixty (360) degrees about its vertical axis.

Vertical signal heads shall contain three (3) sections arranged:

Red Yellow Green	top center bottom
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(1) **Optical Units.** Each optical unit includes a lens, reflector, a lampholder, and a clear traffic signal lamp visible to traffic.

Standard lenses shall be of the color shown, circular in shape, and a diameter of about twelve (12) inches. Each lens shall be true to color, free from imperfections and of high luminous transmission. The manufacturer may make the lens of glass or of polycarbonate resin. Glass lens shall conform to the latest ANSI standard for glass lens. The manufacturer shall mold polycarbonate lens of ultraviolet, pre-tinted transparent polycarbonate.

Each reflector includes a one (1) piece, clear glass parabolic reflector, free from bubbles and striae or Alzak processed aluminum alloy. The manufacturer shall silver the convex surface of the clear glass by chemical deposition. The thickness shall be such that the lighted filament of a one hundred fifty (150) watt incandescent lamp shall not be visible through the silver layer. The manufacturer shall protect the silvered surface by an additional coating of electrolytically deposited copper. The opening in the back of the reflector for the lampholder shall have no dark spots cast on the lens.

The lampholder shall be of weatherproof, molded construction, immune to the operating temperatures in the unit, of the vibration-proof type, and shall be substantially supported. The manufacturer shall provide the lampholder with two (2) wires of sufficient length so that the Contractor may connect the lampholder to the terminal block specified below. The reflector and lampholder assembly shall position the lamp filament at the focal center of the reflector.

The manufacturer shall design each reflector, lens and hood to minimize sun phantom.

Lamps for twelve (12) inch units shall be one hundred thirty-five (135) watts, one hundred twenty (120) volt, five thousand (5000) hour rated life, clear, traffic signal lamps conforming to the latest ITE's "Standard for Traffic Signal Lamps".

(2) **Housing.** The signal head housing or case includes an assembly of separate interchangeable sections, expansible type for vertical mounting without tie rods, secured together in a watertight manner to form a unit. Each section shall house an individual optical unit. The side of the housing or door containing the lens shall be square. The housing may be of aluminum or polycarbonate resin.

Aluminum housing shall be of die cast aluminum conforming to ASTM B 85. Doors and end plates shall be of aluminum. The parts shall be clean, smooth and free of flaws, cracks, blow holes, or other imperfections.

Polycarbonate housing shall be of ultra-violet-stabilized virgin polycarbonate resin of the specified color, injection molded complete with integral top, bottom and sides having a minimum thickness of 0.09 inch.

Each section shall be complete with a one (1) piece hinged door mounting for the lens and other parts of the optical system, watertight gaskets, and a simple door-locking device. The Contractor shall mount the optical system so that the Contractor may swing the various parts open for ready access or removal. The sections shall be interchangeable and so constructed to permit removing or adding sections. There shall be a round opening in the top and bottom of each face to receive a one and a half (1-1/2) inch supporting pipe frame. *| *| *| *|

The exposed bolts, screws, hinge pins, and door-locking devices shall be stainless steel. The interior screws and fittings shall be stainless steel or other accepted corrosion resistant material. |

The gaskets including door, lens and reflector gaskets shall be of neoprene. Lampholder gaskets shall be of material not affected by heat. |

The Contractor shall wire the lampholders so that the Contractor may connect a white wire to the shell of the lampholder and a black or colored wire to the bottom or end terminal of the lampholder. The Contractor shall, in turn, connect these wires to the terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals to the block to separate screws. The Contractor shall identify the terminals permanently are attached or color code the wiring to aid field work. *| *| *| *| *| *| *|

The Contractor shall provide each lens with a removable hood of sheet aluminum of the tunnel type 0.030-inch thick or of polycarbonate with a minimum thickness of 0.060 inch. Hoods for twelve (12) inch sections shall be eleven (11) inches minimum length. The manufacturer shall design the hoods to prevent a false indication to traffic by that particular signal face. *| *|

The Contractor shall paint the aluminum housing with one (1) coat of Epon Oxide Baking Primer, Federal Specification TT-P-636, and one (1) coat of medium gray alkyd Urea Exterior Baking Enamel, Federal Specifications TT-E-896. The finish coat shall be a dark green enamel, Alkyd Urea Exterior Baking Enamel, Federal Standard *|

FED-STD-595. The dark green enamel shall be the same shade to match the color chip that is on file with the Department. The Contractor shall paint the signal face housing and the entire surface of hoods used in front of signal lens dull black. The Contractor shall furnish polycarbonate housing in dark green color.

(3) Directional Louvers. If shown, the Contractor shall furnish and install louvers in signal hoods. The Contractor shall construct Directional louvers to fit snugly in the signal hoods. The Contractor shall construct the outside cylinder and vanes of No. 22 U.S. gage sheet steel, and the Contractor shall construct the vanes of No. 27 U.S. gage sheet steel or the cylinder and vanes of 3003 H14 aluminum of similar construction.

The Contractor shall zinc-coat the sheet steel louvers after fabrication.

The Contractor shall paint the louvers dull black.

(4) Back Plates. If shown in the contract, the Contractor shall furnish and attach the back plates to the signal heads. The Contractor shall construct the back plates of 3003 H14 aluminum sheet, 0.058 inch minimum thickness, and shall have minimum dimensions including the signal head size plus an eight (8) inch border shown in the contract. The Contractor shall paint the back plates dull black.

(B) Signal Head Mounting. The Contractor shall support the top of pole, bracket, cantilever, and underslung mounted signal faces by watertight assemblies of one and a half (1-1/2) standard steel pipe and malleable iron, or brass pipe fittings and hardware shown in the contract. The members, when assembled, shall be plumb and symmetrical in arrangement. Construction shall be such that the Contractor conceals the conductors within the assembly. Pipe slipfitter assemblies shall have slipfitters of cast-iron, bronze or malleable iron. Slipfitters shall fit over a four and a half (4-1/2) inch outside diameter standard pipe for top of pole mountings or the two and three-eighths (2-3/8) inch outside diameter tenon at the end of mast arms. Mast arm end mounting fittings shall be the ninety (90) degree type or the elevator type as specified in the contract. The Contractor shall provide each slipfitter with at least two (2) steel setscrews to secure the assembly in plumb position. Setscrews shall be cadmium plated. Each pipe bracket assembly shall have one and a half (1-1/2) inch pipe couplings to attach the assembly to the traffic signal standard. The Contractor shall provide the caps to seal unused mounting holes in the traffic signal housing.

The Contractor shall equip signal faces with positive non-ferrous lock rings and fittings designed to prevent faces from turning by external forces. Lock ring and connection fittings shall have serrated contacts. Fittings shall permit fastening at increments of less than seven (7) degrees.

The Contractor shall paint the mountings with one (1) coat of zinc-coated metal primer and two (2) coats of dark green enamel as specified for signal housings. *

The Contractor may deliver the mountings disassembled or assembled. If the Contractor delivers the mountings disassembled, the Contractor shall mark the various parts of each mounting for easy assembly. *

The Contractor shall equip the signal heads mounted at intermediate points on mast arms with a mast arm mounting bracket. Component parts of the mast arm mounting includes a bracket with a vertical tube with upper and lower devices to fasten the signal face at the bottom and top of the face. The Contractor shall connect the vertical tube to the mast arm with a clamp casting and two (2) high strength stainless steel bands that the Contractor can tighten by screw assembly (one per stainless steel band). Through the mounting assembly, the signal face shall rotate about the mast arm and right and left from the vertical plane. *

The Contractor shall furnish the polycarbonate traffic signal heads for post top mounting with internal reinforcement for the mounting base, or the Contractor shall use type IA mounting. *

(C) Programmed Visibility Traffic Signal Heads.

(1) **General.** The signal shall permit the visibility zone of the indication to be determined optically and require no hoods or louvers. The projection indication may be selectively visible or veiled anywhere within fifteen (15) degrees of the optical axis. No indication shall result from external illumination nor shall one light unit illuminate a second.

Programmed bi-modal heads shall combine an arrow with a ball indication in the same signal face. Simultaneous arrow-ball images shall be projected to predetermined roadway areas, but only one image shall be seen at a time. Traffic up the roadway shall only see a green ball indication of high target value as the signal is approached. At two hundred (200) to three hundred (300) feet from the signal, the driver shall see the ball change to an arrow indication. *

(2) **Optical System.** The components of the optical system shall comprise: lamp, lamp collar, optical limiter-diffuser, and objective lens.

The Contractor shall use bi-modal lens in the programmed bi-modal heads. *

The lamp shall be nominal one hundred fifty (150) watt, one hundred twenty (120) volt Alternating Current, three (3) prong, sealed beam having an integral reflector with stippled cover and an

average rated life of at least six thousand (6,000) hours. The Contractor shall couple the lamps to the diffusing element with a collar including a specular inner surface. The diffusing element may be discrete or integral with the convex surface of the optical limiter. *)

The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects nine hundred (900) to one thousand two hundred (1,200) feet away, and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter includes heat-resisting glass with positive indexing means. *)

The objective lens shall be a high resolution planar incremental lens hermetically sealed within a flat laminate of weather resistant acrylic or accepted equal. The lens shall be symmetrical in outline. The Contractor may rotate the lens to ninety (90) degrees orientation about the optical axis without displacing the primary image. *)

The optical system shall accommodate projection of diverse, selected indicia to separate portions of the roadway such that only one indication will be simultaneously apparent to any viewer. The projected indication shall conform to Institute of Traffic Engineers' (ITE) transmittance and chromaticity standards.

(3) Construction. Die cast aluminum parts shall conform to ITE alloy and tensile requirements and have a chromate preparatory treatment. The exterior of the signal case, lamp housing and mounting flanges shall be finished with a high quality baked enamel prime and finish paint (dark green exterior enamel). The lens holder and interior of the case shall be optical black.

The Contractor shall predrill the signal case and lamp holder for backplates and visors. Hinge and latch pins shall be stainless steel. The Contractor shall seal the access openings with weather resistant rubber gaskets. *)

The Contractor shall provide visors. Visors shall conform to ITE material requirements and include a chromate preparatory treatment and optical black on the surfaces. Visors shall be nine and a half (9-1/2) inch cutaway visors. *)

(4) Electrical. Lamp fixture includes a separately accessible housing and integral lamp support, indexed ceramic socket and self-aligning, quick release lamp retainer. The Contractor shall make electrical connection between case and lamp housing with an interlock assembly that disconnects lamp holder when opened. Each signal section includes a covered terminal block for clip or screw attachment of lead wires. Concealed No. 18 AWM, stranded and coded wires shall interconnect sections. *)

(5) **Photo Controls.** Each signal section includes an integral means for regulating its intensity between limits as a function of individual background illumination. Lamp intensity shall be more than ninety-seven (97) percent of uncontrolled intensity at one-thousand (1,000) foot-candles, and shall reduce to fifteen (15) + two (2) percent of maximum at less than one (1) foot-candles. Response shall be proportional and essentially instantaneous to detectable increase of illumination from darkness to one thousand (1,000) foot-candles, and damped for decrease from one thousand (1,000) foot-candles.

The intensity controller includes an integrated directional light sensing and regulating device interposed between lamp and line wires. The intensity controller shall be compatible with sixty (60) Hz input and responsive within the range one hundred and five (105) to one hundred thirty-five (135) volts. Output may be phase controlled, but the device shall provide a nominal terminal impedance of one thousand two hundred (1,200) ohms open circuit and a corresponding holding current.

(6) **Mounting.** The signal shall mount to standard one and a half (1-1/2) inch fittings as a single section, as a multiple section face or in combination with other signals. The Contractor shall provide a signal section with an adjustable connection that permits incremental tilting from zero (0) to ten (10) degrees above or below the horizontal while maintaining a common vertical axis through couplers and mounting. *

Terminal connection shall permit external adjustment about the mounting axis in five (5) degree increments. The signal shall be mountable with ordinary tools and serviced with no tools.

The Contractor shall furnish a pedestal adapter to fit the Type I signal standard with each programmed visibility signal. The Contractor shall mount four (4) section heads using a Type IA mounting. *

The visor shall conform and fasten to the existing mounting surfaces without affecting water and light integrity of the signal.

(7) **Miscellaneous.** The Contractor shall include a roll of optical masking tape, applicator and instruction manual with each face. *

(D) **Pedestrian Signal.** The manufacturer shall design the pedestrian signal to fit the mountings provided for vehicular signals shown in the contract. *

(1) **Features.** The Contractor shall provide the following features: *

(a) Elimination of sun phantom.

- (b) Improved light output.
- (c) Protection from vandalism.
- (d) Simplified maintenance.
- (e) Improved low temperature operation.
- (f) Simplified handling.
- (g) Elimination of high tension leads.
- (h) Operation at ninety (90) volt applied line voltage.

The Contractor shall enclose the neon tubing in a single plug-in plastic module. The Contractor shall prevent the neon tubing from shocks generated during shipping, handling, and installing.

The maximum overall dimension of the signal shall be nineteen (19) inches wide, nineteen (19) inches high, and nine and a quarter (9-1/4) inches deep, including eggcrate type visor and hinge. The Contractor shall furnish the signal complete with transformers and tubing installed. To ease installation and maintenance, the manufacturer shall design the signal so that components are accessible from the front by opening the signal door.

(2) Messages. Messages shall be the portland orange "HAND" and the lunar white "WALKING PERSON" illuminated by multiple configuration neon tubes encased in a molded plug-in plastic message module.

The "HAND-WALKING PERSON" symbols shall be a minimum of twelve (12) inches in height and seven (7) inches in width and shall be uniformly illuminated with no dark spots.

-- The Contractor shall paint the inside face of the message lens except where the desired symbols are formed. The first coating of paint shall be black to form a contrasting background when viewed from the outside. The second coating of paint shall be white to reflect internal light between symbols.

(3) Message module. The message module includes two (2) neon gas tubes enclosed. The Contractor shall protect the message module by a housing made of white acrylonitrile butadiene styrene or polycarbonate plastic and a screened message lens made of polycarbonate plastic. The tube used for the portland orange "HAND" symbol shall be ten (10) mm in diameter and shall be coated on the inside with fluorescent material producing the desired portland orange output. Tubing for the lunar white "WALKING PERSON" symbol shall be nine (9) mm. The Contractor shall coat the tubing on the inside with fluorescent material producing the desired lunar white

output. The Contractor shall form the tubing to the approximate *| shape of the "WALKING PERSON" and position for maximum lunar white *| intensity.

The Contractor shall mount the two (2) neon tubes to the *| plastic housing via resilient rubber adhesive to prevent transfer of mechanical strain to the glass tubing and to provide effective shock mounting. The manufacturer shall mold the plastic housing to provide positive location of the neon tubing in relation to the *| screened message lens.

The Contractor shall screen the message lens according to *| Subsection 713.39(D)(2) - Messages above. The message lens includes | one-eighth (1/8) inch minimum thickness, clear, U.V. stabilized refractor type, polycarbonate plastic with outer prisms and shall be weather-resistant, craze-resistant and heat-resistant. The prism pattern (designed as C-4) shall face the outside of the module with the screened message enclosed within the module.

The Contractor shall seal the message module into an integral *| assembly with a one (1) piece sponge neoprene gasket fitted around the perimeter to provide positive protection of the neon tubing from handling, weather and moisture.

The Contractor shall provide message module with electrical *| contacts that will plug directly into recessed contacts in the | transformer enclosure when the module is in proper position and shall not require the use of tools for insertion or removal.

(4) Case. The case shall be one (1) piece corrosion-resistant aluminum alloy die casting, complete with integrally cast top, bottom, sides and back. The Contractor shall provide four (4) *| integrally cast hinge lug pairs for operation of a swing open door. *|

The case for pedestrian signals shall be dust-proof, weatherproof, and corrosion-resistant and shall provide for easy access to and replacement of the components.

The case shall be suitable for post-top or bracket mounting.

The top and bottom of the case shall have an opening to adjust | a standard one and one-half (1-1/2) inch pipe brackets. The bottom opening of the signal case shall have a shurlock boss integrally cast into the case. The dimensions of the shurlock boss shall be as follows: Outside diameter two and five-eighths (2-5/8) inches, inside diameter one and thirty-one thirty-secondth (1-31/32), number of teeth seventy-two (72), angle of teeth ninety (90), depth of teeth five -sixty-fourth (5/64) of an inch. The teeth shall be clean and sharp and provide full engagement. The radial angular grooves of the shurlock boss, when used with shurlock fittings, shall provide positive positioning of the entire signal to eliminate rotation or misalignment of the signal.

(5) **Door Frame.** The door frame shall be a one (1) piece corrosion-resistant aluminum alloy casting complete with two (2) hinge lugs and two (2) latch slots for each door. The Contractor shall attach *| the door to the case by two (2) Type 304 stainless steel spring *| pins. The Contractor shall attach two (2) stainless steel hinged *| bolts with captive stainless steel wing nuts and washer to the case *| with the use of stainless steel spring pins. Latching or unlatching of the door shall require no special tools.

(6) **Z-Crate Visor.** The Contractor shall provide each signal with *| a Z-crate type visor designated to eliminate sun phantom. The *| Contractor shall install Z-crate type sunshield parallel to the *| face of the "HAND/WALKING PERSON" message. The Contractor shall *| hold the Z-crate visor assembly in place by stainless steel screws. *| The Z-crate assembly includes a minimum of twenty (20) straight *| horizontal louvers and twenty-one (21) horizontal louvers, each one formed in a zig-zag pattern.

The Contractor shall reserve every other formed louver to form *| cells one (1) inch square but rotated forty-five (45) degrees from *| horizontal to provide diamond-shaped cells when assembled. The *| Contractor shall then bisect each diamond by insertion of a *| straight louver interspersed between each pair of formed zig-zag louvers. If each apex of each formed louver comes in contact with *| the interspersed straight louver, the Contractor shall chemically *| weld the entire length of the joint. The basic material used in *| construction of the Z-crate visor shall be nominally 0.030 inch thick and shall be one hundred (100) percent impregnated black polycarbonate plastic processed with a flat finish on both sides.

The Contractor shall enclose the assembly in a mounting frame *| constructed of 0.040 inch minimum thickness aluminum. This frame shall be one and a half (1-1/2) inches deep and contain mounting holes for direct insertion in the pedestrian signal door frame.

(7) **Transformers.** The Contractor shall provide two (2) transformers *| with recessed secondary contacts and integral pyrex glass electrode *| housing. The Contractor shall mechanically lock the two (2) *| transformers together so that the Contractor requires only four (4) *| mounting bolts for mounting the entire transformer assembly. Both *| transformers shall have a four thousand (4000) volt, thirty (30) milliampere secondary.

Each transformer shall have one hundred twenty (120) volt (nominal) primary windings and a power factor of ninety (90) per cent minimum. Both transformers shall nominally require only thirty-nine (39) watts each at 115VAC.

(8) **Fused Switch.** The Contractor shall provide a fused switch *| inside the case on terminal blocks for de-energizing the transformer *| primary circuit. A fused switch includes two (2) cartridge fuses *| and a lever for disconnecting the fuses. *|