

## 501 TRAFFIC SIGNALS

### 501.1.00 DESCRIPTION

#### 501.1.01 Scope

Electrical work shall consist of furnishing and installing, modifying or removing one or more traffic signals, traffic signal master controller assemblies and interconnection facilities, flashing beacon systems, combination street lighting and traffic signal systems, sign illumination systems, traffic count stations, communication conduit, electrical equipment in structures, false-work lighting, provisions for future systems, or combinations thereof, all as shown on the plans, and as specified in these specifications and the Special Provisions.

The locations of signals, beacons, standards, lighting fixtures, signs, controls, service and appurtenances shown on the plans are approximate and the exact locations will be established by the Engineer in the field.

All systems shall be complete and in operating condition at the time of acceptance of the contract.

#### 501.1.02 Definitions

The following definitions pertain only to Division 500 "Signals and Lighting".

Actuation - The operation of any type of detector.

Channel - A discrete information path.

Controller Assembly - The complete assembly for controlling the operation of a traffic signal, consisting of a controller unit, and all auxiliary equipment housed in a weatherproof cabinet.

Controller Unit - That part of the controller assembly which performs the basic timing and logic functions.

Cycle - A complete sequence of signal indications.

Cycle Length - The time in seconds required for one complete cycle.

Detector - A device for indicating the passage or presence of vehicles or pedestrians.

Detector (Bicycle) - A detector, either a push button type or inductance loop type for indicating the passage or presence of bicycles.

Detector (Magnetic Vehicle) - A detector capable of being activated by the induced voltage caused by the passage of a vehicle through the earth's magnetic field.

Detector (Magnetometer Vehicle) - A detector capable of being activated by the magnetic disturbance caused by the passage of a vehicle.

Detector (Inductive Loop) - A detector capable of being actuated by the change of inductance caused by a vehicle passing over or standing over the loop.

Detector (Pedestrian) - A detector, usually of the push button type, capable of being operated by hand.

Detector (Pressure-Sensitive Vehicle Detector) - A detector capable of being activated by the pressure of a vehicle passing over its surface.

Electrolier - The complete assembly of lighting standard, luminaire, ballast and lamp.

Extension (Maximum) - The maximum time of the extensible portion for which actuation on any traffic phase may retain the green interval after actuation on an opposing traffic phase.

Flasher - A device used to open and close signal circuits at a repetitive rate.

Flasher Controller Assembly - A complete electrical mechanism for operating a warning beacon or intersection control beacon.

Flashing Feature - This feature, when operated, discontinues normal signal operation and causes the flashing of any pre-determined combination of signal lights.

Initial Portion - The first part of the green interval which is timed by a traffic-actuated controller unit before the extensible portion.

Initial Portion (Minimum) - A pre-set initial portion that does not change.

Initial Portion (Variable) - An initial portion which is traffic adjusted.

Initial Portion (Maximum) - The limit of the computed initial portion.

Initial Portion (Added) - An increment of time added to the minimum initial portion in response to vehicle actuation.

Interval - That part of the signal cycle during which signal indications do not change.

Interval Sequence - The order of appearance of signal indications.

Interval (Minimum Green) - In semi-traffic-actuated controller unit, the shortest time for which the green interval shall be given to the approaches not having detectors.

Interval (Yellow Change) - The first interval following the green right-of-way interval in which the signal indication for that phase is yellow.

Interval (Red Clearance) - A clearance interval, which follows the yellow change interval, during which both the terminating phase and the next right-of-way phase display red.

Luminaire - The assembly which houses the light source and controls the light emitted from the light source. Luminaries consist of housing (including socket), reflector, and glass globe or refractor.

Lighting Standard - The pole and mast arm which support the luminaire.

Major Street - The roadway approach or approaches at an intersection normally carrying the major volume of vehicular traffic.

Manual Operation - The operation of a signal controller unit by means of a hand-operated switch.

Maximum Limit - The maximum time for which actuation on any traffic phase may retain the green interval after actuation on an opposing traffic phase.

Minor Street - The roadway approach or approaches at an intersection normally carrying the minor volume of vehicular traffic.

Phase Sections - That electrical portion or program of the controller unit with its manually variable program controls, which provides control of right-of-way and clearance interval timing and other functions for a particular traffic phase.

Portion - A discrete subdivision of an interval.

Pull Box - An exterior junction box designed for in ground installation.

Pre-Timed Controller Assembly - A controller assembly for operating traffic signals in accordance with a pre-determined fixed-time cycle.

Recall Switch - a manual switch in a traffic-actuated controller unit which will cause the automatic return of the right-of-way to a phase.

Right-of-way - The right of a vehicle or pedestrian to proceed in a lawful manner.

Single Face - That portion of a signal head provided for controlling traffic in a single direction and consisting of one or more signal sections.

Signal Head - An assembly containing one or more signal faces.

Signal Indication - The illumination of a signal section or other device, or of a combination of sections or other devices at the time.

Signal Section - A complete unit for providing a signal indication consisting of a housing, lens, reflector, lamp receptacle and lamp.

Split - A division of the signal cycle length allocated to each of the various phases. (Normally expressed in percent).

Traffic-Actuated Controller Assembly - A controller assembly for operating traffic signals in accordance with the varying demands of traffic as registered with the controller unit by detectors.

Traffic Phase - The right-of-way, change and clearance intervals assigned to a movement or combination of movements.

Unit Extension - The timing increment, during the green interval, which is re-settable by each detector actuation. The green right-of-way of the phase may be terminated on expiration of the unit extension time.

Vehicle - Any motor vehicle normally licensed for highway use.

### 501.1.03 Abbreviations

Wherever the following abbreviations occur they are to be construed the same as the respective expressions represented:

ANSI - American National Standards Institute

APWA - American Public Works Association

AWG - American Wire Gauge (ASTM B 258)

AWS- American Welding Society

AWPA - American Wood Preserver's Association

EIA - Electronic Industries Association

IMSA - International Municipal Signal Association

ITE - Institute of Transportation Engineers

NEC or CODE - National Electrical Code

NEMA - National Electrical Manufacturers Association

ODOT - Oregon Department of Transportation

RMA - Radio Manufacturer's Association

S.U.B. - Springfield Utility Board

UL - Underwriters Laboratories, Inc.

#### 501.1.04 Regulations and Code

All electrical equipment shall conform to the standards of the National Electrical Manufacturer's Association (NEMA), the Underwriter's Laboratories Inc. (UL), or the Electronic Industries Association (EIA), wherever applicable. In addition to the requirements of the plans, these specifications, and the Special Provisions, all materials and workmanship shall conform to the requirements of the National Electrical Code, here in after referred to as the Code; standards of the American Society for Testing and Materials (ASTM); American National Standards Institute (ANSI); Springfield Utility Board standards and policies; and any local ordinances which may apply.

Whenever reference is made to any of the standards mentioned above, the reference shall be construed to mean the code, order, or standard that is in effect on the day the Notice to Contractors for the work is dated.

#### 501.2.00 MATERIALS

##### 501.2.01 General

Existing material may be incorporated in the work as indicated on the plans or set forth in the Special Provisions. Miscellaneous and incidental materials required for the complete traffic signal installation or other electrical system that are not mentioned on the plans or in the specifications shall be furnished and placed by the contractor. Such materials shall be of good quality and suitable for the use intended.

##### 501.2.02 Equipment List and Drawings

Within 15 days following award of the contract, the contractor shall submit to the

Engineer a list of equipment and materials which he proposes to install. The list shall include all material which is identified on the plans or in the Special Provisions, listed by manufacturer's name, size and identifying number of each item. Such a list shall be supplemented by other data as may be required, including but not limited to detailed scale drawings and wiring diagrams of any non-standard or special equipment.

Upon completion of work, the contractor shall submit to the Engineer any data required to show in detail all changes made from the original plans.

All Contractor supplied equipment shall include schematic wiring diagrams of the controller units and auxiliary equipment, all cabinet diagrams, and all operation manuals. These documents shall be submitted at the time the controller assemblies are delivered for testing. The diagrams shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such a manner as to be readily interpreted.

All diagrams, plans and drawings shall be prepared using graphic symbols shown in ANSI publication Y32.2 entitled, "IEEE Standard and American National Standard Graphic Symbols for Electrical and Electronic Diagrams."

When required, the Contractor shall furnish three (3), 24" x 36" size sets of cabinet schematic drawing diagrams, signal plans and detector plans made by (1) wet blueprint, white background process using iron-sensitized paper, (2) the offset lithograph process or (3) the electrostatic process and one set on reproducible mylar film or equivalent. The diagrams shall show the location of the installation and shall list all equipment installed in each cabinet.

If required, the Contractor shall furnish an accurately drawn intersection sketch, showing poles, detectors, wire connection terminals and phasing diagrams as shown on the contract plans. One copy of the controller cabinet diagram and the intersection and phase diagram as reviewed by the Engineer shall be placed in a heavy duty plastic envelope with side opening, and attached to the inside of the door of each controller cabinet.

The Contractor shall also furnish 5 1/4" IBM compatible disk copies of any computer generated drawings or plans as required for each project.

### 501.2.03 Conduit

#### 501.2.03A Metal Conduit

Metal conduit and fittings shall be galvanized rigid metal manufactured of mild steel conforming to the requirements of Underwriters Laboratory standard for Rigid Metal conduit, publication UL 6.



### 501.2.03B Non-Metallic Conduit

Non-metallic conduit shall be heavy wall, extruded, rigid PVC (polyvinyl chloride) conforming to the requirements of Underwriters Laboratories, Inc. standard for Rigid Non-Metallic Conduit, publication UL 651, schedule 40 and 80 Rigid PVC Conduit, for 90°C wire rated conduit.

### 501.2.03C Conduit Fittings

Expansion Fittings - Fittings shall be weather proof, malleable iron expansion head and body with a hot-dipped galvanized finish. Where plans do not specify an equipment ground wire in the conduit run, the fitting shall be furnished with external bonding jumpers.

Expansion - Deflection Fittings - Fittings shall be watertight in conformance with NEMA 4 for rigid conduit and shall be furnished with an integral bonding jumper.

Condulets - All condulets shall be corrosion resistant with a zinc coating and lacquer dip finish. Covers for condulets shall be furnished with a moisture-proof gasket.

### 501.2.04 Pull Boxes

Pull boxes, covers and extensions for installation in the ground or in sidewalk areas shall be of the sizes and details shown on the plans and shall be precast reinforced concrete or metal.

Concrete Junction Boxes - Concrete junction boxes shall be precast concrete, water-meter type with recessed checkered 3/8-inch minimum galvanized cast iron cover or checkered cast aluminum cover held down by stainless steel or brass bolts and socket- or hex-head nuts recessed in the cover.

Metal Junction Boxes - Construct metallic junction boxes of cast iron or 1/8 inch nominal welded sheet steel. Make covers from reinforced checkered steel plate. Use a commercial quality steel. Hot-dip galvanize metallic boxes and covers after fabrication according to AASHTO M 232 (ASTM A 153). Each box shall have a cover gasket that will, with cover in place, form a NEMA 4 watertight fit. Provide covers with stainless steel socket-head or hex-head cap screws. Recess screw heads in the cover.

Metal Junction Box Covers - Metal covers, except covers for ceiling pull boxes, shall be secured with 3/8 inch bolts, capscrews, or studs, and nuts which shall be of brass, stainless steel or other non-corroding material. Stainless steel hold-down bolts, capscrews or studs, and nuts and washers shall have a chromium content of not less than 18 percent and a nickel content not less than 8 percent.

All ferrous metal parts shall be galvanized.

Covers for pull boxes, except covers for ceiling pullboxes, shall be marked as follows:

1. "TRAFFIC SIGNAL" Where pull boxes contain traffic signal conductors with or without street lighting conductors.
2. "STREET LIGHTING" Where pull box contains street lighting conductors only. "HIGH VOLTAGE" shall be added where street lighting voltage is above 600 volts.
3. "COMMUNICATION" For pull boxes where communication conduit enters the pull box.
4. "SPRINKLER CONTROL" For pull boxes where sprinkler control conduit enters the pull box.
5. "COUNT STATION" For pull boxes where traffic count station conduit enters the pull box.
6. "RAMP METER" For pull boxes where ramp metering conduit enters the pull box.
7. "SERVICE" For pull boxes in service runs and where conduit from utility facilities terminate.

The markings shall be clearly defined and may be placed parallel to either the long or short sides of the cover.

Marking letters shall be between one and 3 inches high.

Marking shall be cast integrally into the cover or applied to each steel or cast iron cover prior to galvanizing by one of the following methods:

1. Cast iron strips, at least 1/4 inch thick, with the letters raised a minimum of 1/16 inch. Strips shall be fastened to covers with 1/4 inch flathead stainless steel machine bolts and nuts. Bolts shall be peened after tightening.
2. Sheet steel strips at least 22 gauge with the letters raised a minimum of 1/16 inch above the surrounding surface of the strips. Strips shall be fastened to covers by spot welding, tack welding or brazing, or with 1/4 inch round-head stainless steel machine bolts and nuts. Bolts shall be peened after tightening.
3. Bead welding the letters on the covers. The letters shall be raised at least 3/32 of

an inch.

#### 501.2.05 Cable and Wire

Conductors and cable shall conform to the applicable specifications as follows:

Unless otherwise noted, all electrical conductors shall be approved stranded copper conforming to applicable portions of ASTM B 3 and B 8 or C. Insulation shall be 600-volt plasticized poly vinyl chloride, polyethylene, or chemically cross linked polyethylene, conforming to applicable portions of ASTM D 2219, D 2220, D 1351, D 2655, and D 2656. Polyethylene compounds shall not be used where exposed to sunlight.

The use of aluminum conductors shall not be allowed.

The number and size of conductors shall be shown on the plans. Unless otherwise called for on the plans, the conductors shall be sized according to requirements of the NEC and the number of conductors needed to serve the electrical device shall be placed by the contractor.

#### 501.2.05A Color Coding

Color coding shall conform to the wiring color code shown on Standard Drawing 5-8, the plans, or as called for by the Special Provisions.

Where certain colors are not readily available, the contractor shall have the striping applied by commercial methods or apply the stripe using striping tape made for that purpose. Such striping shall be clearly visible for the length of wire wherever exposed.

#### 501.2.05B Control Cable

Control cable shall meet all applicable specifications contained in the IMSA Specifications 19-1, 19-3, 20-1 & 20-3. Specifications 19-3 & 20-3 shall be used only where plans or Special Provisions permit Figure 8 cable. Outside jacket insulation shall be black in color.

Number 14 THWN wire shall be used for all standard signal control cable. See Standard Drawing 5-8 for color coding.

Control cable shall be used on all messenger cable installations and where wiring will be exposed on all other types of installations. On such exposed installations, the control cable shall be run without splicing from the device to be controlled to the terminal points specified.

Control cable used for interior illuminated sign circuits shall be run, without splicing, from the terminal strip in the controller cabinet through the terminal cabinets to the terminal block within the sign cabinet.

Samples of control cable to be used on a project, which are requested by the engineer for testing purposes, shall have a tag attached that bears the manufacturer's certification of compliance with IMSA specifications. The specification number shall be included in the certification.

The straps used to attach control cable to messenger cable shall be heavy-duty U.V. resistant black plastic self-locking straps. The straps shall have serrated gripping surfaces through a binding buckle and when affixed, shall remain securely tightened. The shall have a minimum tensile strength of 45 pounds when tested by a straight-line axial pull across the buckle.

#### 501.2.05C Direct-Burial Cable

All cable shown or specified as direct-burial cable shall be underground service-entrance cable comprised of a heat and moisture resistant cross-linked polyethylene insulated wire. Cable shall be rated for 75°C operation in wet or dry locations and be UL labeled as type USE cable according to the NEC.

#### 501.2.05D Messenger Cable

All messenger cable, except as listed below, shall be 3/8 inch seven wire, utility grade, class "A" coating, rated at 11,500 pounds, ASTM A 475. Where "Figure 8" cable is permitted, such messenger cable shall be 1/4-inch seven wire, Class "A" galvanized.

#### 501.2.05E Interconnect Cable

Interconnect Figure 8 Cable shall consist of required number of color coded, twisted pairs of AWG wire No. as specified on the plans or as specified under the Special Provisions. The wire shall be shielded to comply with Rural Electrification Act (REA) Specification PE-22, PE-38, or ICEA Specification S-56-434 and shall be approved by the Engineer, and the Utility Engineer where applicable.

All interconnect cable shall be labeled with approved bronze or plastic labels permanently and ruggedly attached. The labels shall be embossed with the cable identification number. Additionally, labels used on utility facilities shall bear the legend "TRAFFIC SIGNAL." All ends of cables shall be labeled. All cable shall run continuously without splicing from termination point to termination point.

#### 501.2.05F Power Service Cable

Power service conductors located on traffic signal spans shall be control cable.

#### 501.2.05G Tether and Stabilizer Cable

Provided 1/4 inch seven-wire strand tether and stabilized cable with Class A coating conforming to ASTM A 475.

#### 501.2.05H Wire

1. Type T/W Wire - Where type T/W wire is indicated on the plans or in the Special Provisions, it shall mean wire that has been labeled T/W and approved by UL for wet locations in conduit.
2. Ground and Bond Wire - All ground or bond wire shall be stranded copper wire conforming to the NEC. Ground wire circuits may be bare or with solid green colored insulated covering. Insulated wire shall be THW or THWN wire.
3. AWM Wire - Appliance wiring material shall be a flame retardant, moisture, heat, and oil-resistant thermoplastic insulated copper wire. Rate wire for 60°C in oil, and 105°C dry locations and be UL labeled as AWM wire.
4. MTW Wire - Machine tool wire shall be a flame retardant, moisture, heat, and oil-resistant thermoplastic insulated copper wire. Wire shall be rated for 60°C wet locations and be UL labeled as XHHW wire according to the NEC. Wire used for traffic signal loops shall be No. 14 XHHW wire conforming to IMSA Specification No. 51-3-1984.
5. Signal control cable THHN/THWN Wire - Wires shall be a flame retardant, moisture, and heat resistant thermoplastic insulated copper wire with outer nylon jacket cover. Provide THHN wire rated for 90°C operation in dry locations and THWN wire rated for 75°C operation in wet or dry locations. Label UL wires as THHN or THWN wire according to the NEC. Number 14 THWN shall be used for all standard signal control cable. standard
6. Telephone Interconnect Wire - Insulation color shall be black with cloth labels placed at all connections and marked with the letters "TEL".
7. XHHW Wire - XHHW wire shall be flame retardant cross-linked synthetic polymer insulated copper wire. Wire shall be rated for 90° c dry and 75° c wet locations and be UL labeled as XHHW wire according to NEC. Wire used for traffic signal loops shall be No. 14 XHHW wire conforming to IMSA specification No. 51-3-1984.  
The telephone interconnect cable shall be twisted pairs assembled into layer or group cables. Conductors shall be No. 19 AWG (minimum size) with

heat-stabilized, moisture resistant low-loss polyethylene with a minimum thickness of 15 mils. All conductor pairs shall be fully color coded. A .002" copper tape with a minimum of 20% lap shall be applied liberally to provide a shield. The jacket covering the conductors shall be polyvinyl chloride highly resistant to abrasions, weather, moisture and corrosion. The number of pairs may be greater than that shown on the plans, but not less than 10.

7. Loop Feeder Wire - Construct loop feeder circuits of two conductor No. 14 twisted pair shielded cable conforming with UL 2106 or IMSA Specification No. 50-2-1984.
8. Inductive Loop Detector Wire - Wire used for Traffic signal loops shall be No. 14 XHHW wire conforming to IMSA Specification No. 51-3-1984.

## 501.2.06 Miscellaneous Cabinets

### 501.2.06A General

Service cabinets, ballast cabinets, supervisory circuit cabinets and terminal cabinets shall be constructed of stainless steel or 10-gauge sheet steel and shall be hot-dip galvanized after fabrication in accordance with ASTM A 385 and ASTM A 386. All cabinets shall be made weatherproof, rated as NEMA type 3R, and be constructed as shown on the plans.

### 501.2.06B Equipment Control Cabinet

Construct all cabinets, except signal controller cabinets, of stainless steel or 10-gage sheet steel and hot-dip galvanize after fabrication according to AASHTO M 111 (ASTM A 123) Cabinets shall be weatherproof, rated as NEMA type 3R, and be constructed as shown.

Have the internal wiring of cabinets done by a UL listed facility. Cabinets shall conform to one or more of the following standards where appropriate: UL 50, Cabinets and Boxes; UL 67, Panelboards; and UL 869, Service Equipment.

Use a welded conduit hub to make conduit entrances into cabinets. Hubs shall be of the size required and shall be securely welded to the cabinet before galvanizing. Malleable iron screw-on hubs may be used as approved by the Engineer. Conduit entrances from cabinets, into poles, may be from the bottom of the cabinet through an LB conduit and conduit nipple.

All cabinets with live parts exposed shall have a dead-front panel installed with cutouts for operating handles. Dead-front panels up to and including 120 square inches in size shall have a minimum of 3 holding studs. Install panels larger than 120 square inches in size using an adequate number of studs to maintain rigidity of the panel.

Construct the dead-front panels of code gage galvanized steel and treat all cut edges with zinc rich paint. Prime the dead-front panels with vinyl wash primer and finished with exterior polyurethane silver enamel.

In all wet locations, mounting pans or false backs will be required when circuit breakers, contactors, relays, switches, transformers or other types of electrical equipment are to be mounted inside the cabinet.

Label circuit breakers and equipment to indicate the circuit controlled.

Each cabinet shall have a top and bottom pole mounting bracket. Securely weld the

brackets to the enclosure and evenly space three holes at the top of the bracket. Each bracket shall have a horizontal slot on each side so it may be bent to form to a round or polygon pole or tower.

Provide each cabinet with a latching devices for a standard City of Springfield padlock.

Signal controller cabinets shall be constructed of anodized sheet aluminum as specified in 501.2.16 TRAFFIC SIGNAL CONTROL EQUIPMENT.

#### 501.2.06C Telephone Interconnect Cabinet

The telephone interconnect cabinet shall be constructed in accordance with details shown on the plans.

#### 501.2.06D Signal Circuit Overhead Terminal Cabinets

Each traffic signal pole except as herein set forth shall have a signal circuit terminal cabinet mounted as shown on the plans. A pole or pedestal with a signal control cabinet mounted thereon will not require a terminal cabinet unless such pole supports an aerial messenger cable with control cable attached.

#### 501.2.07 Poles and Standards

##### 501.2.07A General

Metal poles include towers, mast arm poles, strain poles, pedestals, posts, upsweep arms, mast arms, luminaire arms and necessary mounting appurtenances. The fabrication of metal poles from steel and other metals shall comply with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals. The Engineer will make a pre-erection visual inspection of pole welding before placing the pole. Do not erect poles until the Engineer has made a visual inspection.

Standards and poles for traffic signals and street lighting, and steel pedestals for cabinets and other equipment shall conform to the details shown on the plans or as given in the Special Provisions.

Before poles are ordered, the contractor shall submit to the Engineer, catalog cuts or approved detail drawings of poles, including anchor bolt and bolt circle information. All poles, arms, and anchor bolts shall be identified by pole number, catalog number, and contract number.

Use either steel or aluminum supports, however, either all steel or all aluminum supports must be used on a project except that illumination supports may be of different material



and design than traffic signal supports. Supports include poles, pedestals, push-button posts, upsweep arms, mast arms, and necessary mounting appurtenances. With aluminum poles, the mast arms, fittings, bolts, nuts, miscellaneous hardware, and appurtenances shall be steel except those items of signal material normally fabricated from aluminum. Poles may be round or octagonal.

All non-standard poles shall be approved by a licensed Structural Engineer approved to work in Oregon.

Orient fittings as shown on the "Pole Entrance Chart" for traffic signal appurtenances included in the special provisions.

Place a metal tag on all poles within 12 inches above the pole base plate. Stamp the gauge, outside diameter at the base, and pole height into the tag. Make tags and mounting screws of non-rusting metal. Do not paint the tags.

#### 501.2.07B Steel Poles and Standards

Steel poles, mast arms, luminaire arms, fittings bolts, nuts, miscellaneous hardware, and appurtenances shall be galvanized after fabrication according to AASHTO M 111 (ASTM A 123).

Fabricate all pole and arm entrance fittings including handholes, before galvanizing except as shown or specified for mounting traffic signal material. All pole and arm entrance fittings shall be of the type shown or specified and shall be welded into the pole and/or arm except as modified.

Circumferential welds on built-up poles shall be at least 10 feet apart. All exposed butt-welds shall be ground flush with base metal before poles are galvanized.

#### 501.2.07C Aluminum Poles and Pedestals

Material for structural support for aluminum poles and bases shall conform to the requirements of AASHTO's "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals". Fabricate aluminum poles from one piece of seamless aluminum alloy tapered tubing conforming to ASTM B 241, Alloy 6061-T6 or 6063-T6.

All aluminum pole foundations, aluminum anchor bolt circle size, et cetera, shall conform to all details shown on the plans applicable to steel standards, and shall develop same strength as specified for steel.

#### 501.2.07D Wood Poles

All wood poles shall conform to ANSI Specifications 05.1, machine shaved, Pacific Coast Douglas Fir, treated in conformance to AASHTO M 133 and its referenced AWWA Standards. Wood poles shall be treated with oil-borne pentachlorophenol with a minimum retention of 0.416 per cubic foot of dry salt.

Poles shall be round, sound, well proportioned from butt to top, without short kinks or crooks and of the dimensions specified by ANSI. Wood poles for traffic signals and street lights shall be 35 feet ANSI Class 4.

#### 501.2.07E Concrete Poles

Concrete poles shall be manufactured as a tapered concrete shaft with an appropriate base consisting of dense, high strength centrifugally cast concrete, high-tensile steel pre-stressing strands which places the shaft in compression and wire is spirally wrapped around the pre-stressing strands at a controlled pitch.

The pole shall also be manufactured and designed to conform to the appropriate standards of Edison Electric Institute - National Electrical Manufacturers Association (EEI-NEMA), American Association of State Highway Officials (AASHO), Uniform Building Code (UBC), American Concrete Institute, Pre-stress Concrete Institute and to S.U.B. requirements.

#### 501.2.08 Anchor Bolts

Anchor bolts for signal and illumination poles shall conform to the requirements of ASTM A 307 unless otherwise specified in the Special Provisions. Anchor bolts, nuts and washers shall be galvanized after fabrication in conformance of ASTM A 153.

#### 501.2.09 Frangible Aluminum Bases

Frangible aluminum pole bases shall be cast from aluminum alloy conforming to the requirements of ASTM B 108 alloy 356-T6. Walls shall not be less than 1/4-inch thick and bases and tops shall not be less than 3/4-inch thick.

Type I bases shall withstand an ultimate moment of 36,000 ft. lb.

Type II bases shall withstand an ultimate moment of 52,000 ft. lb.

Machine bolts, nuts and flat washers shall conform to the requirements of ASTM A 325, galvanized in accordance with ASTM A 153.

Vehicle Signal Pedestals - Frangible transformer bases for vehicle signal pedestals shall be used only when shown or specified. Transformer bases shall be constructed to bolt to shaft flanges. Bases shall be square with rounded corners and tapered from the base to the

top and approximately 20 inches in height. They shall be made of cast aluminum, cast iron or steel plate. Cast iron and steel plate bases shall be hot dip galvanized after fabrication according to the requirements of AASHTO M 111.

Pedestrian Signal Pedestals - Pedestrian signal pedestal bases shall be a raised, frangible type and shall be constructed of either galvanized cast iron or cast aluminum. Bases shall include a removable access plate and a threaded connection for a 4 inch standard steel pipe pedestal. The profile of the bases shall be similar to Eagle Signals catalog number UA 234, VePed-Traffic Controls catalog number O-SE-5030,

Crouse-Hins Co. catalog number 50953 or an approved equal.

501.2.10 Indication Equipment

501.2.10A General

The vehicle and pedestrian signal housings, doors and hoods shall be constructed of Aluminum or Aluminum Alloy material and shall have a smooth homogeneous finish.

A complete vehicle signal which includes: a single section head with door, lens and optical unit in-place, shall conform to the weight requirements shown in the table below. The use of ballast weights will not be allowed.

<u>Signal Section</u> (Nominal Dia.)	<u>Allowable Weight</u>	
	Max.	Min.
8"	8 lb.	3 lb.
12"	14 lb.	6 lb.

Construct the vehicle and pedestrian signal housings, doors, and hoods of die cast aluminum alloy or aluminum sheet.

The painting of aluminum signal heads shall conform to the requirements of Sub-section 501.3.11 PAINTING.

Each housing shall be of the one section expandable type. Each section shall be of one piece construction. The design shall be such that at any time and without the use of other than simple tools, it shall be possible to convert any housing into a one, two, three, four or five section housing, as may be necessary, by the addition or subtraction of housing sections. The entire housing shall be made dust-proof and waterproof. Vehicle signal heads shall have the hole in the bottom, and/or top, closed when not used for mounting purposes. A 1/4" drain hole shall be drilled in the bottom section to allow for drainage.

Lenses used in traffic vehicle signal indications shall be of the best quality glass, having the highest obtainable transmission quality and shall be free from bubbles, flaws, and other imperfections. All lenses shall conform to the ITE specifications.

Pedestrian signal lenses shall be of acrylic plastic with a minimum light transmittance of 92%. Performance characteristics of the lens as a part of the optical unit shall conform to the minimum requirements of the ITE specifications.

Construct the latching device on vehicle and pedestrian signal heads of a non-rusting metallic material, and utilize a wing nut or a positive type fastener to hold the door securely in place.

501.2.10B Lamps and Receptacles

Vehicular signal lamps shall be rated for 130 volt AC operation, and shall have a rated life of at least 8,000 hours.

The light distribution and candle power intensity from the combination of lamp, reflector, and lens for signal heads shall conform to the current ITE Standards for Adjustable Face Vehicle Traffic Control Signal Heads.

Rate the signal lamps in either watts or lumens. The following are recommended signal lamp ratings. Certification of compliance with ITE Standards shall be submitted on lamps rated for other than the recommended values.

Indication Color	8 in. Lens		12 in. Lens	
	Watts	Lumens	Watts	Lumens
Red	67-69	665	150	1950
Yellow	67-69	665	100-116	1950
Green	67-69	665	150	1950

Light center length for 12 inch signal lenses shall be 3 inches and for 8 inch signal, lenses shall be 2-7/16 inches or as recommended by the Manufacturer. Lamps shall be of the type designed to withstand vibration and intended for use in traffic signal heads. Each lamp receptacle shall be equipped with heat and moisture resistant thermoplastic insulated, color coded or marked leads of stranded wire of sufficient length to allow full movement of the hinged reflector without breaking the lighting circuits. Lamp sockets shall be of weatherproof molded construction and capable of withstanding, without deterioration, the operating temperatures encountered during operation. Design the sockets so the lamps will not become loose due to vibration.

501.2.10C Vehicular Signal Heads

The standard traffic signal heads for vehicular control shall be a one-way, three-section type head adjustable through 360 degrees about a vertical axis, and designed for the method of mounting shown on the plans or set forth in the Special Provisions.

Heads shall be furnished complete, as shown on the plans. This shall include lamps, lenses, visors, reflectors, sockets, backboards and mounting appurtenances.

If required by the Engineer, the contractor shall furnish certification from the manufacturer of the signal heads that the material of construction meet the specifications hereinafter listed.

1. Lenses - Each lens shall be illuminated independently of any other lens and shall be provided with a parabolical alzak-finish aluminum reflector or with a polished, silvered parabolical glass reflector. If required by the Engineer, the contractor shall furnish for approval, samples of the type of lenses he proposes to furnish.

Vehicular signal lenses shall be circular with a nominal diameter of 12" as called for on the plans or noted in the Special Provisions. Each lens shall be mounted in a separate door hinged to the signal housing. Position of the lenses by color, whether in vertical or horizontal mounted heads, shall be in conformance to the "Manual on Uniform Traffic Control Devices for Streets and Highways", published by the U.S. Department of Transportation. Lenses shall be mounted in an endless composition rubber gasket which completely encompasses the edge of the lens and provides a cushion and positive seal between the lens and the door. The lens and gasket shall be secured to the door by a minimum of 4 lens clips.

Lenses shall be of glass with a minimum light transmittance of 92 percent and free from bubbles, flaws and other imperfections. All lenses shall conform to ITE Specifications.

2. Doors - Each door shall be provided with a positive type non-corrosive latching device. Doors shall be properly gasketed to provide moisture proof construction and when closed, shall fit snugly against the reflector. Doors shall open and close easily with one hand.

3. Reflectors - Reflector frames shall be hinged either to the door or to the housing, so that access to the rear of the reflector may be obtained without breaking the light circuit. Each reflector shall be held firmly to its frame by suitable clips in a manner permitting lamp socket inspection without the removal of the reflector.

Removal of the reflector shall not be necessary to replace the lamps on either vehicle or pedestrian signals.

4. Optical Units - Each lens and reflector shall be of such design as to render the lens, when illuminated, clearly visible to the traffic controlled by the signal face at all distances up to 1,000 feet under all light and atmospheric conditions, except dense fog. The optical unit shall be designed with particular attention to the avoidance of reflection from the sun's rays. There shall be no appreciable sun-phantom effect even though the sun may shine directly into the lens face. The optical units shall be designed to operate with maximum efficiency when fitted with a 130-volt lamp, of the wattage specified in Section 501.2.10B.

5. Visors - Visors shall be constructed of sheet aluminum alloy 3003-H16 (ASTM B 209), nominal thickness 0.05 inch. Visors shall be easily detachable from the signal housing doors. Visors shall be of one piece construction. It shall be possible to open the

signal housing doors, with visors attached, a minimum of 90 degrees. Visors shall be provided for each vehicular signal head and shall be 8 inches in length. Tunnel visors shall be used on all vehicular signal indications. Tunnel visors shall have the bottom portions opened such that signal is visible directly in front of and below the signal head.

6. Backboards - Backboards shall be constructed of aluminum sheets alloy 3003-H14 (ASTM V 209), 0.064 inch nominal thickness. All vehicular signal heads shall be provided with backboards and shall include all of the necessary mounting hardware for completing the installation. Backboards shall be of such dimensions as to fit the signal head housings used on the project, with no gap between backboard and housing. They shall conform to the general design shown on the plans. The backboards shall have a minimum border width of 5 inches and a maximum border width of 6 inches.

7. Pedestal Mounted Indicators - Signal heads intended for pedestal mounting shall be equipped with a slip fitters to permit mounting on pedestals of 4-1/2 inch outside diameter. All slip fitters shall be constructed of cast bronze. When terminal compartments are called for on the plans or Special Provisions, they shall be included as part of the slip fitters.

#### 501.2.10D Pedestrian Signal Heads

All pertinent portions of Sub-section (c) above shall also pertain to pedestrian signal heads.

##### 1. Single Section Heads:

a. Light Source - Light source shall use an incandescent 67 or 69 watt light source. The head shall illuminate a 3-line message format with "DON'T" and "WALK" on the top and middle lines and "WALK" on the bottom line.

b. Housing and Door - The housing and door shall use a one piece housing and sealed door constructed of die cast aluminum alloy, that provides a dust-proof and weather-proof enclosure. It shall allow for easy access of maintenance of the interior components with the door open. The unit's exterior shall be painted flat black and have all exterior hardware constructed of a non-rusting, metallic material.

c. Visors - The visor shall use a one-piece z-crate or eggcrate-type polycarbonate plastic visor designed to eliminate the effect of sun phantom at low sun angles. Include vertical (or angled) and horizontal members spaced to provide the required shielding and strength. The visor shall be held securely to the door assembly.

d. Mounting - The mounting shall be designed to use either the bracket assembly

type mounting or the Clam Shell type mount as shown on the plans or described in the Special Provisions.

2. Pedestrian Symbol Indication:

Instead of the "WALK" and "DON'T WALK" lettered indications, symbols shall be used. Single-section heads shall have the "hand" symbol on the left portion of the unit.

501.2.10E Flashing Beacon Signal Heads

Flashing beacons shall conform to all applicable portions of this sub-section. They shall be of single section construction and equipped for the type of mounting shown on the plans.

501.2.10F Mounting of Heads

Mount vehicle signals on mast arms so the top of the backboard is near the center of the arm when standard plumbizers are shown.

Equip all adjustable, multi-directional type signal heads at both top and bottom with spiders, brackets, or arms assembled from 1-1/2 inch "rigid metal conduit" and fittings.

Furnish plumbizers with 3 set screws, and install them over the end of the arm or over welded couplings. Use a bolt to fasten the plumbizer to the mast arm or coupling.

Drill and tap set screws through the first wall of conduit used in signal mountings. Extend the conduit at least 1/2 inch beyond the set screw. Where the tap set screws through the first wall of conduit used in signal housing, place a non-hardening silicon, caulking compound, or approved equal, around the bracket to make a watertight seal.

Equip span wire mounted heads for overhead feed. Use span wire mounted signals with a span wire hanger similar in design to that shown on the plans. Install with an extension of 1-1/2 inch "rigid metal conduit" between the top of the signal and the overhead span wire hanger, so the bottom of all adjacent vehicular signal heads are within a 6" horizontal plane. Mount signal heads at the height shown on the plans or in the Special Provisions.

Elevation of vehicle signal heads on mast arms and span wires shall be based on the elevation of the bottom of the backboard. No signal head shall be less than 17'6" feet or more than 19'0" above the pavement, to the bottom of the backboard.

Vehicle signal heads mounted on poles or pedestals shall be 11'6" to 12'6" above the roadway or as specified in the plans or Special Provisions.



Use locknuts and lock washers on bolts and hangers which extend through and are secured inside the signal head housing.

Mount signals located on poles or pedestals with a bracket assembly, which includes a terminal compartment, and is constructed of 1-1/2 inch rigid metal conduit and fittings. The bracket assembly shall include all hardware necessary for correct placement of the signals, as shown on the plans. Paint the bracket assembly with two coats of aluminum paint.

Use bracket arms for pedestrian or vehicle signals long enough so when the heads are properly aligned, visibility of the signal is not obstructed by the poles, and the heads may be opened fully for maintenance.

Each terminal compartment shall:

- ! Be cast bronze
- ! Have a flanged, gasketed door.
- ! Contain a terminal block with at least 10 pressure type terminals.

Use pole mounted bracket assemblies with a flanged wiring entrance and two mounting holes through the back of the terminal compartment. Drill a hole in the pole which provides a slip fit opening for the flanged wiring entrance in the terminal compartment.

Provide pedestal top mounted bracket assemblies with a 4-1/2 inch slip fit adapter included as part of the terminal compartment.

Pedestal, side mounted, bracket assemblies shall be the same as specified for pole mounted bracket assemblies.

Pedestrian signals may be mounted on poles utilizing a terminal compartment that is hinged to the mounting bracket. The pedestrian signal head may be an integral part of the terminal compartment assembly.

The vehicular signal heads shall be so designed that they can be suspended from mast arms or span wires, or mounted on brackets or pedestals as may be required by the plans. They shall be equipped with positive lock rings and fittings designed to prevent the heads from turning due to external forces. Heads shall be equipped with all necessary appurtenances for the type of mounting that is required by the plans or Special Provisions.

### 501.2.10G Programmed Visibility Vehicle Signals

Programmed visibility vehicle signals shall be furnished complete and shall conform to all applicable portions of Sub-section 501.2.10. (Indication Equipment) and 501.3.14 (Indication Equipment and Signs). A complete vehicle signal shall include the required number of signal sections with optical components, individual intensity control cutaway visor, backboard and mounting hardware.

Each programmed visibility signal section shall provide a nominal 12-inch diameter circular or arrow indication. Color and arrow configuration shall conform to ANSI Standard: D-10.1.

Each section shall be provided with a sun visor.

1. Optical System - Optically programmed vehicle signal shall:
  - ! Be possible to selectively program the visibility zone of the projected indication anywhere within 15° of the optical axis of each signal section.
  - ! Include an easily accessible visibility-limiting device which can be programmed to restrict the viewing area of the projected indication without the use of hoods or louvers.
  - ! Include an integral means for regulating the intensity of the projected indication as a function of the ambient light conditions. The reduction in lamp intensity shall be proportional to the reduction in ambient light within the following limitations:
    - ! If ambient light is 1,000 footcandles or more, the lamp intensity to approximately 97 percent of maximum.
    - ! If ambient light is 1 footcandles or more, the lamp intensity to approximately 15 percent of maximum.
2. Installation - Provide a technically certified representative that shall:
  - ! Program the visibility-limiting device as outlined by the signal manufacturer with a sufficient supply of any special materials.
  - ! Program the signals satisfactorily before placing the signal installation in operation.

Each signal section shall be provided with an adjustable connection that permits

incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mountings. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments.

The signal shall be mountable with ordinary tools and capable of being serviced without tools. Adjustment shall be preset at 4 degrees below the horizontal, unless otherwise specified.

The visibility of each programmed visibility signal face shall be capable of adjustment or programming within the face. When programmed, each signal face's indication shall be visible only in those areas or lanes to be controlled, except that during dusk and darkness a faint glow to each side will be permissible.

#### 501.2.11 Traffic Control Signs

##### 501.2.11A General

Type and method of mounting will be indicated on the plans, in Standard Drawings or in the Special Provisions. Span wire mounted signs shall be provided with a hanger that will permit both vertical and horizontal adjustments.

##### 501.2.11B Advance Warning Signs

Sign message shall be as shown on the plans. If called for on the plans, the sign shall be complete with a flashing beacon unit and/or floodlights.

The flashing beacon shall be a one-way single section head designed for rigid conduit mounting as shown on the plans. The head shall conform to applicable portions of Sub-section 501.2.10 (Indication Equipment). Solid state flasher mechanisms shall be used for flashing the beacon at the advance warning signs. Such units shall be rated to provide the flashing operation required but not less than 20 amperes. Flasher mechanisms shall be jack-mounted. The mechanism shall be installed on the controller cabinet wall and have a labeled "ON-OFF" switch for controlling power to the flashing beacon and/or floodlight.

If the flasher mechanism is to be located in the controller cabinet, all sign flashers shall use one mechanism. If the loading (20 amp), specified above, is not exceeded, the same flasher mechanism may be used for flashing the intersection signal lights.

##### 501.2.11C Overhead Interior Illuminated Signs (Fluorescent)

The sign shall be designed for span wire, bracket, bridge or mast arm mounting as called for by the plans or Special Provisions. Sign legends shall be as shown on the plans or

called for in the Special Provisions.

1. Cabinet Construction - Cabinets shall be constructed from sheet aluminum alloy 6061-T6 (ASTM B 209) of the thickness and according to details shown on the plans. All joints and miters shall be welded. All bends shall be made true to line and angle and all parts shall fit together accurately. Angles forming the slide for plastic fronts shall be mounted in the top of the cabinet in such a manner as to make a watertight joint. Fluorescent tube sockets and ballasts shall be mounted as shown on the plans. A 1/2-inch standard entrance cap shall be mounted through the side of the cabinet for span wire mounted signs. Use mounting hubs for all mountings on span wires, mast arms, and poles. Construct mounting hubs of cast aluminum, cast bronze, or malleable iron. Use a span wire signal hanger with cable clamp for mounting signs on span wires. Tether all interior illuminated signs on span wires as shown.

Top and bottom holding brackets shall be fastened with 1/8-inch aluminum screws and nuts or as shown on the plans.

2. Sign Face - The sign face shall be fabricated from 1/8-inch white translucent acrylite plastic with a luminous transmission of 28 percent. Lettering shall be applied to the sign face by the silk screen process with 0/0/00 ... 0:13:15 black sign lacquer.

3. Service - The service for overhead interior illuminated signs shall conform to the Subsection 501.3.19 SERVICE FOR INTERNALLY ILLUMINATED SIGNS.

#### 501.2.11D Overhead Interior Illuminated Signs (Neon Tube)

The neon tube sign shall be designed for the type of mounting shown on the plans. The sign legend, as called for on the plans or the Special Provisions, shall be red and shall be applied on the inside of the sign face by the silk screen process. Material for the sign face shall be as specified above for fluorescent tube signs. Mounting appurtenances shall be furnished with each sign.

1. Cabinet Construction - Cabinets shall be constructed of sheet aluminum alloy 6061-T6 (ASTM B 209), nominal thickness 0.215. The construction of the cabinet shall conform to the details shown on the plans. All screws, nuts and bolts used in assembling the cabinets shall be aluminum. All interior braces and supporting clips shall be aluminum. The back of the sign shall be constructed so that removal may be accomplished with the use of simple hand tools.

The mounting hub at the top center of the sign may be constructed of cast aluminum, cast bronze or malleable iron.

2. Tubing - Two neon tube grids shall be supplied with each sign. in addition, a

template of the neon grid tubing shall be furnished for each sign. All tubing shall be properly heated, formed and annealed to eliminate strain and stress after being formed. Tubing shall be made in one section of best quality hard drawn, heat resisting lead base glass. Bends shall not be drawn thin enough to cause checks or cracks after short periods of operation. After processing, the tubing grid shall be jack-mounted to the sign in such a manner as to completely insulate tubing from the metal body and so anchored as to relieve the tubing from strain and mechanical vibration. Tubing shall be 10 mm clear, with neon content.

3. Tube Processing - Exhaustion and filling of the neon tube shall be done by the balanced pressure system to insure long life and balance of the electrical circuits. Before installation for continued use, all processed tubing shall be thoroughly tested.
4. Electrodes - Electrodes shall be of the ceramic capped non-sputtering type containing previously degasified metal electrostatic shields. Electrodes shall be designed to operate at 3 ma.
5. Transformers - Only the best quality transformers of standard manufacture shall be used. Transformers shall bear the label of the UL. They shall be of the weatherproof encased type rated at 7,500 volts, 30 ma secondary and 100 volts primary, high power factor corrected.
6. Fusing - Fusing for neon tube signs shall be mounted on the inside wall of the sign cabinet. A medium base receptacle and a 5-ampere fuse shall be installed and wired in the sign circuit primary input to the ballast.

#### 501.2.11E - Overhead Retro-Reflective Signs

Overhead retro-reflective signs shall be constructed of Diamond Grade (3M Brand) or equivalent sign material.

#### 501.2.12 Luminaire Ballasts

Unless otherwise called for, the ballast shall be an integral part of the luminaire unit. It shall be of the pre-wired, built-in type mounted in the luminaire with a holder. The ballast shall provide regulation within plus or minus 5 percent variation in lamp watts with a plus or minus 10 percent variation in primary volts from the ballast voltage design center. Ballasts shall provide sufficient open circuit voltage to start lamps at a temperature down to minus 20 degrees Fahrenheit.

Ballasts shall be either 120/240 volt input or 208/277 volt input, as specified in the Special Provisions. Ballasts voltage shall be easily selectable by means of field re-connection.

Low pressure sodium lamp ballasts shall be compatible with low pressure discharge lamps of the size and type shown on the plans. This item is subject to the Engineer's approval.

A manufacturer's name plate shall be an integral part of the housing. The name plate shall have the manufacturer's name, model number, hook-up diagram, power supply data and the load in watts that the control unit is capable of operating.

#### 501.2.13 Luminaries

Luminaries shall be as specified in the plans and may be low pressure sodium or high pressure sodium shall be used for decorative street lights only.

##### 1. Low Pressure Sodium

Low pressure sodium luminaire housing shall be constructed of acrylonitrile-butadiene-styrene (ABS) 3/32" nominal wall thickness joined by integral hinge pins at the mounting ends with single captive retainer for ballast compartment cover releasing. All external surfaces shall be protected with a fused layer of ultra violet inhibiting Korade Film. The cast aluminum supporting frame shall provide a mounting for all electrical components as well as tenon (mounting arm) fixing.

The luminaire finish shall be aluminum gray. All hardware shall be stainless steel or cadmium plated. The reflector shall be internally surfaced with ABS gloss white with a reflective factor of 88%. The refractor shall be prismatic (injection molded acrylic) hinged and secured with spring latches for rainwater tightness. The lamp socket shall be latches for rainwater tightness. The lamp socket shall be adjustable to three positions for proper light distribution.

All gaskets shall be of high temperature neoprene rubber. A sealing ring shall be installed in the mast arm opening to prevent entry of insects into the ballast and optical assemblies. A slip fitter shall allow leveling adjustment and provide two position securing by means of locking bolts and locating clamp. The maximum projected area shall be 2.52 sq. ft. (90 W and 135 W luminaries) 3.07 sq. ft. (180 W luminaries).

The luminaire shall be supplied with an EE1-NEMA standard three terminal, twist lock type photoelectric control.

The reflector and refractor, or optical unit, shall be designed and constructed to prevent the entrance of dust moisture and other materials. The luminaire shall meet all illumination requirements of the American Standard Association for Roadway Lighting. Replacement parts shall be of a common type and readily available.

Low pressure sodium lamps shall be designed for horizontal operation and shall be provided for single end, bayonet base mounting in the luminaire unit. Lamps shall be

dimpled "U" bend discharge tube.

90 watt low pressure sodium lamps (SOX 90) shall conform to ANSI Code L72RD-90 and shall have a minimum lumen rating of 12,500.

135 watt low pressure sodium lamps (SOX 135) shall conform to ANSI Code L73RE-135 and shall have a minimum lumen rating of 22,500.

180 watt low pressure sodium lamps (SOX 180) shall conform to ANSI Code L74RF-180 and shall have a minimum initial lumen rating of 33,000.

## 2. High Pressure Sodium

Luminaries shall be 100 watt, 120 volt operation, with an internal ballast providing a normal power factor.

The lamp socket shall be a porcelain enclosed mogul-multiple type. The shell shall contain integral lamp grips to assure electrical contact under conditions or normal vibration. The socket leads shall be welded to the screw shell and spring-loaded center contact. The socket shall be rated for 1,500 watts and shall withstand 6-kilovolt high potential test. The socket shall be labeled to provide lamp wattage and type.

Luminaire housing shall be die-cast aluminum with an access door providing direct exposure to all electrical components. The housing shall be equipped with a pole top slipfitter adjustable by three set screws to fit top tenons from 2 3/8 in. to 3 in. O.D.

All components shall be pre-wired to a single terminal strip assuring that field connections are clearly identified. The terminal strip shall have protective barriers between each terminal. The terminal screws shall be captive and shall be equipped with wire grips for wire up to AWG 8.

The luminaire shall be provided with a hood of spun aluminum which is attached to the housing above the refractor by a stainless steel hinge and secured by a stainless steel captive screw. The fixture shall be sealed between the hood and base with a polyester fiber gasket. The hood shall be style "D".

The refractor shall be an acrylic prismatic type and shall be gasketed at both ends to reduce contamination. The refractor shall produce a type II I. E. S. light distribution pattern.

The luminaire housing and hood shall be finished in black.

The luminaire shall be provided with a standard, three-terminal EEI-NEMA photoelectric

control receptacle, mounted on top of the hood. The wire leads shall have a quick disconnect in-line connector that will allow quick removal of the hood/pec assembly from the fixture.

Acceptable manufacturers and types, or equal:

ITT American Contempo 250-Style "D" in black.

Bieber HER-100 HPS-120 type III Black with style "D" top and a 3 pin quick disconnect connector in the photo cell wiring.

#### 501.2.14 Decorative Street Lights

Decorative street lights may be installed where specified. Acceptable Manufacturer types:

Ornamental Post-Georgetown Series 408 manufactured by W.J. Whatley Inc. or equivalent:

##### 1. General Description

The fiberglass lamp post shall be round, hollow, and have a .20 per foot tapered shaft with 16 flutes. The lamp post top diameter shall be minimum of 4.5" O.D. The post shall be non-conductive and chemically inert.

##### 2. Installation Data

Anchor base posts will use electro galvanized steel anchor bases. The anchor base shall be bonded to the post with high strength epoxy adhesive and coated with matching urethane finish. The anchor base plate shall have four 2" X 1" slotted holes at 90° to accommodate 3/4" X 21" X 3" anchor bolts. The anchor bolt circle shall be 9" - 11".

##### 3. Post Shaft Construction

**Outer Fluted Shell:** An outer fluted shell be constructed of advanced RP/C composites and incorporated with the inner filament wound structural member to form a high strength shaft.

**Inner Structural Member:** The post inner structural member will be constructed from continuous fiberglass filaments combined with thermosetting polyester resin.

The fiberglass and resin ratio of the inner structural member will contain at least 65% glass, the balance polyester resin.



The glass filament will be helically-wound under tension first at a relatively high angle (65-85 degrees) to the longitudinal axis of the structural member with alternate layers of filaments in opposite directions for minimum circumferential (compressive) strength.

The structural member shall have a minimum wall thickness of 5/32. The post shall have a tapered wall increasing in thickness from the top to base in proportion to the load and ground line moment requirements. The structural member will be reinforced in areas of handholes.

#### 4. Performance Criteria

The post shall be designed with a minimum safety factor of 2:1 and have no more than 10% deflection at full wind loading.

The post shall deflect no more than 4% of the above ground length with 100 lbs. of top load. The post shall withstand 550 lbs. of top load without failure.

#### 5. Post Top

Tenon Style: A steel tenon will be firmly bonded to the post for mounting a post top luminaire. The steel tenon will be straight with no taper. The tenon will be coated with matching urethane finish.

#### 6. Wire Entrance

The anchor base post shall have a wire entrance hole of 4.0" I.D.

#### 7. Finish

The surface of the post shall be uniform and consistent for the entire length of the post.

The resin shall contain pigment to match the finish coat of the post. Solid coloration will be throughout the RP/C structure of the post.

The finish coating will be a pigmented urethane finish capable of withstanding exposure to ultraviolet, chemicals, and extreme weather conditions.

The surface coating will be minimum dry film thickness of 1-1/2 mils.

#### 8. Handhole

The handhole shall be 2 1/2" round (not available on model #407). The handhole cover shall be non-corrosive metal and painted to match the post. The handhole cover shall be

concealed by the ornamental slip-over decorative base cover.

9. Ornamental Base Cover

An ornamental decorative base cover shall be one piece and constructed of fiberglass and painted to match the post. The base cover will be attached to the post with stainless steel hex socket locking screws.

The luminaire shall be a 100 watt HPS lamp with external optics/acrylic ripple globe. A KA5 AMHERST capital pole adapter shall be used model K118-EAR-11-100-HPS-120-K12-PR.

Luminaire shall have a twistlock photo electric cell.

All decorative street lights shall be installed according to the manufacturer recommendations and special provisions. When installing ornamental posts an anchor base foundation is required.

## 10. Luminaire Arms for Wood Poles

Luminaire arms for wood poles shall be hot-dipped galvanized steel and shall be constructed in accordance with ASTM specification A-36. Arms shall be upswept and formed from 2-inch steel pipe. Standard mounting brackets shall fit all wood poles. The arm length shall be as shown on the plans, and shall be designed to support a luminaire with an effective projected area of 4.0 square feet and a weight of 80 pounds.

### 501.2.15 Fused Splice Connectors

The splice connector shall completely enclose the fuse and shall protect the fuse against damage from water and weather. The contact between the fuse and fuse holder shall be by spring pressure. The terminals of the splice connector shall be rigidly crimped, using a tool of the type recommended by the manufacturer of the fused splice connector, onto the line conductors and the conductors to the ballasts and shall be insulated and made waterproof in accordance with the splice connector manufacturer's recommendations.

Fuses shall be standard midget, ferrule type.

For circuits using more than one phase, each connector shall be designed so that all ungrounded conductors are disconnected simultaneously. The connector shall have no exposed metal parts, except the head of a stainless steel assembly screw may be exposed. The head of the metal assembly screw shall be recessed a minimum of 1/32 inch below the top of a plastic boss which surrounds the head.

### 501.2.16 Traffic Signal Control Equipment

The traffic signal control devices shall conform to requirements of the current edition of the "Standard Specifications for Microcomputer Signal Controller", Oregon Department of Transportation, Highway Division, except as supplemented and/or modified by the Special Provisions.

### 501.2.17 Fire Preemption System

The Fire Preemption System shall be compatible with, and operate on demand of the City of Springfield owned "Opticom" emitter assemblies which are manufactured by the Traffic Control Products Division of the 3M Company.

The system shall include:

! all required discriminator modules, detector feeder cable, wiring harness, interface circuitry, and miscellaneous hardware. phase selectors, detector units,

detector feeder cable, wiring harnesses, interface circuitry and miscellaneous hardware required to provide for preemption of the signal installations as shown on the plans and called for by the Special Provisions.

- ! An "Opticom" Model 562 Discriminator Module, with all Model 170 traffic signal controllers.
  - ! Have detector feeder cable of the type and size recommended by the supplier of the preemption equipment.
  - ! Have cable that runs continuously without splicing from the detector unit to the controller cabinet.
  - ! Not have emitter units, included as part of the system.
1. The controller cabinet shall be factory wired for installation of the required preemption equipment.
  2. The detector feeder cable shall be of the type and size recommended by the manufacturer and be continuous from the detector to the controller cabinet.
  3. "Opticom" emitter assemblies shall not be furnished as part of the project.

Other materials required for the complete installation of the system shall be as called for herein, on the plans or in the Special Provisions.

### 501.3.00 CONSTRUCTION AND INSTALLATION

#### 501.3.01 General

All construction shall be complete and in accordance with the plans, specifications, and Special Provisions as determined by the Engineer. Failure of the Engineer to note faulty workmanship and/or materials during construction shall not relieve the contractor of the responsibility for correcting the faults at no cost to the City of Springfield.

#### 501.3.02 Maintaining Existing and Temporary Electrical Systems

Existing electrical systems (traffic signal, street lighting, flashing beacon and sign illumination), or approved temporary replacements thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted, to allow for alterations or final removal of the systems. The traffic signal shutdowns shall be limited to periods during normal working hours, or shall be as specified in the Special Provisions. Lighting system shutdowns shall not interfere

with the regular lighting schedule, unless otherwise permitted by the Engineer. The contractor shall notify the Engineer prior to performing any work on existing systems.

The Engineer shall be notified 48 hours prior to any operational shutdown of a traffic signal or street light.

The City will continue operation and maintenance of existing electrical facilities.

Where damage is caused by the Contractor's operations, the Contractor shall, at his expense, repair or replace damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any moneys due or to become due the contractor.

The exact location of all existing public facilities shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

Temporary electrical installations shall be kept in effective operation until the temporary installations shall conform to the requirements of the Special Provisions.

#### 501.3.03 Scheduling of Work

A project work schedule shall be submitted to the Engineer at the Pre-construction meeting as required in the Special Provisions. There will be no separate payment for developing, furnishing, monitoring, or updating required schedules as payment will be included in each of the items in the bid schedule.

The schedule is essential to the Division. The Contractor's failure to provide the schedule, schedule information, progress reports, or schedule updates at the times required will be cause to suspend the work or to suspend contract payments until the required data is provided to the Engineer.

Work shall be so scheduled that each traffic signal, street lighting and sign system shall be completed and ready for operation prior to opening the corresponding section of the roadway to traffic, unless otherwise ordered by the Engineer.

Traffic signals shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or

is being installed in conjunction with the traffic signals, unless otherwise ordered by the Engineer.

Traffic signals shall not be placed in operation until the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

Street lighting and traffic signals shall not be placed in operation, including flashing operation, prior to commencement of the functional test period specified in 501.2.20B (Field Testing and Turn-On), unless ordered otherwise by the Engineer.

Conductors shall not be pulled into conduit pull boxes that are not set to grade with crushed rock sumps installed, and metallic conduit bonded.

#### 501.3.04 Excavation

##### 501.3.04A General

It will be the responsibility of the Contractor to make the necessary contacts with utilities and others who have underground facilities in the project area to determine locations of said facilities prior to making any excavations. Any damage to existing facilities shall be repaired by the Contractor at his own expense. Any underground pipes which are exposed and which become a part of the foundation shall be wrapped with a heavy grade tar or roofing paper prior to pouring the foundation.

The Contractor shall do all excavation, back-filling and resurfacing work, including removal and replacement of curbs, sidewalks, paved surfaces and other materials necessary to complete the work in accordance with the plans and specifications.

Excavation work shall conform to all applicable portions of Sections 301 EXCAVATION and 401 TRENCHING BACKFILL.

In making excavations in paved surfacing, cuts shall be made with a concrete saw to a minimum depth of 2 inches along the neat boundaries of the area to be removed, unless other methods are approved by the Engineer. T-cut, crack seal. Refer to backfill and resurfacing trench area.

All landscaping and underground utility systems disturbed by the Contractor shall be returned to original condition by the Contractor at his expense. The Contractor shall use "hand methods" to excavate if so directed by the Engineer.

##### 501.3.04B Excavation for Conduit

Unless specified on the plans, or special provisions, the contractor shall be required to "push" conduit under existing streets.

The open trench method of conduit installation under existing pavement shall be allowed by approval of the Engineer only. The open trench method shall be subject to the following conditions:

1. The trench shall be held to a practicable minimum width.
2. Cuts in the existing pavement shall be clean, straight, vertical cuts. T-cut 1-foot.
3. The trench shall be back-filled with Control Density Fill (CDF) to an elevation of three inches below the top of the existing pavement. The top four inches or existing depth, whichever is larger, shall be finished to provide a smooth riding surface.
4. Controlled Density Fill (CDF) shall conform to the specifications in Sub-section 405.2.04 CONTROLLED DENSITY FILL (CDF).

#### 501.3.04C Excavations for Pole and Pedestal Foundations

All excavations for pole and pedestal foundations shall be made to the neat lines of the foundations. The concrete shall be placed directly against the sides of the excavation. On completion of the work, all surfaces shall be replaced and finished to correspond with the existing surfaces.

Excavations for all steel reinforced concrete pile pole foundations shall be augured, unless otherwise directed by the Engineer.

#### 501.3.04D Disposition of Waste Materials

On completion of the work or as required by the Engineer, all waste material shall be hauled away or disposed of in a manner satisfactory to the Engineer and the site cleaned up and left in a neat and presentable condition.

#### 501.3.05 Foundations

##### 501.3.05A General

Foundations shall be constructed to conform to the details as shown on the plans. All foundations shall be constructed with portland concrete, Class 3300, as specified in Section 311 CONCRETE STRUCTURES or as required in the Special Provisions.

Anchor bolts shall conform to the details shown on the plans or given in the Special Provisions. If aluminum poles are used, the anchor bolts, nuts and washers shall be as specified for steel poles.



All excavations for foundations shall be clear of ground water before the foundation is poured.

Reinforcing steel shall be placed at a minimum of 3 inches clear of surrounding soil. All reinforcing steel shall conform to ASTM A 615 grade 60 and shall be lapped 32 diameters at all splices.

All exposed portions of concrete structures shall be finished to present a neat appearance. The exposed foundations for poles, pedestals and posts shall be finished square, with all holes filled, and the concrete surfaces finished smooth. The elevation of foundations shall be as ordered by the Engineer. Where breakaway or frangible bases are specified, such elevations shall not exceed 4 inches above grade.

Before pole foundations are poured, the Contractor shall submit to the Engineer catalog cuts or approved detail drawings of poles, including anchor bolt and bolt circle information. All poles, arms and anchor bolts shall be identified by pole number or catalog number.

#### 501.3.05B Poles, Pedestal and Post Foundations

The concrete foundations shall rest on solid ground. Concrete foundations shall be installed with a continuous pour. Forms shall be true to line and grade. Tops of foundations shall be finished to roadway grade, sidewalk grade, or as directed. Forms shall be rigid and shall be held in place until the concrete has set. Conduit ends and anchor bolts shall be placed in proper position and to proper height, and shall be held in place by means of a template until the concrete has set.

All steel reinforced concrete pile foundations shall be thoroughly and mechanically vibrated. Foundations for posts standards and pedestals shall be placed monolithically, except for the top 4 inches which may be placed after the post, standard, or pedestal are in proper position.

Standards shall not be erected on steel reinforced concrete pile foundations until the concrete has reached a laboratory test breaking strength of 3300 lbs/psi.

The upper threaded portion of all anchor bolts shall be provided with 2 nuts and 2 washers each.

Welding shall not be performed on any portion of the body of anchor bolts.

Plumbing of the lighting standards shall be accomplished by adjusting the leveling nuts before placing mortar or before the foundation is finished to final grade. Shims or other similar devices shall not be used for plumbing or raking of posts, standards or pedestals.

Both the forms and the ground that will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Where obstructions prevent the construction of a planned foundation, the Contractor shall construct an effective foundation as directed by the Engineer.

Unless otherwise shown on the plans, all standards to be relocated shall be provided with new foundations and anchor bolts of the proper type and size.

Posts, poles, standards, and pedestals, except those to be mounted on steel reinforced concrete pile foundations, shall not be erected until the foundation has reached the specified test strength and shall be plumbed or raked, as directed by the Engineer.

In unpaved areas, a raised pad of portland cement concrete of the size shown on the plans shall be placed in front of each controller cabinet.

When a foundation is to be abandoned, the top of foundations, anchor bolts, and conduits shall be removed to a depth of not less than 0.5-feet below surface of sidewalk or unimproved ground. The resulting hole shall be backfilled with material equivalent to the surrounding material.

#### 501.3.05C Special Foundations

Special foundations not shown on the plans shall conform to applicable portions of the specifications listed hereinabove or as called for in the Special Provisions.

#### 501.3.06 Conduit

##### 501.3.06A General

Conduit runs shown on the plans are for bidding purposes only and may be changed as to location with approval of the Engineer to avoid obstructions. All conduit shall conform to subsection 501.3.06 CONDUIT of these specifications.

It shall be the option of the contractor, at his expense, to use conduit of larger size than specified. If used, it shall be for the entire length of the run from outlet to outlet. Reducer couplings will not be permitted. All underground conduit runs and conduit risers on poles shall be installed as needed even though not shown on the plans.

The Contractor shall place adequate junction boxes as required to facilitate wire pulling. The maximum conduit run between two junction boxes shall not exceed 190 feet. A conduit run shall be continuous between any two poles or junction boxes. Location of

conduit and junction boxes shall be given to the Engineer.

The conduit end for traffic signal detector loops shall be placed as close as possible to and under the curb or pavement edge. All conduit joints, ends and connections shall be made moistureproof.

All conduit to be placed in areas to be paved or landscaped shall be in place prior to paving or landscaping wherever possible.

It shall be the option of the Contractor to use P.V.C. schedule 40 heavy wall conduit in lieu of galvanized rigid metal conduit except under roadways and/or grade crossing, unless specified otherwise.

If P.V.C. is used, the Contractor shall provide a bond wire between all poles, pedestals, posts, and cabinets. The bond shall be not less than bare No. 6 copper wire with terminations made with grounding lugs. The contractor shall also provide "tracer" wire along entire length of PVC conduit.

#### 501.3.06B Underground Conduit Installations

A conduit run must be continuous between any 2 poles or junction boxes and cabinets. Permanently mark all underground conduit runs by installing an underground marking tape directly over the conduit.

The underground marking tape shall be:

- ! A red polyethylene film, 6 inches wide, and at least 4 mils thick.
- ! Imprinted with the following or similar legend:  
**CAUTION CAUTION CAUTION BURIED ELECTRIC LINE**
- ! Placed 6 inches below the surface, plus or minus 1 inch.
- ! Continuous between pole bases, junction boxes, and cabinet locations.
- ! Omitted in roadway areas, if allowed.

Do not cover conduit runs until inspected, unless prior approval to proceed is given. Before pulling a polyethylene line or conductors through underground conduit, blow out the conduit with compressed air.

Where a conduit bend is required, it shall normally be a standard factory bend. Where factory conduit bend sizes are not commercially available, or at those locations requiring special bends, bends performed on the job or in the shops shall have a radius of not less than six times the inside diameter of the conduit. The conduit shall be bent without crimping or flattening.

Underground conduit sizes shall not be less than shown on the plans. In no case shall the

size for underground conduit be less than 1-1/2 inches diameter.

The minimum depth for underground conduit shall be 30 inches in roadway areas and 24 inches in other areas, or shall be as specified in the Special Provisions.

Conduit shall be installed such that the number and degrees of bends in each conduit run is as few as possible. In no case shall the sum of all the bends in any single conduit run exceed 270° unless otherwise approved by the Engineer. All conduit bends shall be made of rigid steel regardless of conduit material.

#### 501.3.06C Conduit Under Pavement

Conduit to be installed under existing pavement shall be installed by jacking or drilling methods. Jacking and drilling pits shall be no closer than two feet to the edge of the pavement or curb whenever possible. Excessive use of water, such that the pavement might be undermined or the base softened, will not be permitted.

The open trench method shall only be allowed when specified, or when directed by the Engineer. Such method shall conform to Subsection 501.3.04B EXCAVATION FOR CONDUIT.

Conduit under roadways and grade crossings shall not be less than 2 inch diameter and shall be rigid metal unless otherwise specified.

#### 501.3.06D Conduit Ends

The ends of conduits shall be cut square and true so that the ends will butt or come together for the full circumference thereof. All couplings shall be tightened wrench tight, providing a good electrical connection throughout the entire length of the run. Slip joints or running threads will not be permitted for coupling conduit.

All conduit ends shall be threaded and capped with standard conduit caps until wiring is started. When caps are removed, the threaded ends of all conduit, including conduit nipples in cabinets, shall be provided with a steel or cast aluminum conduit ground bushing having a smoothly rounded molded insulated insert. Use insulated metallic bushings on all conduit ends, whether metal or PVC. Ground bushings where the conduit contains AC circuits; bushings on conduits containing only DC circuits need not be grounded. Bond conduit end bushings to the equipment ground wire, and connect the grounding bushings in the metal pole to the pole grounding lug with a jumper.

On open conduit ends below ground, the Contractor shall furnish and install a non-hardening compound that will prevent the entrance of moisture.

Field or shop cut threads, ends, and damaged surfaces on metal conduit shall be painted with a high-zinc dust content paint conforming to the requirements of military specification MIL-P-21035 or with a zinc-high primer of equal corrosion resistance qualities.

Cuts of conduits shall be reamed to remove burrs and rough edges. When a standard coupling cannot be used for coupling metal type conduit, an approved threaded union coupling shall be used.

#### 501.3.06E Conduit in Junction Boxes

Conduit entering the sides of junction boxes shall terminate approximately 1 inch inside the box wall. Conduit entering through the bottom of the junction boxes shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduits shall enter from the direction of the run. Conduit terminations in pull boxes shall be sloped toward the top of the box to facilitate pulling conductors.

Conduits with AC and DC voltage inside junction boxes or other cabinets shall be bonded.

Conduit entrances into cast iron junction boxes:

- ! Shall be drilled and tapped at least 3-1/2 full threads for the size conduit used. Provide steel bosses where wall thickness is not sufficient for the minimum number of threads.
- ! May use a watertight malleable iron hub for metal conduit entrances.
- ! Shall use a watertight malleable iron hub when NEMA 3R or NEMA 4 junction boxes are specified.
- ! Shall enter through the bottom of boxes where possible. Shall enter the box from the direction of the run. Shall terminate 1 inch inside the box wall when entering through side walls.
- ! Shall have factory 90° ells of metal conduit.

#### 501.3.06F Conduit in Foundations

Use rigid metal or intermediate metal conduit and extend it 2 to 3 inches above the top of the cabinet foundations or pole anchor bolts and 10 to 12 inches beyond the bottom or side of controller of pole foundations.

Install the ground and/or bond conductor conduit on the side of the foundation adjacent to the driven ground rod. Terminate it at least 6 inches below the finished grade at the ground rod location.

Group conduits in foundations so, with pole in place, it is possible to place an insulated

bushing on each conduit end. If pole is breakaway, insert-type, do not extend the conduit above the slip plane of the base.

Where more than one device is on the same pole, place the conduit for all electrical circuits in the foundation, as required by the plans and specifications.

Conduit from a pedestrian push button post to the adjacent pull box shall be one inch minimum diameter. Conduit from a signal pole or a controller cabinet to the adjacent pull box shall be 2 inch diameter or larger.

#### 501.3.06G Conduit on Wood Poles

Conduit shall be mounted on City owned wood poles by use of two-hole malleable conduit clamps spaced a maximum of 3 feet apart. All conduit on wood poles shall be rigid steel.

Conduit to be mounted on utility owned wood poles shall be mounted according to the local utility regulations. This may call for use of stand-off brackets.

#### 501.3.06H Conduit on Metal Poles

Conduit to be mounted on metal poles shall be mounted by use of 3/4-inch stainless steel band straps. After steel bands have been drawn tight, the ends shall be cut and folded under to eliminate protruding edges. Bands shall be placed a maximum of 3 feet apart.

#### 501.3.06I Existing Conduit

The Contractor shall utilize existing conduit only where shown on the plans. Existing conduit, without conductors, to be incorporated in a new system shall be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air. Where new junction boxes are placed in existing conduit runs, the conduit shall be fitted with ground bushings, as specified in 501.3.06D CONDUIT ENDS above, and the bushings bonded to each other.

#### 501.3.06J Expansion Joints

Where called for on the plans or as needed, Type "AX" conduit expansion joints with bonding jumper where conduits cross bridge and other expansion joints shall be installed in conduit runs. The expansion joints shall be installed in conduit runs. The expansion joints shall permit an 8 inch conduit movement on steel structures and a 4 inch conduit movement on concrete structures.

Expansion-deflection fittings shall consist of 2 silicon bronze couplings and a molded



neoprene sleeve with a bonding jumper passing through a separate waterproof compartment. Fittings shall permit at least 3/4-inch expansion and contraction and a 3/4-inch deflection without deformation.

#### 501.3.07 Pull Boxes

Pull boxes shall conform to the details as shown on the plans and to Subsection 501.2.04 PULL BOXES of these specifications.

Pull boxes shall be installed at the locations shown on the plans or, in long runs, they shall be spaced at not over 190-foot intervals. The Contractor may, at his expense, install additional pull boxes to facilitate his work.

The tops of pull boxes installed in the ground or in sidewalk areas shall be flush with the surrounding grade or top of adjacent curb. Where practical, pull boxes shown in the vicinity of sidewalks shall be placed adjacent to the back of the sidewalk when sufficient right-of-way exists and boxes adjacent to standards shall be placed along the side of foundations as shown on the plans. If installed in the roadway, leave the top of junction box about 1/2 inch below the pavement surface to accommodate box lids.

In boxes having an open bottom, construct a sump of reasonable well graded 1/2-inch gravel 12 inches deep covering the approximate area of the box. Do not install conductors until the sump has been constructed.

The bottoms of pull boxes installed in the ground or in sidewalk areas, shall be bedded in crushed rock as shown on the plans.

#### 501.3.08 Cable and Wire

##### 501.3.08A General

Wiring shall conform to Subsection 501.2.05 CABLE AND WIRE and all applicable portions of the NEC. Wiring within cabinets and junction boxes shall be neatly arranged. Powdered soapstone, talc, or other approved lubricants shall be used when inserting conductors in conduit. Before pulling wires through underground conduit runs, the Contractor shall ascertain that the conduits are free from dirt or accumulation of moisture. Wire shall be installed so as to prevent damage to the insulation.

The push button common shall be carried throughout the system as a separate No. 14 wire.

Sufficient signal light conductors shall be provided to perform the functional operation of the signal system and, in addition thereto, 3 spare conductors of a size equal to the largest

signal light conductor in the run, except the common conductor which shall be provided throughout the signal light system.

All signal light conductors and control circuit conductors, except branch common conductors shall be run continuously without splices from a terminal block located in a cabinet, compartment, or signal head, to a similarly located terminal block. Signal light conductors shall not run to a terminal block on a standard unless they are to be connected to a signal head or overhead span that is mounted thereon.

Connection to each terminal of a pedestrian push button shall be by a single conductor.

Conductors shall be pulled into the conduit by hand and the use of winches or other power actuated pulling equipment will not be permitted.

Pull all wire on a straight line with the conduit opening to prevent damage to insulation. If pulls are made with poles or controller cabinet in place, use a pulley device to achieve a straight pull. Other methods may be used if prior approval is obtained.

When new conductors are to be added to existing conductors in a conduit, all conductors shall be removed; the conduit shall be cleaned and both old and new conductors shall be pulled into the conduit as a unit.

Where signal conductors are run in lighting standards containing street lighting conductors from a different service point, either the signal conductors or the lighting conductors shall be encased in flexible or rigid metal conduit, to a point where the 2 types of conductors are no longer in the same raceway. Where the telephone circuits are installed adjacent to signal and lighting circuits, the telephone conductors shall be encased in UL listed flexible metal conduit.

Conductors less than 10 feet above grade shall be enclosed in rigid metal conduit.

At least one foot of slack shall be left for each conductor at each signal or lighting standard, or combined standard, and at least 3 feet of slack at each pull box.

At least 3 feet of slack shall be left for each conductor at each splice. Ends of spare conductors or conductors terminated in pull boxes shall be taped.

Conductors within fixtures or cabinets shall be cabled together with self-clinching nylon cable ties, waxed lacing or other method permitted by the Engineer.

Use fork-type pressure connectors to connect all traffic signal conductors to terminal screws in cabinets.

Conductor identification shall conform to the details shown on the plans or to the requirements of the Special Provisions.

Unless otherwise noted, all wires inside poles and conduit, except power service wires, shall be stranded XHHW wire. Power service wires shall be Type THWN. All stranded conductors to be connected to terminal screws shall have fork-type pressure terminals.

Any underground utility or underground circuits paralleling or crossing signal or illumination circuits shall be physically separated as directed by the Engineer.

After splicing in the street light circuit for a luminaire on a combination street light and signal pole, fused splice connectors as set forth in Subsection 501.2.15 FUSED SPLICE CONNECTORS shall be installed. Wire from the fused splice connector to the luminaire ballast shall be XHHW No. 10 stranded copper wire.

#### 501.3.08B Control Cable Attachment

Control cable, except as noted hereinafter, shall be attached to messenger cable by heavy-duty black plastic self-locking straps. The straps shall have a minimum tensile strength of 125 pounds and be capable of wrapping the entire installation. The straps shall have serrated gripping surfaces through a binding strap and when affixed, shall remain securely tightened. After placement, all excess material shall be neatly trimmed.

Where supervisory control cable is run aerially between intersections, the control cable shall be attached to messenger cable. Supervisory control cable to the message or figure 8 cable supported on 1/4-inch messenger.

Sufficient conductors shall be provided to perform the functional operation of the signal system. Extra conductors shall have their ends taped with an insulating tape. Where the plans omit necessary wiring to provide the operation of the traffic signals, the Contractor shall furnish and install such wire as may be needed to complete the signal system circuit to meet operational requirements as set forth on the plans or in the Special Provisions. The number of conductors in a cable may be greater than that shown on the plans.

#### 501.3.08C Direct Burial Cable

Either multi-conductor or single-conductor direct-burial cable will be acceptable. The Contractor shall plan the laying of cable so as to eliminate cable splicing in the trenches between poles and junction boxes. Splicing will be permitted in direct-burial cable runs longer than standard reel lengths, if splices are made in a junction box. Insulate splices with heat shrink tubing, listed as UL 486, 90°C, 600V, and constructed of homogeneous polyolefin having an internally applied sealant. Splices may also be made with epoxy resin cast type kits using matted or clear rigid plastic molds. Give the location of all splices to the Engineer. Direct burial cable shall not be used unless approved by the engineer or shown on the plans.

#### 501.3.08D Messenger Cable

Messenger cable shall be attached 6 inches below the top of the pole unless otherwise called for on the plans or in the Special Provisions.

Messenger cable attachments to City-owned wood or metal poles shall be through the use of a thimble-eye bolt and strandvise.

Do not weld eyebolts to metal poles. Install the eye bolts through the entire pole. Pull the shoulder of the eye tight against the front face of the pole. Install a flat washer followed by a hex nut, a lock washer, and a hex nut on the back face of the pole. The eyebolt shall extend at least 1 inch beyond the locknut. If the eyebolt extends more than 2 inches beyond the locknut cut it off. 3/4" diameter eyebolts shall have a minimum ultimate strength of 18,300 pound and conform to ASTM A 307 standards.

Attachments to utility owned poles shall be according to the local utility company regulations and under the supervision of the local utility Engineer.

The Contractor shall furnish and install such back guys, head guys, anchors, etc., as may be requested by the local utility engineer, where such guys are necessary due to the placement of traffic signal equipment on utility poles.

#### 501.3.08E Wire

Wire shall be run without splicing between pole or pedestal bases and all terminating points. Pull boxes shall not be used for splicing except for the following:

1. Where inductive loop or magnetometer detectors are used, splicing will be permitted in the box nearest the detector.
2. Splicing of branch street light or common conductors will be permitted in pull boxes.
3. Other splicing will be permitted when shown on the plans.

Where splicing is permitted, connect the wires with a "Western Union" type splice. Solder the splice with 60/40 resin-core solder using a soldiering iron or gun. Do not use an open flame torch. After soldering, cover the splice with a heat shrinkable tubing listed as UL 486, 90°C, 600 volts constructed of homogeneous polyolefin having an internally applied sealant. Use heat shrink tubing on individual wire splices and also over the entire cable splice. Cover the entire splice with heat shrink tubing, and extend it at least 1-inch beyond where insulation has been removed.

#### 501.3.08F Telephone Interconnect Wire

When called for on the plans or in the Special Provisions the Contractor shall connect the circuit from the control cabinet terminals to the plywood panel in the telephone interconnect cabinet. Telephone company personnel will provide the circuit from the plywood panel to the proper stations. The Contractor shall pay all installation costs of the telephone connections and should include costs as a part of his bid. No extra payment will be made for telephone connection or installation expenses. Interconnect cable shall comply with Rural Electrification Act (REA) Specification PE-22, PE-39, or ICEA Specification S-56-434.

#### 501.3.09 Cabinets

##### 501.3.09A General

The Contractor shall install various cabinets of the type as called for on the plans or Special Provisions. Cabinets shall be fabricated in accordance with Subsection 501.2.06 MISCELLANEOUS CABINETS of these specifications.

##### 501.3.09B Equipment Control Cabinet

The Contractor shall furnish an enclosed meter socket base and main disconnect cabinet with a toggle operated circuit breaker of the size indicated on the plans or in the Special Provisions.

##### 501.3.09C Terminal Cabinet

Mount on traffic signal poles a signal circuit terminal cabinet as shown on the plans. All terminal cabinets shall be 6"x 8"x 18" with a 2-1/2 inch wire entrance, and 3 terminal block mounting brackets.

If a mast arm pole has no span wire attachment, locate the terminal cabinet above the pedestrian signal mounting brackets as shown on the plans.

Install the number of double terminals in each cabinet according to the number needed for the circuits, plus two spare terminals. These spares are not to be used by the Contractor. Divide the number of terminals required as equally as possible over the three mounting brackets in the cabinet.

Where a signal system common enters a terminal cabinet, the cabinet shall contain a 50-ampere double terminal for the system common. If necessary, add other terminals of the same capacity to accommodate all of the commons. If other terminals are required, use a wire jumper of the same size as the system common between the terminals.

All other terminals shall have sectional or stackable 600-volt terminal blocks and be of sufficient size to accommodate all required wires. Use Square D, Type K or approved equal channel mounting terminal blocks.

Enter on the marking strip the wire number and/or letter as coded at the terminal strips in the controller cabinets.

Use weatherproof compression fittings in the bottom of the cabinets for cable entrances.

Use a 2-1/2 inch fitting for the pole entrance for terminal cabinets. Weld this fitting, all around, in place, and use a threadolet as manufactured by Bonnie Forge and Tool Works, TRANS-O-CON as manufactured by Phoenix Forging Co., or equivalent. Clean, wire brush, and paint welds with a minimum of 3 coats of zinc paint. Instead of this, the fitting may be place by the manufacturer and hot dipped galvanized with the pole.

Where a mast arm pole has no span wire attachment, the terminal cabinet shall be located on the pole opposite the signal mast arm attachment to facilitate pulling conductors into the mast arm. Overhead terminal cabinets will not be required on poles that do not have span wire or mast arm attachments, unless otherwise called for on the plans or in the Special Provisions.

Control cable shall run without splicing inside the metal poles to the terminal cabinet, located 6 inches below the upper span.

Control cable shall be run to terminal cabinets without splicing. Cable entrance into terminal cabinets shall be through weatherproof compression fittings in the bottom of the cabinets.

When more than 30 terminals are required the pole entrance size shall be increased to 3 inches.

#### 501.3.10 Pole Placement and Erection

##### 501.3.10A General

Unless otherwise directed by the Engineer, poles shall not be erected on traffic signal projects until all material for the project has been received by the Contractor. Pole locations shall be approved by the Engineer.

##### 501.3.10B Wood Poles

Wood poles shall conform to Subsection 501.2.07D WOOD POLES. The pole shall be raked away from the direction of the service drop and/or opposite the applied load unless

specified otherwise in the Special Provisions. Back fill around wood poles shall be thoroughly compacted.

See Table 501-1 for depth of pole settings.

**TABLE 501-1 SETTING DEPTHS FOR WOOD POLES**

Length of Pole (feet)	Depth in Ordinary Soil (feet)	Depth in Rock
25	5.0	3.5
30	5.5	3.5
35	5.5	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	5.0
55	7.5	5.0
60	8.0	5.5
65	8.5	6.0
70	9.0	6.5
75	9.5	6.5

Where ordinary soil is underlaid with rock, the depth of hole in the rock portion is to be 0.7 of the depth required if it were soil, except that depth in rock should not be more than for full rock setting shown in Table 501-1

Example: 50 foot pole - Soil 2 feet over rock

Required depth of hole for all soil setting	=	7.0 ft.
Actual soil depth	=	2.0 ft.
	Difference =	5.0 ft.
	x	0.7
Depth of hole required in rock portion	=	3.5 ft.
Depth of hole through soil	=	2.0 ft.
Total Depth of Hole	=	5.5 ft.

Where poles are located on other than level areas, the setting depths shall be measured from the low side of the hole.

501.3.10C Metal Poles and Standards

Metal poles and pedestals shall conform to Subsection 501.2.07A GENERAL. Metal poles and pedestals shall be erected on concrete foundations and conform to the



recommendations of the pole manufacturer as shown on the plans. Poles shall be erected with sufficient rake as to assume a substantially vertical position after all attachments and appurtenances are in place. Exercise reasonable care to prevent marking the galvanizing and damaging the poles and towers.

Do not erect poles or towers on concrete foundations until they have reached the required breakage test specified on the plans or in the Special Provisions.

Foundation bolts shall not protrude over 1-1/2" above the top of the pole base plate. Leveling nuts shall be used on all poles. After all appurtenances have been attached, the pole shall be leveled and grouted. A nominal 3/4-inch diameter weep hole shall be left in the grout.

Breakaway or frangible pole bases with embedded shafts shall be raked as necessary prior to the concrete foundation setting up.

Traffic signal poles, pedestal, bridge spans and posts are to be measured from those locations shown on the plans. All standards measured from the face of the curb to the center of the foundation.

All poles with joint traffic signal and street light mast arms shall be installed so that the distance from the pavement to the light center will be as specified on the plans or in the Special Provisions. Traffic signal and street light arms shall be of the same tapered design. Where pedestrian signals are required, mounting height shall be as shown on the plans.

After steel poles have been set, all damaged galvanizing shall be painted with zinc dust - zinc oxide primer for galvanized surfaces with the following modification: a total of one and one-half (1-1/2) ounces of aluminum powder shall be added to each quart of specified zinc paint.

#### 501.3.11 Painting

Equipment fabricated of aluminum or galvanized steel shall be painted except as follows:

1. Signal Heads - Apply flat black powder coat to pedestrian signal heads, vehicle signal heads, beacon heads, and backboards.
2. Signal Control Cabinets - Signal control cabinets shall be constructed of anodized aluminum. No paint shall be used.
3. Brackets and Hangers - Apply 2 coats of aluminum paint to signal head mounting brackets, arms and un-galvanized hangers after they have been prime painted.

4. Interior illuminated Metallic Sign Cabinets (Fluorescent Tube) - Cabinets shall be painted according to the following:
  - a. Inside of Cabinet - Wash all exposed aluminum and steel parts with metal cleaning solvent. When metal is thoroughly dry, spray on one coat of paint.  
  
After the paint is dry, finish with two coats of high quality white enamel.
  - b. Outside of Cabinet - Any exposed metal parts on the outside of the cabinet, other than aluminum, shall be given two coats of aluminum paint.
  - c. Handling - Any scratches or abrasions to the finished surface of the cabinet shall be refinished by the Contractor to the satisfaction of the Engineer.
5. Interior Illuminated Metallic Sign Cabinets (Neon-Type) - Cabinets shall be painted according to the following:
  - a. Inside of Cabinet - Follow the same procedure as (4-1) above except, after the paint is dry, finish with three coats of a dull, flat black, weather-resistant paint. The front exposed face louvers and the tube supports on the inside of the hood shall also be finished with 3 coats of the same black paint.
  - b. Outside of Cabinet - Same as (4-b) above.
  - c. Handling - Same as (4-c) above.
6. Equipment Control Cabinet - Equipment control cabinets, not aluminum or galvanized, shall receive a prime coat and two coats of aluminum paint.
7. Treatment for Aluminum-Concrete/Steel Contact - The base of aluminum poles or aluminum transformer bases that come in contact with concrete foundations and/or steel standards shall be fitted with a gasket covering the entire contact surface. The gasket shall be constructed from 40-lb. felt.

#### 501.3.12 Electrical Service

##### 501.3.12A General

Service points shown on the plans are approximate only; exact location will be determined in the field. Where service equipment is to be installed on utility-owned poles, the positioning and method of attachment of service equipment shall be as required

by the serving utility. The size of wire from the utility company's secondary to the disconnect circuit breaker, when not shown on the plans, shall be as specified by the NEC, and not less in current carrying capacity than the disconnect circuit breaker rating. In no instance shall the service conductor be less than No. 6 AWG. Wiring connections to the terminal screws on the circuit breakers and contactors shall make full contact under the screw head.

Where thimble-eye bolts are to be used on signal or illumination poles to receive overhead power service, the Contractor shall ascertain from the local serving utility the direction the thimble-eye should face.

Each service cabinet shall contain a solid copper neutral bus and the number and size of switches or circuit breakers as required by the plans or in the Special Provisions. All over-current protection and relays shall be installed in accordance with the plans using best common practice with materials and installation meeting all applicable portions

of the NEC. The Contractor shall notify the appropriate utility prior to making any contacts to utility poles. The Contractor's attention is drawn to special requirements for power service and meter base cabinets contained in Subsection 501.2.06 MISCELLANEOUS CABINETS.

As part of each service installation, a meter base, approved by the serving utility, shall be furnished and installed by the Contractor.

#### 501.3.12B Circuit Breakers

Circuit breakers shall be of the rating shown on the plans or as called for in the Special Provisions. Circuit breakers shall be of the enclosed molded case type with end conductor terminals.

Circuit breakers for 120/240-volt circuits shall be rated at 277 volts AC. Circuit breakers shall be labeled to indicate the circuit controlled.

Over-current protection and relay equipment, as called for on the plans or in the Special Provisions, shall be installed according to the best common practice, with materials and installation meeting all applicable requirements of the NEC for roadway lighting installations. Relays shall be jack-mounted and keyed for proper alignment. See Subsection 501.2.06 MISCELLANEOUS CABINETS for dead front panels for circuit breakers.

#### 501.3.13 Grounding and Bonding

Make all conduit, metal poles, grounding wire, metallic junction boxes, metallic junction box covers, and cabinets mechanically and electrically secure to form a continuous, effectively grounded system. Bond together all rigid steel conduit ends that terminate at the same location. Bond the copper equipment ground wire between the metal poles to the grounding rod at each foundation. Use stranded conductors for all ground and bond wires.

Ground rods shall be assessable electrodes of at least 5/8" x 10' non-rusting, copper covered, steel with bronze grounding wire clamp. Drive ground rods full length with the top about 6 inches below the finished grade at the ground rod locations. Install a separate ground rod for each electrical system which originates from a separate power source.

If approved, grounding rods may be driven diagonally or in rock locations that prevent full length driving, with approval, a buried iron or copper plate may be installed at the bottom of the concrete foundation hole. The plate shall be a least 2-foot square and 1/4-inch thick.

In sidewalk or other areas where the ground rod cannot be made accessible, a 5/8" x 10'

non-rusting, copper covered, steel ground rod may be driven diagonally through the foundation on fixed anchor base poles. If this method is used, drive the ground rod at least 4 feet into earth and leave a least 3 inches exposed through the top of the foundation. Bend the rod so that the exposed end is vertical and near the center of the pole. Connect the steel reinforcing cage to the ground rod using a No. 6 copper wire. Securely clamp the wire to the reinforcing steel, through the ground rod clamp, and to the pole grounding lug. Do not use this method on slip base poles.

On the inside of tower shafts provide a 1/2-inch grounding stud, 13 UNC thread. Locate the grounding stud 90° to, and level with the bottom of the head-hole.

For slip plate base poles, the grounding wire shall not intrude into the slip plane. Use the bond wire from the grounding electrode to a 1/2-inch bolt installed in the bottom base slip plate to accomplish bonding.

For standard 4-bolt type anchor base poles, provide a grounding nut for a 1/2-inch 13 UNC threaded bolt or stud on the inside of the shaft. Locate the grounding nut directly opposite and level with the handhole in the pole.

Locate ground rods at ground mounted cabinets outside bases with the ground wires entering the cabinet through a 1-inch metal conduit sweep. Connect the conduit sweep, other conduit inside the cabinet, and ground wire to the ground lug inside the cabinet.

Instead of placing the ground rod outside the traffic signal controller cabinet foundation, the ground rod may be placed within the cabinet base opening.

If resistance to ground is greater than 25 ohms, furnish and install a second ground rod as required by the NEC. Place electrodes at least 6 feet apart. The second ground rod shall be the responsibility of the Contractor and be a part of the Contractor's lump sum bid price.

Ground rods shall be bonded to conduit and the inside of poles, using copper wire and grounding lugs. All ground lugs shall be tight and provide full contact with the ground or bond wire. In addition to supplying grounding equipment at each power service location, the Contractor shall supply and install a ground rod at each controller cabinet location, and through a separate one inch conduit bend, either plastic or rigid conduit, run a bare copper wire from a lug inside the controller cabinets to the ground rod lug. All metallic conduit within the controller cabinet shall also be bonded together and to the cabinet. Grounding or bond wire shall be of a size conforming to NEC.

All poles and pedestals shall be bonded to a conduit end by means of a bond wire running from the conduit ground bushing to bonding lugs inside the pole or pedestal base. Grounding when using PVC conduit shall conform to the requirements of 501.3.06A

GENERAL.

### 501.3.14 Indication Equipment and Signs

Non-Programmable Vehicular Signal Heads - The standard traffic signal heads for vehicular control shall be one-way, three section type heads, adjustable through 360° about a vertical axis, and designed for the method of mounting shown on the plans or set forth in the special provisions. Special vehicular signal heads shall be any signal head required to produce any indication other than those resulting from the use of standard red, yellow, and green lenses. Furnish heads complete, including lamps, lenses, visor,s reflectors, sockets, backboards, and mounting appurtenances as described in Subsection 501.2.10C VEHICULAR SIGNAL HEADS.

The vehicular signal heads shall be:

- ! Designed so they can be suspended from mast arms or span wires, or mounted on brackets or pedestals as required by the plans.
- ! Equipped with positive lock rings and fittings designed to prevent the heads from turning due to external forces.
- ! Equipped with all necessary appurtenances for the type of mounting required by the plans or special provisions.

Optically Programmed Vehicle Signals - Furnish and install, complete, optically programmed vehicle signals that conform to all applicable portions of Subsection 501.2.10G PROGRAMMED VISIBILITY VEHICLE SIGNALS. A complete vehicle signal includes the required number of signal sections with optical components, individual intensity control, cutaway visor, backboard, and mounting hardware.

Optically programmed vehicle signal shall:

- ! Have lenses with a nominal diameter of 12 inches.
- ! Use lamps of the type and wattage recommended by the signal manufacturer.
- ! Be possible to selectively program the visibility zone of the projected indication anywhere within 15° of the optical axis of each signal section.
- ! Include an easily accessible visibility-limiting device which can be programmed to restrict the viewing area of the projected indication without the use of hoods or louvers.
- ! Include an integral means for regulating the intensity of the projected indication as a function of the ambient light conditions. The reduction in lamp intensity shall

be proportional to the reduction in ambient light within the following limitations:



- ! If ambient light is 1,000 footcandles or more, the lamp intensity shall be at least 97 percent of maximum.
- ! If ambient light is 1 footcandle or less, reduce the lamp intensity to approximately 15 percent of maximum.

Installation shall require a qualified technically certified representative that can program the visibility-limiting device as outlined by the signal manufacturer prior to placing the signal in operation.

Programmed vehicle signals mounted on span wires shall have washers installed on the pin which connects the signal hanger to the cable clamp. Install enough washers to limit the lateral movement of the hanger to a minimum.

Pedestrian Signal Heads - All pertinent portions of Subsection 501.2.10C VEHICLE SIGNAL HEADS shall also pertain to pedestrian signal heads.

Two Section Heads - Use square, incandescent illuminated one-way or two-way, two section type pedestrian "DON'T WALK-WALK" signals, designed for vertical bracket or pedestal mounting as required by the plans.

Feed bracket-mounted signals through the support arm, and pedestal mounted signals through the bottom of the head.

Adjust pedestrian signals which have variable lamp socket positions to that recommended by the signal manufacturer.

Single Section Heads - Furnish and Install signal section pedestrian signals meeting the requirements of Subsection 501.2.10D PEDESTRIAN SIGNAL HEADS.

Flashing Beacon Signal Heads - Flashing beacons shall:

- ! Conform to all applicable portions of this subsection and Subsection 501.2.10E FLASHING BEACON SIGNAL HEADS.
- ! Be of signal section construction.
- ! Equipped for the type of mounting shown on the plans.

Use the size of lamps as specified in Subsection 501.2.10B LAMPS AND RECEPTACLES. Do not wire green arrows into the flashing circuit, where used with flashing beacon indications.

Mount single section heads on span wires as shown on the plans for 3-section heads.

Heads shall hang substantially plumb. Where proper adjustment cannot be obtained with the standard hanger, use balance adjusters, pipe extensions, or other approved methods to insure proper sight distance.

Suspension of Heads - Mount vehicle signals on mast arms so the backboard bottoms are within a 6 inch horizontal plane.

Equip all adjustable, multi-directional type signal heads at both top and bottom with spiders, brackets, or arms assembled from 1/2 inch "rigid metal conduit" and fittings.

Furnish plumbizers with 3 set screws, and install them over the end of the arm or over welded couplings. Use a bolt to fasten the plumbizer to the mast arm or coupling.

Drill and tap set screws through the first wall of conduit used in signal mountings. Extend the conduit at least 1/2 inch beyond the set screw.

Where the top bracket enters the top of the signal housing, place a non-hardening silicon, caulking compound, or approved equal, around the bracket to make a watertight seal.

Equip span wire mounted heads for overhead feed. Use span wire mounted signals with a span wire hanger similar in design to that shown on the plans. Install with an extension of 1-1/2 inch "rigid metal conduit" between the top of the signal and the overhead span wire hanger. Span wire hangers used with 1-1/2 inch "rigid metal conduit" shall be female thread. Three through drilled set screws shall secure the pipe extension to the hanger (Refer to Standard Drawing 5-1 & 5-2).

Mount vehicle signal heads on span wires so the bottoms of the backboards are within a 6 inch horizontal plan of each other.

Mount signs on span wires so their tops are within 6 inches of the top of the vehicle signal backboard.

Use locknuts and lock washers on bolts and hangers which extend through and are secured inside the signal head housing.

Mount signals located on poles or pedestals with a bracket assembly, which includes a terminal compartment, and is constructed of 1-1/2 inch rigid metal conduit and fittings. The bracket assembly shall include all hardware necessary for correct placement of the signals, as shown on the plans. Paint the bracket assembly with two coats of aluminum paint.

Use bracket arms for pedestrian or vehicle signals long enough so when the heads are properly aligned, visibility of the signal is not obstructed by the poles, and the heads may be opened fully for maintenance.

Each terminal compartment shall:

- ! Be cast bronze
- ! Have a flanged, gasketed door.
- ! Contain a terminal block with at least 10 pressure type terminals.

Use pole mounted bracket assemblies with a flanged wiring entrance and two mounting holes through the back of the terminal compartment. Drill a hole in the pole which provides a slip fit opening for the flanged wiring entrance in the terminal compartment.

Provide pedestal top mounted bracket assemblies with a 4-1/2 inch slip fit for pole mounted bracket assemblies.

Pedestrian signals may be mounted on poles utilizing a terminal compartment that is hinged to the mounting bracket. The pedestrian signal head may be an integral part of the terminal compartment assembly.

Vehicular Signal Head Covers - Cover mounted vehicle signal heads at all times until the signal installation is ready for continuous operation. Cover the entire face of the signal head to the rim of the backboard, with burlap, canvas, cardboard, or other approved cover materials. Not over 10 percent of each lens may be visible to facilitate testing.

Mounting height of signal heads shall provide a minimum clearance of 17 feet 6 inches and a maximum clearance of 19 feet from the roadway surface.

### 501.3.15 Traffic Signal Detection Equipment

#### 501.3.15A General

This section shall supplement Section 501.2.16 TRAFFIC SIGNAL CONTROL EQUIPMENT. In case of conflicts, Section 501.2.16 shall govern when detectors are to be used as part of a Type 170 controller assembly.

Vehicle detectors shall be the type or types shown on the plans. All sensor units, control units, and amplifiers shall meet all specified performance characteristics for the detection of all licensed motor vehicles when using the vehicle detectors as shown on the plan.

Splices of detector lead-in cable and conductors shall be insulated by a method approved by the Engineer.

Splices of detector lead-in cable in the road bed shall be allowed only when shown on the

plans or approved by the Engineer.

### 501.3.15B Inductive Loop Detectors

The term 'inductive loop detector' applies to a complete installation consisting of a conductor loop or group of loops installed in the roadway, as shown on the plans, lead-in cable and a sensor unit with power supply installed in a traffic signal controller or traffic count station cabinet.

Inductive Loop Detector Amplifier (General) - Detector tuning shall be completely automatic and accomplished within 2 minutes after turn-on. Operation of the detector shall automatically compensate for changes in loop parameters caused by moisture and temperature variations.

Detector amplifier units shall be digital using a MOS/LSI integrated circuit for processing of loop inductance information. The amplifiers shall be capable of operating loop and loop feeder combinations within an inductance range between 50 and 500 micro-henrys.

The detector amplifier tuning shall be completely automatic after turn-on and on restart from power failure. Wire the detector amplifiers so power (117 VAC) to the amplifier is not interrupted during flashing operation.

Inductive Loop Detector Amplifier (Operation) - The detector to be furnished under this specification shall be capable of operating various loop and lead-in wire combinations within an inductance range of 100 micro-henrys to 1000 micro-henrys.

The detector units shall be capable of operating the loops and feeder circuits shown on the plans and shown on the "Loop Detector Wiring" Chart.

The detector and power supply shall be of solid-state construction. The detector output shall be by means of a plug-in relay and shall be normally energized to provide fail-safe operation. The relay shall have a life of 1 million operations with contacts rated 2.0 ampere at 120 volts AC. Instead of the output relay, solid-state circuitry may be used to provide the same function. All printed circuit boards shall be of epoxy glass with 2-ounce copper track.

The detector shall have a minimum of 2 modes of operation selected by a front-mounted selector switch. The two modes shall be pulse and presence. Pulse operation shall provide a pulse width of approximately 100 milliseconds and presence operation shall indicate vehicle presence up to approximately 10 minutes. Detector amplifiers shall have the following mounted on the front panel:

- Mode selection switch
- Sensitivity control switch
- Pilot light

Power supply fuse  
MS plug receptacle

Delay Timer - A delay timer shall be an integral part of the amplifier unit. The delay timer shall be of solid-state construction and adjustable from 0 to 30 seconds in increments of not more than 1 second.

The delay timers shall operate so when the controller is not in the associate green, a vehicle must remain continuously within the influence of the loop for a time equal to that set on the delay timer in order to place a call on the associate phase. When the controller is in the associate green phase, the presence of a vehicle within the influence of the associate detector loop shall immediately register a vehicle actuation within the controller.

Inductive Loop Detectors Construction - Saw cuts shall be at least 1/4 inch wide for loop wires and at least 3/8 inch wide for loop feeder cable. Refer to Standard Drawing 5-12.

Loops shall be compatible with construction and made in the most practical, direct line between loops and junction boxes, except where parallel to or nearly parallel to lane line, then locate under the lane lines.

Loops shall conform to the design as shown on Standard Drawing 5-10 or as specified on the plans or as described in the Special Provisions. Loop field layout shall be the responsibility of the Contractor. Prior to saw cutting, the final loop layout shall be confirmed by the Engineer.

The loop saw cuts shall be flushed thoroughly with a high-pressure water stream and blown free of water and debris with compressed air immediately after the cuts have been made, and before the cuttings dry.

The saw cuts shall be checked with a screw driver or other tool for rocks or other material that may be wedged in them. Before placing loop wire all saw cuts shall be dry.

Any number of loop wires may be installed in a single saw cut, as long as 1-1/2 inch of cover is provided, and adequate pavement depth is available. The Engineer may limit the allowable saw cut depth and width to avoid damage to the pavement.

Round off all corners a minimum amount with a chisel or other tool to prevent abrasion of the wire insulation.

When pre-formed loops are called for on the plans, refer to Standard Drawing 5-12 for requirements. Pre-formed loops shall be approved by the Engineer prior to installation.

Pre-formed loops can also be installed during the paving operation, as long as minimum cover requirements are met. Loops damaged during installation of this type will be the responsibility of the Contractor to replace at no extra charge to the Division. Conduit of detector loops and runs to junction boxes shall be filled with an approved sealant if subjected to high temperatures and compaction of back fill.

Six-foot diameter round loops may be used in 12-foot or wider width lanes as an alternate to our standard three-foot and four-foot diamond vehicle detector loop configuration. They shall be installed as per our standard loop installations, with one exception. The wire used may be four turns of #14 AWG XHHW, encased in Detecta-Duct.

Inductive Loop Wire - Wire use for traffic signal loops shall be No. 14 XHHW wire conforming to IMSA Specification No. 51-3-1984.

Loop Feeder Cable - The loop feeder cable shall be two conductor No. 14 twisted pair shielded cable conforming with UL 2106 or IMSA Specification No. 50-2-1984. Place a permanent plastic label on each cable with the loop numbers, in indelible ink, as shown on the "Loop Detector Wiring Diagram". Place labels at all accessible points on the system.

Loop Installation - After saw cut is cleaned of debris, place the loop wire by pushing in into the slot with a blunt, nonmetallic object. Use care to avoid damaging the insulation.

Use one continuous, unbroken length of loop wire to form a loop of the number of turns required and to reach the loop feeder cable splice point as shown or specified in the special provisions. Use one continuous, unbroken length of loop feeder cable from the loop wire splice point to the cabinet.

Splice loop wire to loop feeder cables in junction boxes. Connect the loop wires to the loop feeder cable with a "Western Union" type splice. Cut back and remove the feeder cables outer jacket, shield and drain wire a distance of 3 inches from the splice. Do not cut the insulation of the feeder cable conductors, and be sure that the shield and drain wire is isolated from ground. Solder the splice with 60/40 resin-core solder using a soldering iron or gun. Do not use an open flame torch. After soldering, cover the splice with a heat shrinkable tubing listed as UL 486, 90°C, 600 volts constructed of homogeneous polyolefin having an internally applied sealant. Use heat shrink tubing on individual wire splices and also over the entire cable splice. Cover the entire splice with heat shrink tubing, and extend it at least 2-inch beyond where insulation has been removed.



After loop wire is placed and before the saw slot is sealed, install loop wire hold-downs made of closed-cell polyurethane (backer rod). Place 1-inch lengths of the hold-down material along the loop perimeter and all other saw slots containing loop wire 6 inches from loop corners and at maximum 1-foot centers. Hold-downs shall fit snugly in saw slots. Backer rod material shall be approved by the Engineer.

After placing the wire, test loops before filling the slots with a sealant. Fill the slots with a pavement colored sealant approved by the Engineer. Sealant shall not protrude above the pavement nor be more than 1/8 inch below the pavement level after curing. Where cuts are made on a slope and sealant runs and puddles, start at the low end, pour the sealant, and hold it in place with 2-inch duct tape placed on the roadway surface over the cut. If duct tape or other device is used to contain the sealant in the saw cut, remove it on the same day, after the sealant is fully cured.

Install the sealant according to the manufacturer's instructions and recommendations. Give close attention to the proper proportioning, and mixing of components. Loop sealant shall be CRAFCO, INC. 34271, or an alternate approved by the Engineer. The Engineer may order a test run of any application method or material before filling saw cuts. A manufacturer's representative shall be present if using a sealant for the first time on a City project.

The sealant shall carry a manufacturer's warranty or guarantee consistent with those provided as customary trade practice and provide in-service operation for a period of twelve (12) months following project acceptance. Sealants that crack and/or pull away from the saw cuts after curing will be rejected within the 12-month period. Remove sealant that fail within this period, clean the cuts of debris and reseal with a sealant satisfactory to the Engineer at the Contractor's expense.

The resistance to ground of the loop and loop feeder combinations, using a 500 volt megger, shall be 200 megohms or greater when checked before placing the sealant and after the sealant has set.

Loop Sensitivity - Loops on side street lanes and main line left-turn lanes shall be bicycle sensitive. After installation is complete test each loop with a lightweight bicycle or other approved bicycle. Ride the bicycle across all portions of the loop during testing. Increase detector sensitivity until the bicycle is detected. If the bicycle is not detected on the highest sensitivity setting, replace the detector at the Contractor's expense, and repeat the procedure.

If approved, a three foot diameter, single loop of No.8 insulated copper wire may be substituted for the bicycle.

If asphalt concrete surfacing is to be placed, the loop detector conductors shall be installed prior to placing the uppermost layer of asphalt concrete. The conductors shall be installed, as shown on the plans, in the compacted layer of asphalt concrete immediately below the uppermost layer. Installation details shall be as shown on the plans, except the sealant shall fill the slot flush to the surface.

#### 501.3.15D Pedestrian Push Buttons

Pedestrian push-buttons shall be of the direct push-button contact type and shall not have any levers, handles or toggle switches externally or internally. The push-buttons shall operate on a voltage not to exceed 24 volts DC and shall be rated a minimum 15 amperes at 125 volts, AC. They shall be substantial, of tamper-proof construction, and equipped with a push-button instruction sign as per Standard Drawing 5-4.

Contacts - Push-button contacts shall be entirely insulated from the housings and operating buttons. The contacts shall be normally open and shall be closed only when the push-buttons are operated by pressure, restoring immediately to the normal open position when the pressure is released.

Housing - The housing containing the pedestrian push-button shall be made of non-rusting cast metal material. There shall be an outlet tapped in the back of the housing for standard pipe or rigid conduit. A metal guard shall be fabricated as a part of the housing. The guard shall extend far enough to prevent abusive damage which may result from the use of foreign objects to strike the button.

External Button - The external operating button shall be of brass or other non-rusting metal alloy, chrome plated, and shall be of sturdy design. It shall be possible to remove the button and contact unit from the housing with the use of simple tools. The button shall be not less than 1-3/4 inches in diameter.

Mounting - Method of mounting pedestrian push-buttons and instruction signs shall be as shown on the plans.

Instruction Sign - The pedestrian instruction sign shall conform to the "Manual on Uniform Traffic Control Devices" and as specified hereinafter. Each sign shall have the legend "PUSH BUTTON FOR WALK SIGNAL" and an arrow pointing in the direction of the crosswalk for which it is intended.

The instruction signs shall be of a one-piece construction assembly of extruded aluminum containing the push button with the signs placed directly on both sides of the extrusions. The sign background shall be of two coats of white enamel with black, silk screened, letters at least 5/8 inch high. The signs shall be at least 7-3/4 inches high by 5 inches wide.

#### 501.3.16 Traffic Control Assembly

Unless otherwise called for on the plans or in the Special Provisions, the controller assembly shall conform to Section 501.2.16 TRAFFIC SIGNAL CONTROL EQUIPMENT of these standards specifications.

#### 501.3.17 Railroad Interconnect

Where interconnection to railroad circuits is called for on the plans or in the Special Provisions, the railroad company will furnish a set of normally closed contacts in the railroad cabinet. The contacts are opened upon train actuation of the track circuit. The contacts are a "fail-safe" device which will cause an actuation if power to the track circuit is interrupted. Interconnection from the traffic signal cabinet to the railroad cabinet shall be installed by the Contractor.

The circuit shall be of the size shown on the plan. The conduit shall terminate in the railroad cabinet at a location and in a manner to be determined by the railroad company Engineer. The ends of the wire shall extend a minimum of 3 feet beyond the end fitting inside the railroad cabinet. All work inside the railroad cabinet shall be done by railroad personnel.

Under no circumstances is the Contractor to do any work in the immediate vicinity of the railroad cabinet without first notifying and receiving permission of the Engineer. The Engineer will obtain supervisory personnel from the railroad company. The cost of providing railroad company personnel shall be included as a part of the lump sum amount bid by the Contractor.

The Contractor is cautioned against placing any type of materials or equipment in the area of the tracks without due regard for proper clearance from the track.

Railroad preemption devices shall be as called for on the plans or in the Special Provisions, railroad preemption shall have priority over fire preemption.

#### 501.3.18 Fire Preemption System

Where a fire preemption system is called for on the plans or in the Special Provisions, the system shall be compatible with and operate on demand of the City's "Opticom" emitter assemblies, see Subsection 501.2.17 FIRE PREEMPTION SYSTEM. Detector units shall be installed as shown on the plans and as recommended by the manufacturer.

### 501.3.19 Service for Internally Illuminated Signs

When internally illuminated signs are called for on the plans or in the Special Provisions, the controller cabinet shall be equipped with a single pole, 15 amp rated circuit breaker, which by-passes the main breaker and is used to service the internally illuminated signs. This breaker shall be supplied in addition to the other breakers that are shown on the plans.

### 501.3.30 Testing for Acceptance

#### 501.3.20A General

The Contractor shall perform such testings as may be required to insure that each portion of the signal system is operational and free of defects.

Control Equipment Testing - Traffic signal control equipment will be tested for conformance with the plans and specifications before installation on a project.

Traffic signal control equipment includes the controller unit, controller cabinet and all equipment required for operation of the signal installation, such as, power supplies, input devices, output device, conflict monitor, flasher unit, relays preemption devices, and auxiliary equipment in the cabinet

The testing of control equipment will be done at the expense of the Contractor. The control equipment will be tested in three categories; physical, functional, and environmental. The City will require a total of six weeks for completion and evaluation of the testing.

Delivery of Control Equipment - Deliver all traffic signal control equipment, including wiring diagrams and operation manuals, in one shipment. Partial shipments will not be accepted and will be returned, freight collect, to the Contractor.

Equipment shipments shall include the following information: contractor, supplier, manufacturer, location, contract number, and agency for which the equipment is to be tested. Include a complete set of plans and specifications to which the equipment is to be tested with shipments for agencies other than the Highway Division.

Deliver the traffic signal control equipment and information for testing to:

Oregon State Highway Division  
Traffic Signal Services Unit  
2445 Liberty St. N.E.  
Salem, Oregon 97310

Control Equipment Failure - A traffic signal control equipment failure is any occurrence which results in non-specified operation of the equipment.

The Contractor will be notified of all control equipment failures, and shall make on-site repairs within 5 days of receiving the notification.

Following repair of the control equipment, the testing will be resumed at the beginning of the test category in which the failure occurred.

Control Equipment Rejection - The traffic signal control equipment will be rejected under either of the following conditions:

- ! If the control equipment fails twice in the same testing category.
- ! If the Contractor fails to repair the control equipment within 5 days of receiving notification of the failure.

Traffic signal control equipment which is rejected shall be picked up by the Contractor within 10 days of receiving the rejection notice. If not picked up within 10 days, it will be returned, freight collect, to the Contractor.

Rejected signal control equipment which is rejected shall be replaced with control equipment having a different serial number. Rejected control equipment will not be accepted for testing or installation on any subsequent traffic signal project within the State of Oregon.

Control Equipment Acceptance - The traffic signal control equipment which successfully passes the testing procedure will be certified by the Oregon State Highway Division, Traffic Signal Services Unit, as acceptable for installation only.

The successful completion of the testing does not relieve the Contractor of the responsibility to furnish a complete working signal installation at the time the equipment is placed in actual operation.

The Contractor will be notified when the testing has been completed and shall pick up the controller cabinet at the test facility.

Control Equipment Installation - The Oregon Signal Services Unit will be responsible for delivery and installation of the other control equipment. Other control equipment typically includes the controller unit, input devices, switch packs, monitor unit, miscellaneous plug-in devices, and auxiliary devices which is not permanently installed in the controller cabinet.

The other control equipment which the Oregon Signal Services Unit is to install will be stored at the test facility until the signal installation is ready to be turned-on.

### 501.2.20B Field Testing and Turn-On

Prior to start of functional testing, the Contractor shall perform the following tests on all traffic signals, sign illuminations, and lighting circuits, in the presence of the Engineer.

1. Continuity - All field circuits will be tested for continuity, the presence of grounds, and proper routing and termination.
2. Inductance and Resistance - All inductive loops and loop feeder circuits will be tested for inductance and resistance to ground. The loops will be tested and adjusted to detect motorcycles and bicycles.

An insulation resistance test at 500 volts DC shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than 10 megohms on all circuits except for inductive loop detector circuits which shall have an insulation resistance value of not less than 200 megohms.

3. General Quality - The signal installation will be inspected for general quality of work and conformance with all applicable codes and regulations.

A functional test shall be made in which it is demonstrated that each and every part of the system function as specified. The functional test for each new or modified traffic signal, traffic signal system, flashing beacon and ramp metering system shall consist of not less than 5 days of continuous, satisfactory operation.

If unsatisfactory performance of the system develops, the condition shall be corrected and the test shall be repeated until the 5 days of continuous, satisfactory operation is obtained.

The Contractor will be notified of the test result and shall make any repairs or corrections required. Upon successful completion of the testing, the signal installation will be approved for turn-on.

Traffic Signal Turn-On - The City will establish the date and time the installation is to be turned-on. The Contractor shall allow 2 weeks from the time of notification that the work is complete for field testing and turn-on of the installation.

The Contractor shall be present at the project site to assist as necessary to turn-on the signal installation.

After traffic signals are turned-on and operating as designed, the agency ultimately responsible for maintenance will assume operation and maintenance of the signal. Turn-on does not constitute final approval. The Contractor is still obligated to finish any incomplete portion of the installation and correct quality of work or replace material that does not meet specifications. After turn-on, damage to the traffic signal installation caused by conditions beyond the Contractor's control will be the obligation of the maintaining agency.

The initial turn-on shall be made between 9:00 a.m. and 2:00 p.m. Turn-ons shall not normally be conducted on Fridays.

#### 501.2.20C Vehicular Signal Head Covers

Mounted vehicle signal heads shall be covered at all times until the signal installation is ready for continuous operation. Cover materials shall be burlap, canvas, or other materials approved by the Engineer, and shall cover the entire face of the signal head to the rim of the backboard, with the exception that not over 10% of each lens may be visible to facilitate testing.

### 501.4.00 MEASUREMENT AND PAYMENT

#### 501.4.01 Measurement

There will be no separate measurement for individual items of work done under this division.

#### 501.4.02 Payment

The lump sum price for "Traffic Signal System Complete", as covered in this section, shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals, and for doing all the work involved in furnishing and installing the systems, or system combinations, as shown on the plans, and as specified in the Special Provisions and/or directed by the Engineer.

This shall also include any necessary pull boxes; excavation and backfill, concrete foundations, restoring sidewalk, pavement and appurtenances damaged or destroyed during construction; salvaging existing materials; and making all required tests, including all tests performed by the Oregon State Highway Division.

Full compensation for all additional materials and labor, not shown on the plans, or specified, which are necessary to complete the installation of the various systems, shall be considered as included in the price paid for the systems, therefore, no additional



compensation will be allowed.

## **502 STREET LIGHTS**

### **502.1.00 DESCRIPTION**

#### **502.1.01 Scope**

The work done under this section shall consist of furnishing and installing, modifying or removing one or more street lights, or street light systems, as shown on the plans, and as specified in these specifications and the Special Provisions when such work is not combined as part of a traffic signal system.

#### **502.1.02 Definitions and Abbreviations**

Definitions and abbreviations shall be as found in Subsections 501.1.02 DEFINITIONS and 501.1.03 ABBREVIATIONS respectively.

#### **502.1.03 Regulations and Code**

Regulations and code shall be as found in Subsection 501.1.04 REGULATION AND CODE.

### **502.2.00 MATERIALS**

#### **502.2.01 General**

Materials shall meet the applicable subsections of Section 501 TRAFFIC SIGNALS as follows:

Conduit.....	501.2.03
Pull Boxes.....	501.2.04
Cable and Wire.....	501.2.05
Cabinets.....	501.2.06
Steel Poles.....	501.2.07B
Aluminum Poles.....	501.2.07C
Wood Poles.....	501.2.07D
Concrete Poles.....	501.2.07E
Anchor Bolts.....	501.2.08
Frangible Base.....	501.2.09
Ballasts.....	501.2.12
Luminaries.....	501.2.13
Luminaries on Wood Poles .....	501.2.14
Fused Splice Connectors.....	501.2.15

Other materials required for the complete illumination installation shall be as called for herein, on the plans or in the Special Provisions.

### 502.2.02 Equipment List and Drawings

Within 15 days following execution of the contract, the Contractor shall submit to the Engineer a list of equipment and materials which he proposes to install. The list shall include all material which are identified on the plans or in the Special Provisions, listed by manufacturer's name, size and identifying number of each item, when it is necessary or customary in the trade to identify such materials. Such a list shall be supplemented by other data as may be required, including but not limited to detailed scale drawings and wiring diagrams or any nonstandard or special equipment.

Upon completion of the work, the Contractor shall submit to the Engineer any data required to show in detail all changes made from the original plans.

If requested by the Engineer submit 3 copies of isocandela photometric diagrams indicating the vertical light distribution, vertical control limits, and the lateral light distribution classifications for each type of luminaire submitted for approval. Include a letter from the luminaire manufacturer detailing lamp socket position with respect to lamps and refractors furnished for each Illumination Engineering Society (I.E.S.) light distribution type specified.

Upon request, submit 1 copy of candlepower distribution data in I.E.S. format in an ASCII file on a 3 1/2 or 5 1/4 inch IBM compatible computer disk for each type of luminaire submitted. Complete description data is required with the following information:

Vertical angles: Data shall be in increments of 5° or less for the vertical angles of 0° to 90° inclusive.

Horizontal angles: A maximum of 10° increments shall be used for all horizontal angles.

Provide a sample luminaire for inspection and photometric testing if required. Sample luminaire may be considered as part of the shipment furnished for installation.

### 502.3.00 CONSTRUCTION

#### 502.3.01 General

All construction shall be complete and in accordance with the plans, specifications and Special Provisions as determined by the Engineer.

Failure of the Engineer to note faulty workmanship and materials during construction shall not relieve the Contractor of the responsibility for correcting the faults at his own

expense.

Existing material may be incorporated in the work as indicated on the plans or set forth in the Special Provisions. Miscellaneous and incidental materials required for the complete street lights installation that are not mentioned on the plans or in the specifications shall be furnished and placed by the Contractor. Such materials shall be of good quality and suitable for the use intended.

Construction shall meet the applicable subsection of Section 501 TRAFFIC SIGNALS as follows:

Excavation.....	501.3.05
Foundations.....	501.3.05
Conduits.....	501.3.06
Pull Boxes.....	501.3.07
Equipment Control.....	501.3.09B
Pole Placement & Erection.....	501.3.10

Other construction required for the complete street light installation shall be as called for herein, on the plans or in the Special Provisions and as shown on Standard Drawings 5-23 and 5-24 (Street Light Installation).

502.3.02 Cable and Wire

Wiring shall conform to all applicable portions of the NEC. Wiring within cabinets and junction boxes shall be neatly arranged. Powdered soapstone, talc, or other approved lubricants shall be used when inserting conductors in conduit. Before pulling wires through underground conduit runs, the Contractor shall ascertain that the conduits are free from dirt or accumulation or moisture. Wire shall be installed so as to prevent damage to the insulation.

Pre-wired factory equipment shall be installed in accordance with the manufacturer's instructions. All wire and cable shall consist of copper conductors. Wire may be solid or stranded. No aluminum wire shall be used. The use of staples for supporting conductors shall not be acceptable.

After splicing into the circuit at the base of the pole or in the pull box adjacent to the base of the pole fused connectors as set forth in Subsection 501.2.15 FUSED SPLICE CONNECTORS shall be installed. Conductors less than 10 feet above grade shall be enclosed in rigid metal conduit.

At least one foot of slack shall be left for each conductor at each lighting standard, except wood poles, and at least 3 feet of slack at each pull box.

Wire from the fused splice connector to the low pressure sodium ballast shall be UF No. 10-2 with ground on wood poles, and XHHW No. 10 stranded copper on other poles.

Wire from ballast to lamp holders shall conform to manufacturer's recommendations. Any underground utility or underground circuits paralleling or crossing illumination circuits shall be physically separated as directed by the Engineer.

The street light conductors shall be joined by the use of pressure connectors. Splices shall be insulated by the use of moisture-resistant self-fusing tape, applied to a thickness equal to and well lapped over the original conductor insulation, followed by two layers of thermoplastic electrical insulating tape.

#### 502.3.03 Photocell

Unless otherwise specified on the plans or in the Special provisions, photocell shall be per Section 501.2.13 LUMINAIRE.

#### 502.3.04 Cabinets

Equipment control cabinets shall be constructed as called for on the plan and shall be equipped with mounting brackets to securely fasten the cabinets to the wood or steel poles, and with a false back-pan set out from the back of the cabinet to permit adequate galvanizing in the back. Each cabinet shall be rainproof with a top-hinged door provided with a slot to hold the door open and with a bottom latching device for a standard padlock.

The outside face of the service disconnect cabinets and/or equipment control cabinet doors shall be labeled with a permanent metallic sign indicating the voltage of the control and roadway lighting circuit. The sign shall have lettering approximately 3/8-inch high and shall read '208-280 Volt, or 120/240 Volt, Street Lighting'.

All cabinets shall have a dead-front panel installed with slots for operating handles. Dead-front panels up to and including 120 square inches in size shall have a minimum of three holding screws or two top holding tabs and one screw. Panels larger than 120 square inches in size shall be installed with an adequate number of screws to maintain rigidity of the panel.

Installation methods and mounting height of cabinets on utility-owned poles shall be done in a manner satisfactory to the utility company engineer.

#### 502.3.05 Painting

Equipment fabricated of aluminum, stainless steel or from material that is hot-dipped

galvanized shall not be painted except as called for on the plans or in the Special Provisions.

#### 502.3.05A Treatment for Aluminum-Concrete/Steel Contact

The base of aluminum poles or aluminum bases that come in contact with concrete foundations and/or steel standards shall be fitted with a gasket covering the entire contact surface. The gasket shall be constructed from 30-lb. felt.

#### 502.3.06 Electrical Service

##### 502.3.06A General

Service points shown on the plans are approximate only. The exact location will be determined in the field. The contractor shall coordinate all electrical service points with Springfield Utility Board prior to installation. If service equipment is to be installed on utility-owned poles, position and attach the service equipment as required by the serving utility. When the size of wire from the utility company's secondary to the disconnect circuit breaker is not shown on the plans, use the size specified by the NEC, but not less in current carrying conductor than No. 6 AWG. Wiring connections to the terminal screws on the circuit breakers and conductors shall make full contact under the screw head.

Where eyebolts are to be used on signal or illumination poles to receive overhead power service, determine from the local serving utility the direction the eyebolt should face.

Each service cabinet shall contain a solid copper neutral bus and the number and size of switches or circuit breakers as required by the plans or in the Special Provisions. Install all overcurrent protection and relays according to plans and all applicable portions of the NEC. Notify the local serving utility company before making any contacts to utility poles.

As a part of each service installation, furnish and install a meter base (with cover, if required by utility), approved by the serving utility, when shown on the plans.

##### 502.3.06B Circuit Breakers

Circuit breakers - Circuit breakers shall be of the rating shown on the plans or as called for in the Special Provisions. Circuit breakers shall be of the unenclosed molded case bolt-on type with end conductor terminals, suitable for surface mounting in the cabinet on a false back or bracket.

Circuit breakers shall conform to Federal Specifications W-C 375b. All 100 ampere

frame breakers shall be Class 12c for single pole breakers: 225 ampere frame breakers shall be Class 20a: 400 ampere frame breakers shall be Class 21a: 800 ampere frame breakers shall be Class 23a.

Circuit breakers shall be labeled to indicate the circuit controlled.

Over current protections and relay equipment, as called for on the plans or in the Special Provisions, shall be installed according to the best common practice, with materials and installation meeting all applicable requirements of the NEC.

#### 502.3.07 Grounding and Bonding

##### 502.3.07A General

Metallic conduit, metal standards, nonmetallic conduit grounding wire, metallic junction boxes and cabinets shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. Bond together all rigid steel conduit ends that terminate at the same location. Bond the copper equipment ground wire between the metal poles to the grounding rod at each foundation. Use stranded conductors for all ground and bond wires.

The Contractor shall ground the neutral conductor, the control cabinets and meter base to a grounding electrode in conformance with the National Electrical Code.

##### 502.3.07B Ground Rods

Construct accessible grounding conditions with electrodes of at least 5/8" x 10' non-rusting copper covered steel with bronze grounding wire clamp. Drive ground rods full length with the top about 6" below the finished grade at the ground rod locations. Install a separate ground rod for each electrical system which originates from a separate power source.

A grounding electrode shall be installed at each foundation, in addition to the grounding equipment at each power service location. The Contractor shall supply and install at the ground rod at each pole location a separate 1 inch conduit bend, either plastic or steel conduit, with a bare copper wire from a lug inside the pole to the ground rod lug. All metallic conduit within the pole shall also be bonded together and to the grounding electrode. Grounding or bond wire shall be of a size conforming to the NEC.

Ground rods at pole locations shall be driven full length with the top approximately 6 inches below the finished grade at the ground rod locations. In rock locations that prevent full length driving the Contractor may install, with the approval of the Engineer a buried iron and copper plate at the bottom of the concrete foundation hole. Grounding

electrodes shall have impedance sufficiently low to facilitate the operation of the overcurrent devices in the circuit.

The grounding wire shall be bare No. 6 solid copper wire placed through the conduit in the concrete foundations for the metal poles.



The bare copper equipment ground wire between the metal poles shall be bonded to the grounding electrode at each foundation. The grounding nuts shall be located 90 degrees to, and level with the bottom of the handhole.

Where slip plate base poles are installed, the grounding wire shall not intrude into the slip plane. Bonding shall be accomplished by the bond wire from the grounding electrode to a 1/2-inch bolt installed in the bottom base slip plate.

Where standard 4-bolt type anchor base poles are called for, a grounding nut for a 1/2-inch 13 UNC threaded bolt or stud shall be provided on the inside of the shaft. The grounding nut shall be located directly opposite and level with the handhole in the pole.

#### 502.3.07C Nonmetallic Conduit

For bonding purposes in all nonmetallic type conduit, a bare copper wire of the size called for on the plans shall be run continuously. Where nonmetallic conduit is to be installed for future conductors, the copper wire may be omitted.

#### 502.3.07D Wood Poles

On wood poles, all equipment, metallic conduit, etc., shall be grounded.

#### 502.3.08 Maintaining Existing and Temporary Illumination Systems

Existing illumination systems (street and highway lighting and sign illumination), approved temporary replacements thereof, or temporary construction lighting, shall be kept in effective operation for the benefit of the traveling public during progress of the work, except when shutdown is permitted to allow alteration or final removal of the systems. Lighting system shutdowns shall not interfere with the regular lighting schedule unless otherwise permitted by the Engineer. The Contractor shall notify the Engineer prior to performing any work on existing systems.

Determine the exact location of existing conduit runs and pull boxes before using equipment that may damage such facilities or interfere with any system.

The City will continue operation and maintenance, including the furnishing of electrical energy, of existing illumination facilities.

If damage is caused by the Contractor's operations, the Contractor shall, at his expense, repair or replace damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any moneys due or to become due the Contractor.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

Temporary construction lighting installations shall be kept in effective operation until they are no longer required for the protection of the traveling public.

#### 502.3.09 Field Test

The Contractor shall satisfactorily operate the completed lighting system, continuously, for 7 consecutive days before final acceptance.

As an alternative to the above 7 day operation test, the Engineer shall have the option of using the following method for the operation test:

Prior to acceptance, and at the time of final inspection, the Contractor shall cause a burn test of the fixtures to take place. For this purpose, the photo electric eye shall be hooded and temporary power source used to prove illumination of the fixture. If utility company power is available at time of final inspection, no auxiliary power will be required.

Prior to completion; of the work, the Contractor shall cause perform the following tests on all lighting circuits, in the presence of the Engineer.

A megger test on each circuit between the conductor and ground with all switch boards, panel boards, fuse holders, switches, receptacles and over-current devices in place and all readings recorded. The Contractor shall furnish the Engineer with three copies of the test results identifying observed readings with their respective circuits.

The insulation resistance between conductor and ground shall be as follows on circuits with total single conduction length of:

- 2,500 feet and over - at least 6 megohms.
- Less than 2,500 feet at least 8 megohms.

### 502.3.10 Removal

All salvaged material in good condition including luminaries, poles and arms, signs and cabinets not re-used shall remain the property of the City and shall be delivered to Springfield Utility Board by the Contractor. Springfield Utility Board will determine whether salvaged material is in good condition. If it is determined that material is not in good condition said material will become the property of the contractor. The Contractor shall provide a minimum of 24 hours advance notice to Springfield Utility Board prior to delivering salvaged material. Springfield Utility Board will be available to accept salvaged material from the Contractor on normal work days between the hours of 8:00 A.M. to 4:00 P.M. at the following location:

Springfield Utility Board  
1001 Main Street  
South A Street  
Springfield, OR 97477  
Phone: Harry Derhak (503) 726-2395 ext. 410

All other material removed by the Contractor shall become the Contractor's property and shall be the Contractor's responsibility for removal from the project. Payment for delivery of salvaged material and material removed from the project shall be included in the contract bid for work done under this section.

## 502.4.00 MEASUREMENT AND PAYMENT

### 502.4.01 Measurement

There shall be no separate measurement of work done under this Section.

### 502.4.02 Payment

The lump sum price for 'Street Light System Complete' as covered in this Section shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals, inspections, and power hook-ups and for doing all work involved in furnishing and installing the system, as shown in the Contract Documents or directed by the Engineer. This shall include any necessary pull boxes, excavation and backfill, concrete foundations, restoring sidewalk, pavement and appurtenances damaged or destroyed during construction, salvaging existing materials, and making all required tests.

Full compensation for all additional materials and labor, not shown on the plans, or specified, which are necessary to complete the installation of the street light system, shall be considered as included in the price paid for the system, therefore, no additional compensation will be allowed.

