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**PART 00900 - PERMANENT TRAFFIC CONTROL AND ILLUMINATION SYSTEMS****Section 00905 - Removal and Reinstallation of Existing Signs****Description**

**00905.00 Scope** - This work consists of one or both of the following:

- Removing existing signs, specific service signs, and tourist-oriented directional signs (TODS) as shown or directed.
- Removing and moving existing signs, specific service signs, and tourist-oriented directional signs (TODS) from their existing locations and reinstalling them at new locations as shown or directed.

**Construction**

**00905.40 General** - Do not remove signs from existing supports until new supports are in place, ready to receive the signs. Install the signs on the new supports immediately after removing from existing supports. Provide temporary supports as required. Provide permanent supports according to Sections 00910, 00920, and 00930 as required.

Protect specific service signs (business logos) and TODS from damage, whether the signs are to remain in place or are placed on temporary supports, until reinstalled on permanent supports. Repair or replace damaged signs at no additional cost to the Agency. Liquidated damages will be assessed against the Contractor in the amount of \$200 per day for each sign out of service for more than five calendar days.

Install rigid, temporary vertical ties to the back of all extruded aluminum panel signs to prevent buckling of the sign panels and/or their legends during removal, moving and reinstallation of the signs. Repair any damage inflicted to the signs or their legends.

Remove to 1 foot below the ground line those installations with concrete or steel footings set in the ground unless indicated otherwise. Fill the resultant hole and finish the surface to correspond with the surrounding area. Do not remove the existing appurtenances until ordered. Dispose of all existing appurtenances removed and not used in reinstallation, according to 00290.20.

**Measurement**

**00905.80 Measurement** - No measurement of quantities will be made for work performed under this Section.

**Payment**

**00905.90 Payment** - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

<b>Pay Item</b>	<b>Unit of Measurement</b>
(a) Remove Existing Signs .....	Lump Sum
(b) Remove and Reinstall Existing Signs .....	Lump Sum

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

**Section 00910 - Wood Sign Posts**

**Description**

**00910.00 Scope** - This work consists of furnishing and installing preservative treated wood sign posts at the locations shown or as directed.

**Materials**

**00910.10 Materials** - Furnish wood posts of either Douglas fir or Hem fir meeting the following requirements:

Posts.....	02110.40
Preservative Treatment of Posts.....	02190

**Construction**

**00910.40 Post Holes** - Excavate post holes to the lines and grades established and to the depth shown or to a depth necessary to achieve the required mounting height, whichever is greater. If necessary, obtain the required depth by blasting. Do not set the post until the location, lines and grades of the holes have been approved. Align the post to a vertical position in the hole and backfill the hole. Backfill with selected general backfill meeting the requirements of 00330.13. Place in layers not greater than 6 inches. Solidly ram and tamp the layers into the excavated area around the post. Dampen during placement if too dry to compact properly. On completion of the work, replace and finish the surface around the post to match the surrounding surface.

**Measurement**

**00910.80 Measurement** - The quantities of wood sign posts will be measured on the volume basis, to the nearest 0.01 foot board measure (FBM), using nominal sizes and lengths of each wood post installed. Post volume will be determined by multiplying the nominal post size by the commercially available length shown on the standard drawings. For calculation purposes, post length will be determined by rounding the installed length to the nearest higher commercial length.

The estimated wood post lengths will be indicated on the plans. Final lengths of wood posts will be determined or verified by the Engineer prior to fabrication.

**Payment**

**00910.90 Payment** - The accepted quantities of wood sign posts will be paid for at the Contract unit price, per foot board measure (FBM), for the item "Wood Sign Posts".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for route marker frames, wind bracing, or special sign brackets.

## Section 00920 - Sign Support Footings

### Description

**00920.00 Scope** - This work consists of constructing major and minor sign support footings of the dimensions and design shown and at the locations shown or directed.

### Materials

**00920.10 Materials** - Furnish materials for constructing sign support footings meeting the following requirements:

Anchor Bolts.....	02560.30
Backfill (unless otherwise directed).....	00510.10 or 00510.11
Commercial Grade Concrete .....	00440
Conduit .....	02920.10 through 02920.12
Reinforcement.....	00530

### Construction

**00920.40 Excavation and Backfill** - Excavate and backfill footings according to Section 00510.

Finish the surface of backfill to match the existing surface. Where required, reinstall curbs and pavement markings.

**00920.41 Concrete** - Construct concrete sign foundations according to Section 00440 and the applicable portions of 00540.48(a).

Pour concrete spread footings and concrete shaft footings against undisturbed material or backfill with selected granular backfill material according to 00510.11. Compact to 95% maximum density according to 00330.43 or as shown.

During concrete placement, accurately and securely hold in place all anchor bolts or post stubs until the concrete has set.

Remove forms and place subsequent loading according to Table 00540-1.

**00920.42 Reinforcement** - Fabricate and place steel reinforcement according to Section 00530.

**00920.43 Conduit** - Fabricate and install conduit according to Sections 00960, 00970, and 00990.

### Measurement

**00920.80 Measurement** - No measurement of quantities will be made for work performed under this Section.

Estimated quantities of concrete for minor sign supports and estimated quantities of excavation, backfill, concrete, reinforcement, and miscellaneous metal for major sign supports will be listed in the Special Provisions. Miscellaneous metal includes anchor rods and associated hardware, templates, and anchor plates.

### Payment

**00920.90 Payment** - The accepted quantities of work performed under this Section will be paid for at the Contract lump sum amount for the item "Sign Support Footings".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

## Section 00930 - Metal Sign Supports

### Description

**00930.00 Scope** - This work consists of furnishing, fabricating, galvanizing, and erecting metal sign supports.

#### **00930.01 Definitions and Terms:**

**Multi-Post Breakaway Sign Supports** - The complete structure is composed of post stubs, base plates, posts, hinges, sign support members, and fastenings, but does not include the sign support footings.

**Triangular Base Breakaway Sign Supports, Pipe Breakaway Sign Supports, and Square Tube Breakaway Sign Supports** - The complete structure is composed of post stub, base plates, metal post, sign support members, and fasteners, but does not include the sign support footings.

**90 Degree Rotational Sign Supports** - The complete structure is composed of post stubs, base plates, posts, rotator connection, sign support members, and fastenings, but does not include the sign support footings.

**Pipe Sign Supports and Square Tube Sign Supports** - The complete structure is composed of metal post, sign support members and fasteners, but does not include the sign support footings.

**Truss Sign Bridges, Monotube Sign Bridges, Butterfly Sign Structures and Monotube Cantilever Sign Structures** - The complete structure is composed of base plates, support columns, cantilever arms, trusses, horizontal beam, sign support arms, supporting brackets, and fasteners, but does not include the sign illumination equipment, maintenance walkways and sign support footings.

**Bridge Structure Mounts** - The W-shapes or special detailed attachments used for mounting signs to bridge structures, and includes all necessary support brackets, arms, and fasteners, but does not include sign illumination equipment and maintenance walkways.

**Exit Number Sign Mounts** - The S-shape, spacers, special mounting brackets, and fasteners, necessary to install the exit number signs.

**Signal Pole Mounts** - The complete support including horizontal and vertical arms, supporting brackets, and fasteners.

**Adjustable Sign Mounts** - The complete support is adjustable horizontally and vertically to facilitate signal pole mast arm and pole mounting of flat sign sheets. The bracket consists of cast aluminum and galvanized steel elements, stainless steel straps, and fasteners.

**Vertical Sign Mounts on Existing Structures** - The additional or replacement vertical members and fasteners necessary to install a new sign onto an existing major sign support.

**Secondary Sign Mounts** - This group includes tubes, S-shapes, channels, plates, and fasteners necessary to install secondary signs.

**Major Sign Supports** - This group includes Truss Sign Bridges, Monotube Sign Bridges, Butterfly Sign Structures, and Monotube Cantilever Sign Structures.

**Minor Sign Supports** - This group includes Multi-Post Breakaway Sign Supports, Triangular Base Breakaway Sign Supports, Pipe Breakaway Sign Supports, Square Tube Breakaway Sign Supports, 90 Degree Rotational Sign Supports, Pipe Sign Supports, and Square Tube Sign Supports.

**00930.02 Working Drawings** - Submit six copies of unstamped working drawings according to 00150.35 for all structural metal work. Submit six copies of stamped designs, details, plans, and calculations according to 00150.35 for all engineered details and drawings that are not prepared by the Agency but are required by the Contract Documents and Specifications for the Project prior to fabrication. Include the Field Verification of Post Lengths form for Major Sign Supports, available from the Engineer. Material ordered or work done before the Engineer finishes and returns the documents will be at the Contractor's risk.

In addition to the working drawings, submit six copies of all available data including manufacturer's pamphlets and brochures, technical bulletins, working drawings and other technical information relative to products used on the Project. After installation, submit corrected working drawings that represent the material as installed and in operation. Include sufficient information to enable the Agency's maintenance forces to replace all or part of the commercially manufactured sign structures, under routine or emergency maintenance, by direct reference to the information furnished by the Contractor.

Working drawings are not required for the following types of steel supports:

- Multi-Post Breakaway Sign Supports
- Triangular Base Breakaway Sign Supports
- Signal Pole Mounts
- Exit Number Sign Mounts
- Secondary Sign Supports
- Route Marker Frames
- Square Tube Sign Supports

Working drawings for these supports will be provided by the Agency's Engineer of Record. Use the Field Verification of Post Lengths form, available from the Engineer, to provide the necessary site data to the Engineer of Record for use in producing working drawings. All work done, or materials ordered, before receiving working drawings from the Engineer of Record will be at no additional cost to the Agency.

**00930.09 Identifying Tags** - Overhead and butterfly sign support structures, except structure mounts, shall have stainless steel or brass identifying tags attached to all posts, arms, and truss sections. The tags shall be at least 1/16 inch thick. Tag lettering shall be at least 1/4 inch in height, and shall be stamped into the tag. Tags shall be attached with stainless steel pop rivets of at least 3/16 inch nominal body diameter. Do not locate pop rivet holes within 6 inches of welds. Post tag shall be located approximately 5 feet above the baseplate. Holes for pop rivets shall be drilled prior to hot-dip galvanizing. Remove excess hot-dip galvanizing from holes and repair according to ASTM A 780.

Tags shall include the following information:

- Structure number
- Manufacturer
- Month and year of manufacture
- Highway number and mile point

## Materials

**00930.10 Materials** - Furnish structural steel materials meeting the applicable portions of Section 02530, with weights and sizes as shown or specified.

Furnish galvanized bolts, nuts, hardened washers, and direct tension indicators meeting the requirements of Section 02560, except the rotational capacity test of 02560.60(a) does not need to be repeated at the job site.

All components of steel sign structures shall be galvanized after fabrication and before assembly. Galvanizing shall conform to the requirements of Section 02530.

## Labor

**00930.30 Fabricators** - Fabricators of metal sign supports shall have either a current AISC Simple Steel Bridge Structures (Sbr) certification or a current AISC Major Steel Bridges (Cbr) certification.

## Construction

**00930.40 Fabrication and Erection** - Fabricate and erect according to the applicable portions of Section 00560, except where in conflict with the following:

**(a) General** - Erect breakaway sign posts, pipe sign posts and pipe support columns at a true vertical.

Where two or more posts are required to support a sign, orient and position both posts so that no twist or warp will be imparted to the sign panels.

**(b) Assembly of Metal** - Accurately assemble the parts as shown on the plans and follow any match marks. Handle the material carefully so that no parts will be bent, broken or otherwise damaged. Clean bearing surfaces and surfaces to be in permanent contact before the members are assembled. Roughen faying surfaces of slip-critical structural connections utilizing high strength bolts by means of hand wire brushing after galvanizing. Power wire brushing is not allowed.

**(c) Welding** - Weld steel sign structures according to AWS D1.1. The fabricator shall inspect welds according to with details and requirements called out on the Contract Documents. This requirement will override all appropriate weld inspection requirements called out in Section 5.15 WELDING CONNECTIONS in AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals". Submit all testing procedures for Engineer's review prior to starting inspection. Submit certified copies of inspection reports to the Engineer for review.

If requested by the Engineer, additional weld inspection may be required upon arrival of the material at the job site. If defects are found by this additional inspection, the Contractor shall be responsible for the additional testing and repair costs. If no defects are found, the Engineer will be responsible for the additional inspection costs.

**(d) Bolt Installation** - Do not reuse galvanized high strength bolts. Other high strength bolts may be reused, if approved, but not more than once. Retightening previously tightened bolts that may have been loosened by the tightening of adjacent bolts will not be considered a reuse.

Provide all high strength bolts with hardened washers under the element (nut or bolt head) turned in tightening. If a high strength bolt is installed in an oversized or short slotted hole in an outer ply, use a hardened washer. If a high strength bold is installed in a long slotted hole in an outer ply, use a plate washer or a continuous bar made of structural grade steel at least 5/16 inch thick with standard holes. Make the washer or bar sufficiently large to completely cover the slot after installation.

Protect fasteners from dirt and moisture at the jobsite. Do not remove the lubricant that is present in as-delivered condition. Clean and relubricate fasteners that accumulate dirt according to 02560.70.

**(1) Bold Installation for Slip Bases (Breakaway)** - Furnish, at no additional cost to the Agency, a calibrated torque wrench of a capacity appropriate to the size of the high-strength bolts installed and tightened. Confirm the accuracy of the calibrated torque wrench through calibration by an approved testing agency at least once a year.

Remove any dirt and moisture from the lubricated fasteners, and recoat the lubricated fasteners with a fresh, second coat of lubricant immediately before tightening. Tighten the bolts, in the presence of the Engineer, to the minimum torque or tension shown to seat the bolts in the base plate slots. After all the bolts in the slip base are tightened, loosen each bolt and retighten to the prescribed torque or tension shown in the same order as the initial tightening.

**(2) Bolt Installation for Slip-Critical Connections** - Tighten high strength bolts by direct tension indicator method unless noted otherwise. The calibrated torque wrench method of final tightening is not acceptable. Use of direct tension indicators is not allowed with Type 3 high-strength bolts in AASHTO M 270, Grade 50W (ASTM A 709, Grade 50W; ASTM A 588), unpainted weathering steel connections.

**a. Direct Tension Indicator Tightening** - Install new and unused direct tension indicator washers meeting the requirements of 02560.20(d) and 02560.40(b) at each bolt. Do not permit the surfaces contacting the protrusions of the direct tension indicator washer to turn during tightening. Bring each bolt to a snug-tight condition as indicated by partial compression of the direct tension indicator protrusions. Then tighten all fasteners in the connection, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening before final tightening to deform the protrusion to nil gap or as specified.

A "nil gap" is defined as the condition that exists when at least half of the spaces between the direct tension indicator protrusions refuse entry to a 0.005 inch feeler gauge, and a visible gap exists in at least one space.

**b. Turn-of-Nut Tightening** - During all turn-of-nut tightening, proceed systematically from the most rigid part of the connection to the free edges. Tighten all bolts until they are simultaneously snug tight and the connection is fully compacted. Snug tight is defined as the tightness that exists when all plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a worker using a 12 inch long wrench. Following this initial operation, further tighten all bolts in the connection by the amount of rotation specified in Table 00560-3 in Section 00560. During the tightening operation do not permit rotation of the part not turned by the wrench.

**(e) Bolt Inspection:**

**(1) General** - The Engineer will observe the installation and tightening of bolts to determine that the selected tightening procedure is properly used and that all bolts are tightened, and in the case of direct tension indicators that the correct indication of tension has been achieved. Bolts may reach tensions substantially above the value given in Table 00560-1 in Section 00560, but this will not be cause for rejection.

**(2) Direct Tension Indicator Method** - Provide the Engineer full opportunity to witness installation of bolted connections. The Engineer will periodically observe the installation and tightening operations to ensure that proper procedures are being adhered to.

Upon completion of a bolted joint, the Engineer will determine that all bolts have been tightened. A minimum of 10%, but not less than two bolts in each joint, will be inspected. If all gaps checked are nil or as shown, the joint will be accepted as properly tightened. If gaps checked are in excess of the above, reinspect all bolts and retighten bolts in the joint, as required, then resubmit the joint for inspection.

Apply the feeler gauge to all of the openings between protrusions around the indicator circumference. To satisfy the nil gap requirement, the feeler gauge shall be refused by at least one-half of the applied places.

**(3) Turn-of-Nut Method** - When all turn-of-nut tightening activities have been witnessed and are acceptable by the inspector, no additional bolt tightening inspection is required. If turn-of-nut tightening has been performed without being witnessed by the inspector, use the following inspection procedure:

- In the presence of the Engineer, use an inspection wrench, which may be a calibrated torque wrench.
- Place three bolts of the same grade, diameter and condition as those under inspection individually in a calibration device capable of indicating bolt tension. Use a hardened washer under the part turned in tightening each bolt.
- Tighten each bolt specified in the paragraph above in the calibration device by any convenient means to an initial condition equal to 20% of the required tension, and then to a tension not less than 5% greater than specified for its size in Table 00560-1 in Section 00560. Tightening beyond the initial condition shall not produce greater nut rotation than 1.5 times that allowed in Table 00560-3 in Section 00560. Then apply the inspecting wrench to the tightened bolt and determine the torque necessary to turn the nut or head 5 degrees, approximately 1 inch at 12 inches radius, in the tightening direction. Take the average torque measured in the tests of three bolts as the job inspecting torque to be used in the manner specified in the next paragraph.
- Test bolts that have been tightened in the structure and are represented by the sample prescribed above with the inspecting wrench. Apply the job inspecting torque to 10% of the bolts, but not less than two bolts selected at random. If no nut or bolt head is turned by this application of the job inspecting torque, the connection will be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque, test all bolts in the connections. Retighten all bolts whose nut or head is turned by the job inspecting torque, and re-inspect. Retighten all of the bolts in the connection and then resubmit the connection for the specified inspection.

**00930.41 Adjustable Sign Mounts** - The mount shall allow vertical adjustment for positioning the sign and shall rotate to plumb the sign. Use galvanized or stainless steel nuts, bolts and washers for fasteners.

### **Measurement**

**00930.80 Measurement** - No measurement of quantities will be made for metal sign supports.

Estimated quantities of structural steel will be listed in the Special Provisions. If field verified post lengths increase or decrease by more than 25% of the length specified, adjustments to the Contract lump sum amount will be made according to 00190.10(h).

## Payment

**00930.90 Payment** - The accepted quantities of metal sign supports will be paid for at the Contract unit price, per unit of measurement, for the following items:

<b>Pay Item</b>	<b>Unit of Measurement</b>
<b>Major Sign Supports</b>	
(a) Truss Sign Bridge .....	Lump Sum
(b) Monotube Sign Bridge .....	Lump Sum
(c) Butterfly Sign Structures .....	Lump Sum
(d) Monotube Cantilever Sign Structures .....	Lump Sum
<b>Mounts</b>	
(e) Bridge Structure Mounts .....	Lump Sum
(f) Exit Number Sign Mounts .....	Lump Sum
(g) Signal Pole Mounts .....	Lump Sum
(h) Adjustable Sign Mounts .....	Lump Sum
(i) Vertical Sign Mounts on Existing Structures .....	Lump Sum
(j) Secondary Sign Mounts .....	Lump Sum
<b>Minor Sign Supports</b>	
(k) Multi-Post Breakaway Sign Supports .....	Lump Sum
(l) Triangular Base Breakaway Sign Supports .....	Lump Sum
(m) Pipe Breakaway Sign Supports .....	Lump Sum
(n) Square Tube Breakaway Sign Supports .....	Lump Sum
(o) 90 Degree Rotational Sign Supports .....	Lump Sum
(p) Pipe Sign Supports .....	Lump Sum
(q) Square Tube Sign Supports .....	Lump Sum

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for route marker frames or special sign brackets.

## Section 00940 - Signs

### Description

**00940.00 Scope** - This work consists of furnishing, fabricating, and erecting traffic signs of the types shown.

**00940.02 Types of Signs** - Traffic signs are classified by sign type according to the descriptions in 02910.02. Use either retroreflective, reflective, or nonreflective sign sheeting as shown and according to 02910.02.

Use sign sheeting colors conforming to the Federal Highway Administration "Color Specifications for Retroreflective Sign and Pavement Marking Materials". In addition, specified color coordinates shall be subject to visual matching by the Engineer to determine that all panels in any one sign match.

**00940.03 Drawings** - Copies of working drawings for non-standard signs will be made available to the Contractor by the Engineer. Standard signs called for in the Contract Documents shall be constructed using drawings available in FHWA's "Standard Highway Signs" (FHWA English Version) or ODOT's "Sign Policy and Guidelines for the State Highway System". The ODOT sign policy is available for purchase from the ODOT Procurement Office, Salem.

### Materials

**00940.10 Materials** - Furnish materials for signs meeting the requirements of Section 02910.

### Construction

**00940.40 General** - Finished signs shall conform to the designs shown or specified.

Choose the substrate material from the following table:

Sign Size	Acceptable Substrate Materials
Up to 4 feet x 5 feet	Sheet aluminum Plywood Extruded aluminum panels
From 4 feet x 5 feet to 4 feet x 8 feet	Plywood Extruded aluminum panels
Over 4 feet x 8 feet	Extruded aluminum panels
Over 8 feet in any dimension	Extruded aluminum panels

Street name signs mounted on signal pole mast-arms, and EXIT ONLY panels riveted to extruded aluminum panels, may exceed the width limit of 4 feet for sheet aluminum substrate.

See Table 02910-1 in Section 02910 for sheet aluminum thicknesses for various sizes of signs.

Fabricate all components of each individual sign with sheeting from the same supplier, to ensure that all components are compatible, and are warrantable by the manufacturer. Removable legend does not have to be fabricated with sheeting from the same supplier as the background sheeting on the sign panels.

Construct standard signs as shown in the FHWA "Standard Highway Signs" manual or in ODOT's "Sign Policy and Guidelines for the State Highway System".

#### **00940.41 Aluminum Panel Sign Fabrication:**

**(a) General** - Fabricate aluminum panel signs as shown or specified. Do not round corners of panels outside the border. Reinforced sheet aluminum signs will not be allowed. All aluminum used for sign panels shall be new material.

**(b) Extruded Aluminum** - Each panel of extruded aluminum panel signs shall be a continuous section. Apply the sign sheeting to the extrusion a sufficient distance around the edge to ensure that no aluminum surface is visible on the face of the sign.

**(c) Sheeting** - The sign sheeting applied to the extrusions shall be the background color of the sign.

**(d) Legend** - Signs consisting of only one extrusion may use permanent legend.

**(e) Transparent Paste** - Do not use transparent paste background on extruded aluminum signs.

#### **00940.42 Sheet Aluminum Sign Fabrication:**

**(a) General** - Cut the sheet aluminum sign to size and shape as shown or specified. The sign shall be free of buckles, warps, dents, cockles, burrs and defects resulting from fabrication.

Before application of retroreflective, reflective, or nonreflective sheeting, treat the entire surface of the sign with a conversion film according to the sheeting manufacturer's recommendations.

#### **(b) Mounting Holes:**

**(1) On Posts** - Signs having a vertical dimension of less than 48 inches and mounted on wood or metal posts shall have at least two mounting holes. Signs having a vertical dimension of 48 inches or greater shall have three mounting holes. Place the third mounting hole near the center of the sign. Locate mounting holes so the mounting hardware will not cover any portion of the legend unless otherwise shown.

**(2) On Extruded Aluminum Signs** - Provide a minimum of eight mounting holes for sheet aluminum signs mounted on extruded aluminum signs.

**00940.43 Plywood Sign Fabrication** - Perform all fabrication with saw blades that do not tear plywood grain. Cut all holes clean and uniform. Splicing will not be allowed unless specified. Locate mounting holes so that the mounting hardware will not cover any portion of the legend. Provide mounting holes for signs according to 00940.42(b).

After fabrication and before the application of retroreflective, reflective, or nonreflective sheeting, seal all edges with plywood sealer tinted to match the color of the panel overlay material. Where retroreflective, reflective, or nonreflective sheeting is to be applied, prepare the surface of the sign according to the sheeting manufacturer's recommendations.

**00940.44 Retroreflective, Reflective, or Nonreflective Sheeting Application** - Apply the sheeting according to the sheeting manufacturer's recommendations on extruded aluminum panel signs. Up to 25% of the extruded aluminum panel signs required in the plans will be allowed one manufacturer's splice for each sign. One patch will be allowed for each 50 square feet of sign to a maximum of three patches for each sign. Patches shall be between 3/4 inch and 3 3/8 inches in diameter. No Contractor splices will be allowed.

On all other signs, manufacturer's splices will not be allowed except as noted on approved shop drawings, or when sign dimensions exceed the sheeting manufacturer's capabilities. Make these splices horizontal with the upper section of sheeting overlapping the lower by a minimum of 3/8 inch on encapsulated lens sheeting, and butt splice prismatic lens sheeting with no appreciable substrate visible. The use of overlaid transparent paste or electronic cuttable film will not be allowed on overlapped splices. No Contractor splices will be allowed.

#### 00940.45 Legend Installation:

**(a) General** - The word "legend" means the entire message and border for a sign. A group of words, numbers and/or symbols constitute the "message" for a sign. Install the type of legend for each traffic sign as shown and according to 00940.02.

Spacing between letters and/or numbers shall conform to the FHWA "Standard Alphabets for Highway Signs" manual.

Spacing between words for Series "E" (modified) legend shall be 1.5 times the upper case letter height. Spacing between words for other fonts shall be as tabulated below unless otherwise shown:

Legend Series	Word Spacing
B	(0.531) H
C	(0.625) H
D	(0.836) H
E	(1.000) H

H = height of upper case letter

Spacing between symbols shall conform to FHWA "Standard Highway Signs" unless otherwise shown.

Space all lines equally between side borders unless otherwise shown. Space the legend vertically as shown. For diamond shaped signs, space between lines in the legend a minimum of one half the average letter height and space between the message and the borders equally so the message is centered on the sign.

**(b) Attachment** - Attach removable legend to aluminum panels using aluminum, domed head, 1/8 inch diameter, self-plugging blind rivets. Remove aluminum shavings from the sign face before attaching the legend. The entire sign will be rejected if any shavings are left beneath the legend. Drill 0.128 inch diameter holes in the removable legend and sign panel as shown on the "Mounting Details for Removable Legend" standard drawings.

Apply screened legend according to the sheeting manufacturer's recommendations. Apply cut-out legend according to 00940.44.

Attach 1 inch retroreflective removable border sections by placing two rivets 1/2 inch from the end of each border section with additional rivets spaced at a maximum of 6 inches apart, centered in the section. Corner border sections shall be attached with a minimum of five rivets, two rivets 1/2 inch from each end, and the remaining rivet centered in the middle of the section.

Attach 2 inch retroreflective removable border sections by placing two rivets 1/2 inch from the end of each border section with additional rivets spaced at a maximum of 6 inch apart, along the top and bottom edge of the section. Corner border sections shall be attached with a minimum of five rivets, two rivets 1/2 inch from each end, and the remaining rivet centered in the section.

**(c) Border Sizes** - Unless otherwise shown, the width of the sign borders shall be according to the following:

Maximum Letter Size	Border Width
5" Capital or Upper Case	1/2 inch
8" or 10 2/3" Upper Case	1 inch
10" or 12" Capital	1 inch
13 1/3" or 16" Upper Case	2 inches
15" or 16" Capital	2 inches

The corner radii shall be approximately one-eighth of the least dimension of the sign. Determine the corner radii by rounding this approximate value to the nearest 1 1/2 inches, 3 inches, 6 inches, 9 inches, or 12 inches.

Except for the corners, mount the border flush with the edge of the sign. Do not round the corners of the aluminum panels.

**00940.46 Inspection** - The Engineer will inspect signs at the fabrication shop or at the jobsite. Inspection will be for conformance to plans and Specifications. Testing for nighttime visibility will be according to ODOT TM 804. The Contractor's expense for sign inspection will be according to 00165.91.

**00940.47 Sign Erecting** - Erect all signs at the locations staked and as shown or directed. Do not erect individual signs until the sign is complete with legend. Signs not mounted as shown or directed will not be accepted.

Erect the signs so the sign face is vertical, unless otherwise directed.

When signs are installed on supports 10 feet or less from the edge of guardrail, curb, or shoulder, set them to reflect 3 degrees away from traffic. When signs are installed on supports more than 10 feet from the edge of guardrail, curb or shoulder, set them to reflect 3 degrees toward traffic.

The closest edge of any column or overhead sign structures shall be as shown.

Where signs are mounted to supports by bolting through the sign, a sheeting manufacturer approved lubricant may be used on the nylon and metal washers to prevent sign sheeting deformation. Replace damaged signs, or signs with sheet deformation, with new signs at no additional cost to the Agency.

If a sign installation is a replacement for an existing sign, install the new sign immediately after removal of the existing sign unless otherwise directed.

### Measurement

**00940.80 Measurement** - The quantities of signs will be measured on the area basis, by multiplying the height by width, using the dimensions shown. No deductions will be made for irregular shapes cut from the rectangle.

Route markers and other signs fastened to the face of larger signs will be measured as separate signs.

### **Payment**

**00940.90 Payment** - The accepted quantities of signs will be paid for at the Contract unit price, per square foot, for the item "Type \_\_\_\_\_ Signs In Place".

The type of sign will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Payment for work done under this Section will be limited to 75% of the amount due until the Agency has received the signed warranties required by 02910.75.

**Section 00941 - Sign Covers****Description**

**00941.00 Scope** - This work consists of covering sign faces as shown, specified, or directed.

**Materials**

**00941.10 Materials** - For permanent signs, furnish sign covers from the QPL or porous cloth covers pre-approved by the sign sheeting manufacturer. Do not use plywood.

For temporary signs comply with Section 00225.

**Construction**

**00941.40 Fabrication** - Fabricate sign covers in one piece, unless otherwise directed. Make them large enough to completely cover the sign, and capable of easy attachment to the sign without damaging the sign face.

**00941.41 Installation** - Lap covers over all sign edges and secure to the sign or support as recommended by the sign sheeting manufacturer.

**00941.42 Alternate** - The Contractor may elect one or more of the following as alternate methods subject to approval:

- Install signs in conjunction with the movement of the traffic flow.
- Remove demountable legend from signs and re-install legend as directed.
- Remove entire sign and store in a vertical position for future reinstallation.

**Measurement**

**00941.80 Measurement** - No measurement will be made for sign covers.

**Payment**

**00941.90 Payment** - No separate or additional payment will be made for sign covers or for the alternate methods listed in 00941.42. Payment will be included in payment made for the appropriate items under which this work is required.

## Section 00950 - Removal of Electrical Systems

### Description

**00950.00 Scope** - This work consists of removing existing electrical systems as shown or specified.

#### **00950.02 Definitions:**

**Electrical Systems** - Electrical systems will be described in the Special Provisions.

### Construction

**00950.40 General** - Remove existing electrical systems in the order directed.

Keep existing electrical systems to be removed in operation until the new electrical systems are ready to be turned on or as directed. Keep authorized downtime to a minimum. Perform the changeover with a minimum disruption to traffic.

Remove existing materials, as specified or approved, which interfere with or which are incompatible with new construction before completion of the new construction. Notify the Engineer at least four calendar days in advance of removal.

**00950.41 Removal and Abandonment** - Remove from the right of way conductors, junction boxes, wood poles, and foundations. Dispose of materials according to 00290.20. Abandon conduit by removing all wiring, elbows, and risers.

If a foundation is shown as abandoned, remove the top of the foundation, anchor bolts, and conduits to a depth not less than 2 feet below the adjacent finished ground line. Backfill resulting holes with material equivalent to the surrounding material. Finish and blend the surface area to the adjacent surface area.

Repair all holes or damage to existing surfacing caused by removal of existing installations as directed at no additional cost to the Agency.

### Measurement

**00950.80 Measurement** - No measurement of quantities will be made for work performed under this Section.

### Payment

**00950.90 Payment** - Payment for work performed under this Section will be made by either method "A" or method "B" as follows:

- **Method "A"** - Method "A" will be used when existing electrical systems are removed and replaced with new electrical systems. Under method "A" no separate payment will be made for removal of electrical systems.

Payment for removal of existing electrical systems will be included in payment made for the appropriate new electrical system.

- **Method "B"** - Method "B" will be used when existing electrical systems are removed and are not replaced with new electrical systems. Under method "B" payment will be made at the Contract lump sum amount for the item "Removal of Electrical Systems".

Payment will be payment in full for all furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

## Section 00960 - Common Provisions for Electrical Systems

### Description

**00960.00 Scope** - This work consists of furnishing and installing materials for electrical systems and for modifying existing systems.

**00960.01 Regulations, Standards, and Codes** - All electrical materials and workmanship shall conform to the following standards where applicable:

- American National Standards Institute (ANSI)
- International Municipal Signal Association (IMSA)
- Underwriter's Laboratories, Inc. (UL)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NESC)
- National Electrical Code, Oregon Amended (NEC)
- Standards of the American Society for Testing and Materials (ASTM)
- Local laws

Wherever reference is made to any of the standards mentioned above, the reference means the code, order, or standard in effect on the date the Project is advertised unless otherwise shown or specified in the Specials Provisions.

Do not begin installations until all permits are obtained and copies are given to the Engineer.

**00960.02 Equipment List and Drawings** - Within 30 calendar days after execution of the Contract, submit at least six copies of:

- A list of materials the Contractor proposes to install. List all material shown or specified by manufacturer's name, size, and identity number of each item. Supplement the list with other data, including but not limited to, detailed scale drawings.
- Wiring diagrams for all circuits and any nonstandard or special equipment.
- Brochures, technical bulletins, parts lists, service instructions, working drawings and other technical information relative to products proposed for use on the Project.
- Use materials from the current list of acceptable materials. The updated list is available from the Engineer. Mark the list according to the instructions on it. The list eliminates the need for most catalogue cutsheets.

All engineered details and drawings which are not prepared by the Agency, but are required in the Contract Documents, shall be submitted for review prior to fabrication. Submit stamped designs, details, plans, and calculations according to 00150.35.

Upon completion of the installation, submit six copies of all changes made from the original plans. The information furnished shall include all modifications made and shall represent the material installed and in operation. It shall be sufficiently detailed to enable maintenance forces to replace or repair any part of the Project under routine or emergency maintenance by direct reference.

## Materials

**00960.10 Materials** - Furnish electrical materials meeting the requirements of Section 02920.

Furnish concrete meeting the requirements of Section 00440.

## Labor

**00960.30 Licensed Electricians** - According to the Oregon Administrative Rule 918-282-0120(1), every person engaged in the installation of electrical equipment and wiring systems shall possess a valid Oregon Electrical Supervising or Journeyman's License, or be registered as an Electrical Apprentice. Every person who installs electrical systems on the Project shall submit a copy of his or her electrical license or apprentice registration to the Engineer prior to performing any work.

## Construction

**00960.40 General** - The Agency will continue normal maintenance and operations of the existing systems including the furnishing of electrical energy.

**00960.41 Excavation:**

**(a) General** - Remove and replace sidewalks, paved surfaces, and other materials as needed. Place the conduit under curbs without disturbing curbs. Replace and finish all surfaces to correspond with the existing surfaces. Restore all disturbed landscaping and underground systems to original condition. Use hand excavation if directed.

Excavate trenches to lines, grades and cross sections established or approved. Furnish, place, and remove any shoring required to prevent caving of walls.

When excavating in paved areas, cut with an approved pavement cutting saw to a depth of at least 2 inches along the neat boundaries of the area to be removed. Cut sharp and well-defined pavement edges with no evidence of cracking, delaminating, or stressing.

**(b) Excavation for Pedestal and Cabinet Foundations** - Make all excavations to the neat lines of the foundations. Hand excavation may be required. Place the concrete directly against the sides of the excavation in undisturbed or well-compacted material.

**(c) Excavation for Conduit** - Excavate and backfill conduits as follows:

### Minimum Cover from Finished Surface <sup>1</sup>

Type of Conduit	Roadway and Shoulders	Other Areas
Metal	24 inches	18 inches
Rigid Nonmetallic	30 inches	18 inches

<sup>1</sup> Use permit depths if greater than these.

**(d) Conduit under Paved Surfaces** - Install conduit under all paved surfaces by horizontal directional drilling or the open trench method.

**(1) Horizontal Directional Drilling** - Drilling shall not "hump" or deform the pavement and shall be guided. Keep drilling pits at least 2 feet from the edge of pavement unless otherwise

authorized in writing. Do not use water to the extent that the pavement might be undermined or subgrade softened. Sand bedding and marking tape are not required with this method.

**(2) Open Trench** - If the open trench method is used, do the following:

- a. **Width** - Hold trench width to a practical minimum.
- b. **Pavement Cuts** - Cut the existing pavement as required in 00960.41(a).

**(e) Conduit under Railroad Tracks** - Install conduit inside a galvanized, rigid metal conduit at the depth required by the governing railroad company. Construct so that conduit ends are at least 30 feet beyond the centerline of every track or other distance as required by the railroad.

**(f) Disposition of Waste Materials** - Dispose of all waste materials according to 00330.41(a-5).

**(g) Backfill** - Use an approved sand blanket, selected general backfill meeting the requirements of 00330.13, selected granular backfill meeting the requirements of 00330.14, or concrete meeting the requirements of Section 00440 as follows:

**(1) Rigid Nonmetallic Conduit** - For rigid nonmetallic conduit, provide bedding, cover, and backfill according to the following:

- a. **Bedding** - Place 2 inches of sand blanket in trench bottom before placing conduit.
- b. **Cover** - Cover conduit with 2 inches of additional sand blanket.
- c. **Backfill** - Backfill according to the following:
  - 1. **New Roadway and Shoulder** - Place selected granular backfill material in layers not greater than 6 inches thick. Compact the selected granular backfill material according to 00405.46(c-2).
  - 2. **Existing Roadway and Shoulder** - Backfill all conduit trenches with CLSM according to Section 00442. Place to an elevation 6 inches below the surface of the existing pavement or to the bottom of the existing pavement, whichever is lower. When this method is used the sand blanket may be omitted.
  - 3. **Unpaved Areas** - Place selected granular backfill material in layers not greater than 6 inches thick. Compact the selected granular backfill material according to 00405.46(c-2) to the top of trench, surrounding ground level or upper limit of excavation. The sand blanket requirement of a. and b. above may be deleted as approved when excavated material does not contain large, angular stones that could fracture or dent conduit.
- d. **Pavement** - Place and compact AC and PCC according to Sections 00744, 00745, 00755, and 00756, as applicable, and the following:
  - 1. **Existing Non-roadway Pavement** - Match existing surfacing thickness.
  - 2. **Existing Roadway and Shoulder** - Match existing surfacing thicknesses or provide a minimum surfacing thickness of 6 inches, whichever is greater.
  - 3. **Finish** - Finish to a smooth riding surface.

**(2) Rigid Metal Conduit** - For rigid metal conduit, provide backfill according to 00960.41(g-1-c) and 00960.41(g-1-d) except the sand blanket is not required.

**00960.42 Conduit:**

**(a) General** - Conduit runs shown on the plans are for bidding purposes only. Locations may be changed to avoid obstructions. Larger size conduit than specified may be used at the option and cost of the Contractor. Use the same size conduit for the entire length, outlet to outlet.

Use non-metallic or rigid metal conduit as shown or specified.

Install a No. 16 AWG THWN stranded copper wire with orange base and blue tracer in all conduits as a locate wire, even if not shown. Extend the wire 2 feet beyond conduit ends and install a wire nut. Do not join multiple locate wires under a common wire nut.

In areas to be paved or landscaped, place all conduit before paving or landscaping.

If corrosive soil conditions exist, coat metallic conduit with a non-metallic coating or wrap with corrosion protection tape at least 10 mils thick.

**(b) Conduit on Wood Poles** - Mount conduit on wood poles with two-hole, galvanized, steel conduit straps spaced no more than 3 feet apart. Mount conduit on utility-owned wood poles according to local utility regulations. Use stand-off brackets if required.

**(c) Conduit on Metal Poles** - Mount conduit on metal poles with 3/4 inch, stainless steel straps or a single-hole, galvanized steel strap, drilled and tapped with galvanized bolts. Place straps no more than 3 feet apart. After tightly drawing steel bands, cut and fold under the ends to eliminate protruding edges.

**(d) Conduit in Foundations** - Use fiberglass conduit and extend it as follows:

- 2 inches to 3 inches vertically above the top of the foundation
- 10 inches to 12 inches horizontally beyond edge or vertically below the foundations

**(e) Underground Conduit Installation** - Make conduit runs continuous between any pole, junction box, or cabinet. Do not cover conduit runs until inspected. Permanently mark all underground conduit runs by installing an underground marking tape directly over the conduit.

The underground marking tape shall be:

- Placed 6 inches  $\pm$  1 inch below the surface.
- Continuous between pole bases, junction boxes and cabinet locations.

**(f) Elbows** - Use a standard factory bend where a conduit bend is required that:

- Has a radius of at least six times the inside diameter of the conduit.
- Is bent without crimping or flattening.
- Is fiberglass conduit.

**(g) Conduit Ends and Couplings** - Ream the ends of all conduits to remove burrs and rough edges. Make cuts square and true so the ends will fit together for their full circumference. Slip joints or running threads will not be allowed for coupling conduit. Plug or cap all conduit ends until wiring is installed. After wiring is installed install duct seal compound or precut closed cell polyethylene foam that will prevent debris from entering the conduit system.

**(1) Metallic Conduit** - Paint the following with rust-preventative coating:

- Threads on all metal conduit
- Areas where the coating has been damaged so underlying metal is exposed.
- Exposed, ungalvanized threads resulting from field cuts.

**(2) Nonmetallic Conduit** - Connect nonmetallic conduit with solvent welds. Use a nonmetallic female threaded connector to connect nonmetallic conduit to metallic conduit.

**(3) Riser** - Provide and install conduit risers within junction boxes according to the following:

- Use PVC conduit risers with fiberglass elbows.

**(4) Bushings** - Provide and install bushing according to the following:

- **Push on PVC End Bell** - Use push on PVC end bells with fiberglass elbows, PVC risers, nonmetallic junction boxes with nonmetallic lids.
- **Metallic Bushing** - Use metallic bushings with rigid metallic elbows, metallic risers, and junction boxes containing circuits less than 25 V.
- **Metallic Bonding Bushing** - Use metallic bonding bushings with rigid metallic elbows, metallic risers, and junction boxes containing 25 V or greater circuits.

**(h) Conduit in Junction Boxes:**

**(1) General** - Install conduit in junction boxes according to the following:

- Enter through the bottom of boxes.
- Enter the box from the direction of the run.
- If shown, terminate conduit 1 inch inside the box wall when entering through the side walls.

**(2) Cast Iron Junction Boxes** - Conduit entrances into new or existing cast iron junction boxes shall:

- Use a watertight malleable iron hub for metal conduit entrances when installed in pavement or earth.
- Use lock nuts and a metallic bushing for metal conduit entrances when installed in cast in place portland cement concrete walls, barrier, or structures.
- Be cut with a hole saw.
- Repair damage to galvanizing.

**(3) Concrete Junction Boxes** - Install conduit entrances into concrete junction boxes according to the following:

- Locate conduits near the end walls to leave the major portion of the box clear.
- Orient conduit ends towards the top of the box so that conductors may be pulled out of the conduit from the top of the box without touching the side of the box or other conduits.

**(i) Conduit Installed for Future Use** - If conduit is noted on the plans for future use, with no conductors installed, insert a polyethylene pull line.

Include 3 feet of slack in the polyethylene pull line within the conduit and 3 feet outside the conduit.

**(j) Existing Conduit** - Use existing conduit only where shown. Clean existing conduit, without conductors, with a mandrel or cylindrical wire brush, and blow out with compressed air before incorporating into the new system.

**(k) Conduit In or On Structures** - Install conduit in or on structures as shown. Use expansion fittings at all expansion joints in or on a structure.

**(l) Installation by Horizontal Directional Drilling** - If jointed conduit is used, verify the joints have not separated by pulling a mandrel through the conduit after installation.

### **00960.43 Foundations:**

**(a) General** - Construct foundations for pedestals, posts, and cabinets according to Section 00440 and the applicable portions of 00540.48(a). Place concrete:

- With a continuous pour.
- To the elevation shown or directed.
- With conduit ends and anchor bolts held securely in proper vertical position, to proper height, using a manufacturer's recommended template until the concrete sets.
- Maintain rebar clearances during concrete pour.

Make no adjustment of anchor bolts after concrete has set.

Set forms square and true to line and grade. Construct forms of rigid materials that remain in position until removed.

Remove forms and place subsequent loading according to Table 00540-1.

Finish tops of foundations to roadway, sidewalk or curb grade, or as directed.

Finish exposed concrete foundations to present a smooth, neat appearance. Fill all holes.

Where breakaway bases are specified, the post stub projection shall not exceed the limits shown.

**(b) Treatment for Aluminum-Concrete Contact** - Separate the aluminum from the concrete with one layer of 30 pound nonperforated, asphalt-saturated felt. Neatly trim the felt pad to the size and shape of the base contact surface.

### **00960.44 Junction Boxes:**

**(a) General** - Install junction boxes at the approximate locations shown, or, if not shown, no more than 300 feet apart. The Contractor may, at no additional cost to the Agency, install additional junction boxes to facilitate the work.

The tops of junction boxes installed in the ground or in sidewalk areas shall be flush with the surrounding grade or top of curb. Where practical, place pull boxes shown behind curbs against the back of the curb. If installed in the roadway or shoulder, leave the top of junction box 1/2 inch below the pavement surface. If installed outside roadways or shoulders, install a portland cement concrete apron around the junction box.

In boxes having an open bottom, construct a sump of reasonably well graded 3/4" - 0 crushed gravel, 12 inches deep covering the approximate area of the box. Do not install conductors until the sump has been constructed.

**(b) Junction Box Locations** - Mark the location of all flush-mounted junction boxes installed in unsurfaced areas with a Type 1 delineator, placed 3 feet behind the box, or as directed. Use white targets with black, 3 inch, series "B" letters reading "JCT. BOX". Reflectors are not required.

**00960.45 Cable and Wire** - Arrange wiring neatly within cabinets and junction boxes. Use electrical lubricants when inserting conductors in conduit. Before pulling wires through underground conduit runs, blow the conduit out with 120 cubic feet per minute compressed air.

Before cable and wire installation, clean all existing and new conduit with cylindrical mandrel of the proper size for that conduit and blow out with compressed air. Mechanical pulling methods may be used for conduit cleaning.

Do not use tapes, straps, ties or other binding materials to bundle single conductors or cables together inside conduits or poles. Bundling of conductors or cables will be allowed at the terminating end points for pulling only.

Pull all wire on a straight line with the conduit opening to prevent damage to wire and cable insulation. If pulls are made with poles or controller cabinet in place, use a pulley device to achieve a straight pull.

#### **00960.46 Wiring Practices:**

**(a) General** - Install electrical system and electrical system components in a neat and workmanlike manner.

**(b) In-Line Fuse Holder** - Insulate terminal ends using either heat shrink tubing or electrical insulating rubber tape over-wrapped with electrical vinyl plastic tape as specified.

**00960.48 Coating** - Coatings shall conform to all applicable portions of Section 00594. Do not paint equipment fabricated of aluminum, stainless steel, or hot-dipped galvanized material, except as shown or specified.

#### **00960.49 Electrical Service:**

**(a) General** - Service points shown on the plans are approximate only. The exact location will be determined in the field. Wiring connections to the terminal screws on the circuit breakers and contactors shall make full contact under the screw head. Size and depth of power service conduit shall be as specified by the supplying power company.

Equip each service cabinet with a solid copper neutral bus and the number and size of switches or circuit breakers shown or specified. Notify the local serving utility before making any connections to utility poles.

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

**(b) Circuit Breakers** - Provide circuit breakers of the rating shown or specified.

**00960.50 Grounding and Bonding:**

**(a) General** - Make all ground rods, metal conduit, metal poles, grounding wire, metallic junction boxes, metallic junction box covers, and cabinets mechanically and electrically secure to form a continuous, effectively grounded and bonded system. Ground/bond wire shall be No. 6 AWG stranded copper wire or as shown.

**(b) Ground Rods** - Drive ground rods into the ground with the top about 6 inches below the finished grade at the ground rod locations. Ground each above ground metallic structure with a separate ground rod. The equipment ground rod may be placed in the foundation if shown, or in the first junction box nearest the equipment.

**(c) Services and Cabinets** - Bond the neutral conductor, the control cabinets, and the metal base to the grounding electrode system.

**(d) Structure Mounted Poles and Cabinets** - Bond all poles and cabinets mounted on structures or walls to a common ground rod at the end of the structure. Ground the system at the first convenient acceptable location off the structure.

**(e) Wood Poles** - Bond all metallic conduit, messenger cable, terminal cabinet, and other metallic parts within 10 feet of the ground line.

**(f) Nonmetallic Conduit** - In all nonmetallic conduit, run a ground/bond wire continuously between all poles, pedestals, posts, and cabinets. Bond wires are not required in conduit that only contains circuits that operate at less than 25 volts.

**(g) Metallic Junction Boxes and Lids** - Bond metal junction boxes and lids to form a continuous effectively grounded and bonded system with metallic conduit, grounding wire, metal standards and controller cabinets. Leave enough slack in the bond wire connected to the lid to allow complete removal of the lid. Junction boxes only containing circuits that operate at less than 25 V do not need to be bonded.

**00960.70 Electrical Energy** - Obtain the required permits and have the power service inspected by the utility providing power. Arrange for the utility to make the electrical hookup. When agreeable to the Agency and the local power company, power consumption for traffic signals may be flat-rated.

Electrical energy costs will be billed to the Agency or those named in the construction agreement for permanent installations. Do not use for construction purposes electrical energy billed to the Agency or other agencies.

## Section 00962 - Metal Illumination and Traffic Signal Supports

### Description

**00962.00 Scope** - This work consists of furnishing, fabricating, galvanizing, and installing materials for illumination and traffic signal supports and foundations. The location of illumination/signal material shown is approximate, with exact locations established in the field.

**00962.01 Regulations, Standards, and Codes** - All designs and workmanship shall conform to the following standards where applicable:

- AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
- AWS D1.1

Wherever reference is made to any of the standards mentioned above, the reference means the code, order, or standard in effect on the date the Project is advertised unless otherwise shown or specified in the Specials Provisions.

Do not begin installations until all permits are obtained and copies are given to the Engineer.

**00962.02 Calculations and Drawings** - Within 30 calendar days after execution of the Contract, submit at least six copies of:

- Pre-approved manufacturing shop drawings
- Calculations and shop drawings of all nonstandard poles
- Calculations and installation drawing of all nonstandard pole foundations

All engineered details and drawings which are not prepared by the Agency, but are required in the Contract Documents, shall be submitted for review prior to fabrication. Designs, details, plans, and calculations shall be stamped and submitted according to 00150.35.

Upon completion of the installation, submit six copies of all changes made from the original plans. The information furnished shall include all modifications made and shall represent the material installed and in operation. It shall be sufficiently detailed to enable maintenance forces to replace or repair any part of the Project under routine or emergency maintenance by direct reference.

**00962.05 Design** - Design all traffic signal and illumination poles according to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

**(a) Traffic Signal Mast Arm Supports** - Design non-standard poles and foundations according to the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals 4th Edition" with 2001, 2002, and 2003 interim revisions. Design factors include:

Basic wind speed (3 second gust) .....	110 mph
Gust factor (G) .....	1.14
Importance Factor (Ir) .....	1.0 (50 year recurrence interval)
Fatigue Category .....	II

**(b) Traffic Signal Strain Pole Supports** - Design non-standard poles and foundations according to the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and

Traffic Signals 4th Edition" with 2001, 2002, and 2003 interim revisions. Design factors include:

Basic wind speed (3 second gust) .....	110 mph
Gust factor (G) .....	1.14
Importance Factor (Ir) .....	1.0 (50 year recurrence interval)

Fatigue design is not required.

**(c) Illumination Supports** - Design non-standard Luminaire slip base, fixed base, and high mast poles and foundations according to the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals 1994". Design factors include:

Basic wind speed (fastest mile per hour) .....	100 mph
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**Materials**

**00962.10 Materials** - Furnish materials meeting the following requirements:

Anchor Rods .....	02560.30
Commercial Grade Concrete .....	00440

Furnish steel pole materials meeting the requirements of 02530 modified as follows:

- Provide steel sheet for pole and arms meeting the requirements of ASTM A 595, Grade A or B, ASTM A 572, or approved equal.
- Provide all other steel sheet and plate meeting the requirements of ASTM A 36 or ASTM A 572, or approved equal.
- Supplementary Requirement S18 (ASTM A 6), maximum tensile strength, is required.
- Galvanized base plates and small and hidden pieces do not require controlled silicon content.

**Construction**

**00962.41 Excavation** - Protect all existing pipes that become a part of a foundation as directed by the Engineer or local utility company.

Do all excavation, backfilling and resurfacing work necessary to complete the work. This includes removal and replacement of curbs, sidewalks, paved surfaces and other materials. On completion of the work, replace and finish all surfaces to correspond with the existing surfaces.

Furnish, place, and remove any shoring required to prevent caving of walls.

When excavating in paved areas, cut with an approved pavement cutting saw to a depth of at least 2 inches along the neat boundaries of the area to be removed. Cut sharp and well-defined pavement edges with no evidence of cracking, delaminating, or stressing.

Restore all disturbed landscaping and underground systems to original condition upon completion of the work at no additional cost to the Agency. Use hand excavation if directed.

**(a) Excavation for Poles Foundations** - Make all excavations for pole foundations to the neat lines of the foundations. Hand excavation may be required. Place the concrete directly against the sides of the excavation in undisturbed or well-compacted material.

**(b) Disposition of Waste Materials** - On completion of the work, dispose of all waste materials according to 00330.41(a-5).

**00962.43 Foundations** - Construct foundations according to Section 00440 and the applicable portions of 00540.48(a). Place concrete as follows:

- With a continuous pour.
- To the elevation shown or directed.
- With conduit ends and anchor rods held securely in proper vertical position and height with the manufacturer's recommended template until the concrete sets.

Make no adjustment of anchor rods after concrete has set. Any adjustment made may be cause for rejection of the foundation.

Maintain rebar clearances during concrete pour.

Set forms square and true to line and grade. Construct forms of rigid materials that remain in position until removed. Use a steel template to accurately locate the anchor rods and hold them plumb and in proper alignment. Out-of-position anchor rods and anchor rods installed more than 40V:1H out of plumb are cause for rejection of the foundation. Field bending of anchor rods and field modification of the base plate are not allowed.

Remove forms and place subsequent loading according to Table 00540-1.

Finish tops of foundations to roadway, sidewalk or curb grade, or as directed.

Finish exposed concrete foundations to present a smooth, neat appearance. Fill all holes.

Where breakaway bases are specified, the post stub projection shall not exceed the limits shown.

Where obstructions prevent the construction of planned foundations, construct the foundations in the location directed. Any extra cost due to the site change will be paid according to Section 00196.

If it is determined that foundations will extend deeper than shown, the extra foundation depth will be paid according to Section 00196.

**(a) Design of Illumination Pole Foundations** - Design non-standard foundations according to the Rutledge method using a S1 allowable average soils stress of 1,500 pounds per square foot unless site conditions do not meet poor soil requirements as listed in the Rutledge method.

**(b) Design of Non-Standard Foundations** - Design non-standard foundations according to the Agency's Traffic Structures Design Manual

**(c) Installation of Traffic Signal Pole Foundations** - Construct drilled shafts according to Section 00963.

**00962.46 Steel Illumination and Signal Poles** - Metal poles include vertical posts, signal mast arm, luminaire arms, connection hardware, and anchor rods. Do not erect poles until the Engineer has made a visual inspection of pole welding.

Fabricate entrance openings in metal poles and arms, including handholes, before galvanizing, except as shown for mounting traffic signal material.

**(a) Design** - Design all metal poles with self-supporting upsweep arms similar to the details shown.

**(b) Pole Height** - Before poles are ordered, the Engineer will check the pole heights in the field and verify that the specified luminaire mounting heights above pavement are provided. Provide upsweep

bracket arms of lengths shown in the Metal Light Pole Table or shown on the plans. Provide traffic signal poles of heights as shown or specified. Height of poles requiring slip plate bases is the length of shaft above the slip plate.

**(c) Mast Arm** - Install mast arms for traffic signals and signs according to details provided by the manufacturer. Use proper type and size of mounting appurtenances that correctly fit the pole furnished, or as shown. Provide self-supporting mast arms without tie rods or braces. Provide tapered mast arms that are either round, 8 sided, 12 sided, or 16 sided.

All mast arms shall allow wiring entrances directly into the pole from inside the mast arm.

**(d) Luminaire Arm** - The luminaire end of the arm shall be level when loaded to design weight. Use a bolted, flange type connection to join the upsweep arm to the pole. The connection shall be raintight and shall develop the strength of the arm. Provide the mast arm rise according to the Metal Light Pole Table, or as shown or specified.

Arms shall be self-supporting without tie rods, or braces. Measure upsweep rise from the point of attachment to the pole to the end tangent portion of the arm. Provide tapered arms that are either round, 8 sided, 12 sided, or 16 sided.

All arms shall allow for wiring entrances directly into the pole from inside the arm.

All pole bracket attachments for mounting upsweep arms shall have reamed, smooth ends.

The nominal mounting height (MH) shown in the Metal Light Pole Table or on the plans is the distance between the roadway at the edge of the pavement and the luminaire. This height may vary plus or minus 1 foot.

**(e) Deflection** - The horizontal dead load deflection at the top of the poles shall not exceed 1% of the pole length (2% for strain poles).

**(f) Deviation from Straightness** - After the poles are delivered to the jobsite, and before they are erected on the foundations, the Contractor may be required to check any or all poles for deviation from straightness according to the following:

**(1) Deviation in One Plane and One Direction Only** - A straight line joining the surface of the pole at the base and the same surface of the pole at the top shall not be more than 1/2 inch from the surface of the pole for each 10 feet of length from the closest of these points. The opposite surface shall meet the same requirement.

**(2) Deviation in Any Plane** - A straight line connecting the midpoint of the pole at the base, with the midpoint at the top, shall not pass through the surface of the pole at any intermediate point.

Any pole not meeting these requirements will be rejected. If more than 25% of the poles fail to meet these requirements, sufficient cause exists to reject the entire shipment of poles for the Project.

**(g) Welding** - Weld steel illumination and signal poles according to AWS D1.1. The fabricator shall inspect welds according to details and requirements called out on the Contract Documents. This requirement will override all appropriate weld inspection requirements called out in Section 5.15 WELDING CONNECTIONS in AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals". Submit all testing procedures for Engineer's review prior to starting inspection. Submit certified copies of inspection reports to the Engineer for review.

If requested by the Engineer, additional weld inspection may be required upon arrival of the material at the job site. If defects are found by this additional inspection, the Contractor shall be responsible

for the additional testing and repair costs. If no defects are found, the Engineer will be responsible for the additional inspection costs.

**(h) Welding Steel After Galvanizing** - No field welding of galvanized steel will be allowed. The effected piece shall have the existing galvanizing removed from the heat effected area before welding. Perform the weld, remove the galvanizing totally from the entire piece, and hot-dip galvanized it. Submit the following data, stamped according to 00150.35, for review:

- Explanation for modification
- Name of shop performing the work
- Welding procedure
- Description of the work that will be performed
- Name of the shop performing the hot-dip galvanizing

**(i) Identifying Tags** - Attach a stainless steel identifying tag to all poles. Provide tags that are at least 1/16 inch thick. Tag lettering shall be at least 1/4 inch in height, and be stamped into the tag. Attach tags with stainless steel pop rivets of at least 3/16 inch nominal body diameter. Do not locate pop rivet holes within 6 inches of welds. Locate the pole tag approximately 24 inches below the top of the mast arm or messenger cable attachment point. Locate the tag on the side of the pole furthest from the intersection. Drill holes for pop rivets prior to hot-dip galvanizing. Remove excess hot-dip galvanizing from holes and repair according to ASTM A 780.

Include the following information on the tags, if applicable:

- Manufacturer
- Month and year of manufacture
- Lum Arm Yield (ksi)
- Lum Arm thickness (inch)
- Mast Arm Yield (ksi)
- Mast Arm thickness (inch)
- Pole Yield (ksi)
- Pole thickness (inch)
- Base Plate Yield (ksi)
- Anchor Rod Yield (ksi)

**(j) Erecting Metal Poles** - Erect metal poles on concrete foundations and according to the recommendations of the pole manufacturer and as shown. Exercise reasonable care to prevent marking the finish and damaging poles.

Install all joint traffic signal and illumination poles so the distance from the pavement to the light center is as shown or specified. Use the same tapered design for traffic signal and street light arms.

Bolt protrusion on slip base poles shall not interfere with the breakaway action of pole. File sharp edges smooth and repair according to ASTM A 780.

**(1) Repair Damaged Finish** - Repair damaged galvanizing according to ASTM A 780. Minor scratches less than 3 inches long by 3/16 inch wide or an area of 1/2 square inch can be repaired with the sprayed zinc method.

**(2) Assembly of Supports and Bolt Tightening** - Nuts shall have full thread engagement.

**a. Anchor Rods for Signal Supports and Fixed Base Luminaire Supports** - After foundation concrete strength and curing requirements are satisfied and after inspection of the foundation, pole installation may begin.

Lubricate anchor rods and nuts according to 02560.70. Estimate the required rake, if any, and set the lubricated leveling nuts accordingly, so that when pole installation is complete and all appurtenances are installed on the pole, the top of the pole is plumb with the base of the pole.

Lift the pole into position on the leveling nuts and washers. Make sure all leveling nuts and washers are in full contact with the base plate.

Install washers and lubricated top nuts, and bring to a snug tight condition. Snug tight is defined as the condition when all plies of the connection are in firm contact, and can be obtained by the full effort of a worker on the end of a 12 inch long wrench. Several passes may be required to obtain uniform snug tightness.

When all anchor rods are snug tight, proceed with installation of arms and other appurtenances, if not previously installed. When installation of arms and appurtenances is complete, and the pole is plumb as defined above, final anchor rod tightening may begin. If the pole is not plumb, adjust as required and repeat snug tightening as described above. As a safety measure, provide crane support of the pole until anchor rods tightening is completed.

Mark the position of each turned element (nut or bolt head) with a felt tip pen or similar marker. Rotate each top nut past snug tight by the amount shown in "d." below. Several passes may be required to obtain uniform final tightness. "Cheater" bars or slugging wrenches are allowed if required for large diameter anchor rods.

**b. Anchor rods for Slip Base (Break-away) Luminaire Supports** - After foundation concrete strength and curing requirements are satisfied and after inspection of the foundation, pole installation may begin.

Furnish, at no additional cost to the Agency, a calibrated torque wrench of a capacity appropriate to the size and type of the bolts being tightened. Confirm the accuracy of the calibrated torque wrench through calibration by an approved independent testing agency at least one a year.

Lubricate anchor rods and nuts according to 02560.70. Estimate the required rake, if any, and set the lubricated leveling nuts accordingly, so that when pole installation is complete and all appurtenances are installed on the pole, the top of the pole is plumb with the base of the pole.

Install the anchor plate on the leveling nuts and washers. Make sure all leveling nuts and washers are in full contact with base plate.

Install washers and lubricated top nuts, and bring to a snug tight condition. Snug tight is defined as the condition when all plies of the connection are in firm contact, and can be obtained by the full effort of a worker on the end of a 12 inch long wrench. Several passes may be required to obtain uniform snug tightness.

When all anchor rods are snug tight, proceed with the "Slip Base Bolting Procedure" as shown. When the slip base bolting procedure is complete, final anchor rod tightening may begin. As a safety measure, provide crane support of the pole until anchor rod tightening is complete.

Mark the position of each turned element (nut or bolt head) with a felt tip pen or similar marker. Rotate the top nut of each anchor rod past snug tight by the amount indicated in paragraph "d." below. Several passes may be required to obtain uniform final tightness. "Cheater" bars or slugging wrenches are allowed if required for large diameter anchor rods.

**c. High-Strength Bolts in Mast Arm-to-Pole Connections and Luminaire Arm-to-Pole Connections** - Lubricate high-strength bolts according to 02560.70. Provide all high-strength bolts with hardened flat washers under the element turned during tightening.

If arms or appurtenances are attached after pole erection, support them until bolts are snug tight.

Install high-strength 4-bolt connections to a snug tight condition. Snug tight is defined as the condition when all plies of the connection are in firm contact, and can be obtained by the full effort of a worker on the end of a 12 inch long wrench. Mark the position of each turned element (nut or bolt head) with a felt tip pen or similar marker. Rotate the top nut of each anchor rod past snug tight by the amount indicated in paragraph .d below. Several passes may be required to obtain uniform snug tightness.

Install high-strength 8-bolt connections according to 00930.40(d).

**d. Final Tightening** - Required final tightening of anchor rods and high-strength bolts are shown in the following Table:

Connection Type	Rotation Past Snug Tight
ASTM A 307 Anchor rods	30° (1/12 turn)
ASTM A 449 Anchor rods	60° (1/6 turn)
ASTM F 1554 Gr. 55 Anchor rods	60° (1/6 turn)
ASTM A 325 4-bolt connection	60° (1/6 turn)

**(3) Bolt Inspection** - The Engineer will observe the installation and tightening operations to ensure that proper procedures are followed. All inspections will be visual and no testing will be conducted.

Top surface of bolts or rods that are not flush or extend passed the top of the nut requires the rejection of the installation.

**00962.48 Coating** - Coat according to all applicable portions of Section 00594.

**00962.50 Grounding and Bonding:**

**(a) Metal Poles** - For fixed base poles, provide a 1/2 inch, Type 308, 309, or 310 stainless steel stud on the inside of the shaft. Locate the stud directly opposite and level with the handhole in the pole. Attach grounding electrode conductors and bonding conductors to the stud with a grounding wire clamp, "acorn style".

For slip base poles, do not allow the grounding wire to intrude into the slip plane. Instead, run a bond wire from the grounding electrode to a 1/2 inch, Type 308, 309, or 310 threaded stainless steel stud welded to the bottom base slip plate.

## Section 00963 - Signal Support Drilled Shafts

### Description

**00963.00 Scope** - This work consists of excavating and constructing drilled, cast-in-place, reinforced concrete shafts for signal supports according to these Specifications.

#### **00963.01 Definitions:**

**Drilled Shafts** - Reinforced concrete sections, cast-in-place against in situ soil, rock or a casing.

**Temporary Casing** - Casing installed to facilitate drilled shaft construction only and removed during or after concrete placement.

**00963.02 Subsurface Investigation** - The Soils and Geological Exploration Logs are available for review through the Engineer's office. The data shown for each test boring or test pit applies only to that particular boring or test pit. Subsurface conditions may vary between borings or test pits. Core samples and laboratory test results, if obtained and performed for the Project, are available for review by contacting the Engineer.

### Materials

**00963.10 Materials** - Furnish materials meeting the following requirements:

Commercial Grade Concrete .....	00440
Reinforcement.....	00530 and 02510

**00963.13 Steel Casing** - Furnish temporary casing meeting the requirements of ASTM A 252 or ASTM A 36. Test each heat of steel at 40 °F with a minimum absorbed energy requirement of 15 foot pounds. Use casing of sufficient strength to resist handling, transportation and installation stresses and the external stresses of the subsurface materials. Ensure that the casing is clean and watertight prior to placement in the drilled shaft excavation. Use casing with an outside diameter not less than the specified drilled shaft diameter.

**00963.19 Quality Control** - Provide quality control according to 00512.19.

### Labor

**00963.30 Personnel Qualifications** - Perform the drilled shaft construction work using a company and personnel experienced in drilled shaft construction work. Submit a list to the Engineer for approval identifying the on-site supervisors and drill rig operators assigned to the Project and the companies experience relevant to the project. Experience shall be relevant to the anticipated subsurface materials, groundwater conditions, shaft size, depth, and all special construction techniques required. Before the preconstruction conference, provide the following information to verify the firm's experience and the qualifications of personnel scheduled to perform the drilled shaft construction:

- Submit a project reference list of at least three separate foundation projects, successfully completed in the last five years, with drilled shafts of diameters and depths equal to or larger than those shown in the plans and in ground conditions similar to those indicated. Include a brief description of each project and the owner's contact person's name and current phone number for each project listed.
- On-site supervisors shall have at least two years experience in supervising construction of drilled shaft foundations of similar size (diameter and depth) and scope to those shown in the plans and in similar geotechnical conditions to those described in the geotechnical report. Experience shall include the direct supervisory responsibility for the on-site construction operations.

- Drill operators shall have at least one year experience in the construction of drilled shaft foundations.

The Engineer will respond within 21 calendar days after receipt of the submittal. Do not begin work on any drilled shafts until the qualifications have been approved. The Engineer may suspend the drilled shaft construction if the Contractor substitutes unapproved personnel during construction. Submit requests for substitution of either on-site supervisors or drill operators to the Engineer, who will have seven calendar days to respond to each request. Additional costs resulting from the suspension of work due to the changing of personnel will be the Contractor's responsibility, and no adjustment in Contract Time resulting from the suspension of work will be allowed.

### **Construction**

**00963.40 Submittals** - Provide the following submittals to the Agency for review and approval:

**(a) Drilled Shaft Installation Plan** - At least 21 calendar days before beginning shaft construction, submit the following:

- The sequence of drilled shaft construction as it relates to the overall construction plan.
- A review of equipment suitability based on the Contractor's understanding of the site subsurface conditions. Include a project history of the drilling equipment that demonstrates the successful use of the equipment for drilled shafts of equal or greater size in similar subsurface conditions.
- Details of shaft excavation methods, including proposed drilling methods and a disposal plan for excavated material. Include details of methods used to perform final cleaning of the excavation. Include details of the methods and materials used to fill or eliminate all voids between the plan shaft diameter and excavated shaft diameter, or between the casing and surrounding soil, if permanent casing is specified. Include a disposal plan for any water or contaminated concrete expelled from the top of the shaft (if applicable).
- Details of the proposed method(s) for ensuring drilled shaft stability during excavation and concrete placement.
- Unstamped reinforcing steel shop drawings and details of reinforcement placement, including bracing, centering and lifting methods and the method for supporting the reinforcement on the bottom of the shaft excavation. Include details on the type, number and placement of spacers and other devices for ensuring the reinforcing cage position is maintained during construction.
- Evidence that the proposed materials conform to all applicable Specifications.
- Details of concrete placement, including proposed operational procedures for pumping and tremie methods.
- Detailed procedures for temporary casing installation and removal. Include casing diameters, dimensions, and depths and the methods and equipment for casing installation and removal.
- Confinement methods required to contain drilling fluids, spoils, waste concrete and other products from contacting sensitive environmental areas according to Section 00290 and all applicable regulatory permits.
- Methods for protecting existing structures according to 00170.82.

The Engineer will approve or reject the drilled shaft installation plan within 21 calendar days after receipt of all submissions. Provide any additional information and submit a revised plan, if requested, for review and approval. All procedural approvals given by the Engineer will be subject to trial in the field and will not relieve the Contractor of the responsibility to satisfactorily complete the

00963.40(a)

work. Submit requests for modification of adopted procedures to the Engineer. Allow 21 calendar days for approval of modifications. Do not begin drilled shaft construction work until all drilled shaft submittals have been approved.

**(b) Drilled Shaft Repair Plans** - For any shaft determined to be unacceptable, submit a repair plan to the Engineer for approval. Furnish all materials and work, including engineering analysis and design, needed to correct unacceptable drilled shafts, at no additional cost to the Agency. Do not begin repair operations before remedial procedures or designs are approved. Any modifications to the dimensions or materials of the drilled shafts shown on the plans that are proposed in the repair plan will require stamped calculations and working drawings according to 00150.35.

**00963.41 Drilled Shaft Coordination Meeting** - Hold a drilled shaft coordination meeting at least seven calendar days before beginning any shaft construction work at the site to discuss construction procedures, schedules, staging, personnel, equipment to be used, and other elements of the approved shaft installation plan as specified in 00963.40. Those attending the meeting include:

- **Representing the Contractor** - The superintendent, on-site supervisors, and all supervisors in charge of excavating the shaft, placing the temporary casing, placing the steel reinforcing bars, and placing the concrete.
- **Representing the Contracting Agency** - The Project Engineer, key inspection personnel, and designers of record or their appointed representatives.

If the Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved shaft installation plan, an additional meeting shall be held before any additional shaft construction operations are performed.

**00963.42 Construction Tolerances** - Excavate drilled shafts as accurately as possible at the locations shown. Determine the drilled shaft dimensions and alignment with approved methods.

Frequently check the plumbness alignment and dimensions of the shaft during construction. Correct all out-of-tolerance shaft excavations and completed shafts to the satisfaction of the Engineer. Correct out-of-tolerance drilled shafts at no additional cost to the Agency, and no extension of the Project completion date will be granted. Materials and work necessary to complete corrections for out-of-tolerance drilled shafts resulting from the removal of unexpected drilled shaft obstructions will be paid for as Extra Work.

**00963.43 Drilled Shaft Excavation** - Perform drilled shaft excavation according to the following:

**(a) General** - Excavate drilled shafts to the dimensions and elevations shown or as directed. Provide and maintain stabilized drilled shaft sidewalls for the full depth of the excavation, using approved materials, equipment and methods. If caving or other unstable conditions occur during any construction procedure, stop further construction, notify the Engineer, and stabilize the shaft excavation by approved methods and submit a revised installation plan which addresses the problem and prevents further instability. Do not continue with shaft construction until any damage which occurred has been repaired according to the Specifications and until receiving the Engineer's approval of the revised shaft installation plan.

If the Engineer has reason to believe that the drilled shaft excavation techniques or workmanship have been deficient, so that the integrity of any excavation is in question, work on that drilled shaft may be stopped. Drilled shaft excavation will not be allowed to resume until the deficient excavation techniques or workmanship have been changed to the Engineer's satisfaction.

Dispose of materials removed from the shaft excavations according to 00290.20.

Do not leave partially completed shaft excavations open overnight unless they are cased full depth or otherwise stabilized with approved methods. If approved by the Engineer, a partially excavated shaft may be left open overnight, provided that the excavation:

- Is stabilized at the bottom, sides and surface to prevent soil caving or swelling or a reduction of soil strength, and
- Is covered at the surface to protect the public.

Extend the drilled shaft excavation if the Engineer determines that the subsurface materials encountered are not capable of providing the required bearing resistance or differ from those anticipated in the design of the drilled shafts.

**(b) Protection of Existing Structures** - Protect existing structures according to 00512.43(b).

**(c) Temporary Casing** - Provide temporary casing according to the approved installation plan and of sufficient quantities to meet the needs of the anticipated construction method.

**(d) Unexpected Drilled Shaft Obstructions** - Remove unexpected drilled shaft obstructions according to 00512.43(d).

**(e) Lost Tools** - Promptly remove drilling tools lost in the excavation. Lost tools will not be considered unexpected obstructions and shall be removed without additional compensation. Drilling tools lost during the course of removing unexpected drilled shaft obstructions will be paid as Extra Work.

**(f) Clean Out** - Clean out drilled shafts according to 00512.43(h).

**00963.45 Reinforcing Steel** - Furnish and place reinforcing steel as shown and according to the following:

**(a) Placement** - Do not place reinforcing steel in the shaft excavation until the Engineer has approved the final elevation of the bottom of the shaft.

In each shaft, place reinforcing steel extending from 3 inches above the bottom of the shaft excavation to the elevation shown. The reinforcing cage may be supported on the bottom of the shaft excavation if approved. Support the reinforcing cage to prevent distortion or settlement during concrete placement. If concrete placement does not immediately follow cage placement, remove the reinforcing cage from the excavation and rectify the integrity of the excavation prior to reinstallation of the cage.

**(b) Bracing** - Rigidly brace the reinforcing cage to retain its shape for lifting. Lift the cage in a manner that does not cause permanent racking or distortion. Show bracing and any extra reinforcing steel required for fabrication of the cage on the submitted shop drawings. Remove cross bracing during cage placement, unless otherwise approved.

**(c) Concrete Cover** - Maintain the required concrete cover shown on the plans by placing concentric spacer bars or other approved devices around the reinforcing cage. Provide details of the proposed centering method on the shop drawings submitted according to 00963.40.

**00963.47 Concrete** - Furnish and place concrete according to the following:

**(a) Concrete Placement** - Place concrete immediately after completion of the shaft excavation and with the approval of the Engineer. Immediately prior to concrete placement ensure the shaft clean out requirements are met according to 00963.43(f).

Place concrete according to 00540.48(a) and continuously until concrete at the top of the shaft is free of water, soil, and debris, and uncontaminated concrete extends to the plan top-of-shaft elevation. Dispose of all contaminated concrete expelled from the top of the shaft in an approved manner. Remove waste concrete from the site. If a delay in concrete placement occur because of a delay in concrete delivery or other factors reduce the placement rate to maintain a flow of fresh concrete into the shaft excavation.

Unless otherwise approved, allow a maximum of 60 minutes between concrete placements and use no concrete older than 90 minutes from batch time. In addition to the above, use procedures for concrete placement which ensure that the concrete within the shaft becomes a monolithic, homogeneous unit.

Place concrete using hoses or pipes having watertight joints. For concrete placement by gravity tremie, use hose or pipe having an inside diameter not less than 8 inches. For placement by concrete pump, use hose with inside diameter not less than 4 inches. Provide an alternate delivery system that can be used in case of failure of the primary delivery system. Place concrete only against the bottom of the drilled shaft or into fresh concrete.

If caving occurs during concrete placement, the shaft may be rejected.

**(b) Wet Shaft Concrete Placement** - Perform wet shaft concrete placement according to 00512.47(c).

**(c) Concrete Curing and Cleaning** - Allow the exposed top of concrete to cure a minimum of seven days by covering with wet burlap overlain with plastic sheets or by keeping top of concrete under water. Keep the burlap wet during the concrete cure.

Prior to placing any fresh concrete on top of a completed shaft, clean the upper surface of the concrete by removing all scum, laitance, loose gravel and sediment and chip off any high spots on the upper surface that would prevent the steel reinforcing bar cage from being properly placed in the position shown on the plans.

**(d) Casing Removal** - Remove all temporary casing during or after completion of concrete placement. Do not start temporary casing removal until the level of fresh concrete within the casing has reached a depth of 10 feet or the level necessary to adequately counteract the external hydrostatic pressure head. As the temporary casing is withdrawn, maintain a minimum 5 feet head of concrete above the bottom of the casing. A slight downward movement of the casing while exerting downward pressure, or hammering or vibrating the casing will be allowed to facilitate extraction. Extract the casing so that concrete is cast directly against the surrounding in-situ material. Check the elevation of the top of the reinforcing cage before and after temporary casing extraction for conformance with the construction tolerance criteria of 00963.42. Casing that cannot be extracted during or immediately after the concrete placement operation may be cause for rejection of the shaft.

**00963.48 Drilled Shaft Testing and Acceptance** - Acceptance of drilled shafts will be based on the Engineer's review of the field inspection reports and visual observations during drilled shaft construction. The Engineer has final authority on the approval of drilled shafts.

**00963.49 Scheduling and Restrictions** - Do not proceed with additional shafts until the first drilled shaft has been approved. After the first drilled shaft on the project has been accepted, make no significant change in construction methods, equipment or materials used in the construction of subsequent shafts, unless approved by the Engineer.

For 24 hours after completion of concrete placement in a newly-constructed shaft, including withdrawal of casing if applicable, do not, within 15 feet of the shaft:

- Excavate adjacent shafts
- Construct footings
- Apply equipment wheel loads
- Introduce vibrations with a velocity greater than 1/4 inch per second

#### **Measurement**

**00963.80 Measurement** - The quantities of signal support drilled shafts will be measured on the length basis, by the vertical excavated length from the bottom of the shaft to the ground surface. If directed to construct drilled shafts below the elevations shown, the drilled shaft will be measured from the revised bottom of shaft.

#### **Payment**

**00963.90 Payment** - The accepted quantities of signal support drilled shafts will be paid for at the Contract unit price, per unit of measurement, for the following items:

<b>Pay Item</b>	<b>Unit of Measurement</b>
(a) 36 Inch Diameter Signal Support Drilled Shaft.....	Foot
(b) 42 Inch Diameter Signal Support Drilled Shaft.....	Foot

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for:

- excavating the shafts and disposing of the excavated material
- furnishing, placing, splicing and removing temporary shaft casing and forms
- concrete and all reinforcement

## Section 00970 - Highway Illumination

### Description

**00970.00 Scope** - In addition to requirements of Section 00960 and Section 00962, install highway illumination according to the following Specifications.

**00970.02 Equipment List and Drawings** - Submit six copies of isocandela 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 Illuminating Engineering Society (IES) light distribution type specified.

Upon request, submit one copy of luminous intensity distribution data in IES format on a compact disk or using electronic mail for each type of luminaire submitted with the following:

- **Vertical angles** - Provide data in increments of 5 degrees or less for the vertical angles of 0 to 90 degrees, inclusive.
- **Horizontal angles** - Use a maximum of 10 degree increments for all horizontal angles.

Complete description data is required.

**00970.03 Luminaire Submittal** - Provide a sample luminaire for inspection and photometric testing if required. Sample luminaires may be considered as part of the shipment furnished for installation.

### Construction

**00970.41 Metal Light Pole or Tower Table** - The metal light pole or high mast tower table for the Project is shown on the highway illumination plans.

**00970.42 Cable and Wire** - Use type XHHW stranded copper wire in all current-carrying conductors in raceways.

Support the conductors at the top of the pole using a flexible metal cable support grip to prevent insulation damage at the upsweep arm opening. When splicing into a new or existing circuit at a pole base (minimum wire length: 18 inches outside handhole), install a watertight, in-line fuseholder in the pole base for each ungrounded wire going up the pole. This fuseholder shall conform to the requirements of 02920.26 and be constructed so the wire to the ballast can be disconnected without cutting or disconnecting wiring at the ballast.

Use No. 12 AWG Type XHHW or THWN wire from the control cabinet to the photoelectric relay.

Use 3 conductor No. 10 type TC cable from the pole base to luminaire ballast. Use 2 conductors for luminaire ballast connection and 1 conductor for circuit grounding at the luminaire. Extend and securely connect electrical circuit grounding for each circuit connected to the luminaire end.

For double arm illumination pole, two sets of wires shall be installed separately from the pole base to each luminaire end. Do not splice wires inside the illumination pole except at the pole base.

Wires from the ballast to the lamp holders shall conform to the manufacturer's recommendations.

**00970.43 Photocontrol Electronic Relay** - Install the photocontrol electronic relay on either the control cabinet or on the metal pole as shown.

Use 1 1/4 inch welded hub in top of cabinet to install photocontrol electronic relay with minimum 24 inch long galvanized metal conduit and twistlock plug. When photocontrol relay is attached on the side of the cabinet, use LB type conduit outlet body, 1 1/4 inch galvanized metal conduit riser, and galvanized channel support for the riser. Riser conduit shall be minimum 2 feet above the top of the control cabinet. Secure field installed relay and conduit extensions against vandalism and ensure they are rain tight.

When photocontrol relay is installed on metal pole, use welded hub outlet located 180 degree from luminaire arm, threaded close nipple and 1 1/4 inch LB type conduit outlet body. Locate the hub 30 feet above base plate or as shown.

Mount the relay away from adjacent light units, and orient the light sensitive relay's window to the northern sky. Mark the date of installation on the bottom of the photocontrol electronic relay.

**00970.44 Luminaires** - Level luminaires on the upsweep arms in both the transverse and the longitudinal direction, as recommended by the manufacturer.

On roadway grades greater than 4%, orient luminaires on the upsweep arm so that the light beams strike the pavement equidistant from the luminaire.

**(a) Mounting Height** - Mount luminaires at heights shown. Measure the nominal mounting height from the top of the nearest edge of pavement to be lighted to the center of the luminaire.

**(b) Lamp Marking** - Mark the month and year the lamp is installed on the lamp base dating system with a sharp instrument.

**(c) Lamp Size and Identification Decals:**

**(1) Identification Decals for High-Intensity Discharge Lamps** - Indicate the lamp size and type with a NEMA-approved decal on each luminaire as specified below. Apply decals on clean and prepared surfaces. Use decals that provide a durable, legible surface for the life of the luminaire, and:

- Are at least 3 inches square.
- Are made of noncorrosive, pressure sensitive material.
- Have a colored background with black numbers as shown in Table 00970-1.

For pole-mounted luminaires, install the decals on the bottom side of the luminaire or on the arm adjacent to the luminaire, whichever is more visible, as directed.

For wall-mounted luminaires, install the decals vertically on the luminaire housing or adjacent to the luminaire on the wall, as directed.

For pendant-mounted luminaires, install the decals horizontally on the ballast housing or externally at the top portion of the reflector if a remote ballast installation.

**(2) Lamp Size and Identification Decal Code** - Use the lamp size and color codes that conform to the following:

**Tables 00970-1 A and B - Lamp Decal Code  
High Intensity Discharge Lamps**

TABLE 00970-1 A		TABLE 00970-1 B	
Lamp Wattage	Identifying Number	Lamp Type	Background Color
50	5		
70	7	Phosphor-Coated Mercury	White
100	10		
150	15	High Pressure Sodium	Gold - Yellow
175	17		
200	20	Clear Metal Halide <sup>1</sup>	Red
250	25		
310	31	Phosphor-Coated Metal Halide <sup>1</sup>	Green
400	40		
750	75	Induction Lamp	Orange
1000	x1		

<sup>1</sup> In addition, metal halide lamp targets shall include a 1/2 inch wide by 3 inch long strip of pressure sensitive, flat top, wide angle reflective tape to show lamp burning position requirements. Apply tape 1/2 inch from the lamp size target as follows:

Lamp Burning Position	Target Color
Any position	None
Base up to horizontal	None
Base down to horizontal	Gold
Position-oriented-mogul socket (POM)	Red

**00970.45 Pole Identification** - Identify luminaire poles with a numbered label corresponding to the pole numbers on the highway illumination plans. Labels shall:

- Be made of noncorrosive, pressure-sensitive material suitable for outdoor use and resistant to fading and abrasion.
- Have blue or black numbers with a high-contrast colored background.
- Have 1/4 inch block numbers at least 2 inches high.

Install labels on poles so they are visible from a passing vehicle.

### Maintenance

**00970.60 Maintaining Existing and Temporary Illumination Systems** - Protect existing illumination systems and approved temporary replacements. Shutdown of a system may be allowed for alterations or final removal, as approved. Lighting system shutdowns shall not interfere with the regular lighting schedule. Notify the engineer before 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.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, keep the existing systems in operation until the final connection to the modified circuit is made. The modified circuit is to be complete and operating by nightfall of the same day the existing system is disconnected.

### Finishing and Testing

**00970.70 Field Test** - Operate the completed lighting system or subsystem continuously for seven consecutive days and an additional seven days normal burn afterwards. When the lighting performance is satisfactory, the Contractor may be relieved of maintenance responsibility according to 00170.80(b).

Before completing the work, conduct 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 switchboards, panelboards, fuse holders, switches, receptacles and overcurrent devices in place. Record all readings. Furnish the Engineer with one copy of the test results identifying observed readings with their respective circuits.
- Test the insulation resistance between conductor and ground. Resistance shall be as follows on circuits with total single conduction length of:
  - 2,500 feet and over - at least 6 MΩ
  - Less than 2,500 feet - at least 8 MΩ

### Measurement

**00970.80 Measurement** - No measurement of quantities will be made for work performed under this Section.

The estimated quantities of lighting poles and arms will be listed in the Special Provisions. If plan changes by more than three feet are made to pole lengths or arm lengths or if field verified pole lengths or arm lengths increase or decrease by more than three feet, adjustments to the Contract lump sum amount will be made according to 00190.10(h). Adjustments will be made only for the increased or decreased length greater than three feet.

### Payment

**00970.90 Payment** - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Pole Foundations .....	Lump Sum
(b) Lighting Poles, Fixed Base.....	Lump Sum
(c) Lighting Poles, Slip Base .....	Lump Sum
(d) Lighting Pole Arms.....	Lump Sum
(e) Luminaires, Lamps, and Ballasts .....	Lump Sum
(f) Switching, Conduit, and Wiring. ....	Lump Sum
(g) Refurbishing and Reinstalling Existing Illumination Systems .....	Lump Sum

Item (a) includes all concrete foundations for lighting poles.

Item (f) includes all switches, conduit, cabinets, wiring, delineators, and other items required to construct the lighting system as specified.

00970.90

Item (g) includes all refurbishing, reinstalling, and other work as specified and not included in the removal of existing illumination.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for labeling the lights or poles.

If shown or specified as part of the work for concrete bridges or retaining walls, all conduit, junction boxes, cabinets, and other items permanently encased within concrete bridges and retaining walls, as well as pole foundations incorporated into a bridge or wall, will be included in payment made for the appropriate bridge and wall items.

**00970.92 Electrical Energy Costs** - All electrical energy costs for the lighting systems or subsystems will be paid for by the Agency.

## Section 00990 - Traffic Signals

### Description

**00990.00 Scope** - In addition to requirements of Section 00960 and Section 00962, install traffic signals according to the following Specifications.

### Materials

**00990.10 Backer Rod and Loop Sealant** - Furnish backer rod material and hot-melt loop sealant from the QPL.

### Construction

#### 00990.40 Cable and Wire:

**(a) General** - Install wire and cable according to 00960.45 and the following:

Install wire and cable between terminal blocks without splicing, except for loop wire to loop feeder cable.

Leave slack in each wire and cable at each pull box, pole, and controller cabinet as follows:

- 2 feet in pull boxes and poles
- 6 feet in controller cabinets
- 6 feet in the first pull box nearest the controller

In mast arm poles, use control cable from the pole terminal cabinet to vehicle signal heads and signs. Run a separate No. 14 AWG cable as required for each signal head. If existing cables or equipment are damaged by the Contractor's operations, immediately notify the Engineer and the affected owner.

Tape the ends of unused conductors with insulating vinyl plastic tape.

**(b) Control Cable Attachment** - Use self-locking cable ties to attach cables to the messenger cable. Tighten to remove gaps between the control cable and the messenger cable. After tightening, trim all excess material.

**(c) Messenger Cable** - Install the eyebolts through the entire pole. Pull the shoulder of the eye tight against the front face of the pole.

**(d) Tether and Stabilizer Cable** - Tighten cables to limit signal and sign movement. Install Agency furnished S-hooks between the eyebolt and turnbuckle.

#### **(e) Interconnect Cable:**

**(1) Labels** - Label all interconnect cable with approved bronze or plastic labels, permanently and ruggedly attached. The labels shall be embossed with the cable identification number if shown. Additionally, labels used on utility facilities shall bear the legend "TRAFFIC SIGNAL". Label all ends of cables. Label all overhead cable in each direction away from the point of attachment, 2 feet from utility poles. Do not install labels until the Engineer approves the labels and attachment mechanism. Label all cables in the interconnect terminal cabinets and at terminal panel locations.

**(2) Installation** - Use approved cable guides, feeders, shoes and bushings to prevent damage to the cable during installation. Do not pull cable over edges or corners, over or around obstructions or through unnecessary curves or bends.

Cable in trunk runs may be installed by hand or by mechanical methods, as approved. Trunk runs are those lengths of conduit that will have 25 or more pairs of interconnect cable installed. Install all other cable by hand methods only.

Before installing cable, provide the Engineer with one copy of the cable manufacturer's recommended and maximum pulling tensions for each cable type.

When installing cable using a pulling eye, do not exceed the cable manufacturer's maximum recommended pulling tension for pulling from the pulling eye. When installing cable using a pulling sock over the outer jacket, do not exceed the cable manufacturer's maximum recommended pulling tension for pulling by the outer jacket, or 80% of the manufacturer's maximum recommended pulling tension for pulling by a pulling eye, whichever is smaller. Use an approved dynamometer to ensure that the maximum allowable pulling tension is not exceeded during installation.

**(3) Aerial Cable** - Use terminal cabinets for aerial pole entrance of interconnect cable.

Match the sag as closely as possible with wires already on poles to minimize movement in windstorms and conflict with adjacent wires.

Use a cable grip on the jacketed messenger when pulling and tensioning. Pull and tension cable without damaging the jacket. When separating the messenger on figure-8 cable from the jacketed conductor assembly for dead-ending or splicing, split the web using approved tools designed for this task.

At corners and run ends, dead-end the messenger strand with approved automatic dead end connectors. Cut the strand and remove the jacket, exposing enough strand so that the ends of the strands coming through the chucks of both vises can be overlapped and bonded together to form a continuous ground. Use a one-bolt guy clamp to bond the strand ends together. Remove unused strand.

**(4) Underground** - In transition areas from overhead to underground, continue the aerial cable underground to the nearest termination panel. If figure-8 type cable is used for overhead locations, strip the messenger wire from the cable, using approved tools, where the cable is within a conduit, pole or cabinet.

Pull the necessary length of cable to be installed from pull point to pull point skipping any intermediate junction box, handhole, or other opening in underground system. Carefully store the remaining length of cable to be installed in the next conduit in a manner that is not hazardous to pedestrian or vehicular traffic, and protects the cable from damage. Obtain the Engineer's approval of the storage methods to be used.

**(5) Testing** - Test interconnect cable according to 00990.70(i).

#### **00990.41 Cabinet:**

**(a) Signal Circuit Overhead Terminal Cabinets** - Mount signal circuit terminal cabinets as shown.

In each cabinet, install the number of sectional terminal blocks needed for the circuits, plus two spare terminal blocks. These spares are not to be used by the Contractor. Divide the number of terminal blocks required as evenly as possible among the mounting brackets in the cabinet.

Terminate only one wire in each termination point. If necessary, add additional terminals of the same capacity to accommodate additional taps. If additional terminals are required, use a factory jumper between the terminals.

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

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

**(b) Flasher Cabinet** - Cabinets shall contain the devices shown.

**(c) Power Service Cabinet** - Install traffic signal service cabinets so that the meter placement is acceptable to the local power company if shown.

**(d) Cabinet Protection** - Keep interiors of all cabinets clean and free of dust, dirt, moisture, and other foreign matter.

### 00990.42 Indication Equipment:

**(a) Standard Vehicle Signal Heads** - Standard traffic signal heads shall be one-way, three-section heads, adjustable through 360 degrees about a vertical axis, and designed for the method of mounting shown or specified. Furnish heads complete, including lamps, lenses, LED modules, visors, reflectors, sockets, backboards and mounting appurtenances.

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.
- 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.

Tighten all backboards and visors securely against the signal head.

**(b) LED Traffic Signal Modules** - Fit modules into all types of traffic signal heads without the need to modify the head.

**(c) Optically Programmed Vehicle Signals** - Conform to all applicable portions of 00990.42(a). 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 signals shall:

- Use lamps of the type and wattage recommended by the signal manufacturer.
- Permit selective programming of the visibility zone of the projected indication anywhere within 15 degrees of the optical axis of each signal section.

When mounted on span wires, install additional washers on the hanger to shoe attachment pin to limit the lateral movement of the hanger.

**(d) Pedestrian Signal Heads** - All relevant portions of 00990.42(a) and 02925.65 apply to pedestrian signal heads.

**(e) Flashing Beacon Signal Heads** - Flashing beacons shall:

- Conform to all applicable portions of this subsection.
- Be of single-section construction.
- Be equipped for the type of mounting shown.

Use the size of lamps specified in 02925.51.

Mount single-section heads on span wires as shown for three-section heads.

**(f) Suspension of Signal Heads** - Suspend vehicle and pedestrian signal heads as shown.

**(g) Signal Head Covers** - Cover mounted vehicle signal heads and pedestrian signal heads at all times until the signal installation is ready for continuous operation.

**00990.43 Traffic Signal Detection Devices:**

**(a) Pedestrian Push Buttons** - Mount pedestrian push buttons on a pole, pedestal or post whose foundation directly abuts an asphalt concrete or portland cement concrete landing or walkway. Install push buttons in an H-frame mount having an arrow pointing to the crosswalk for which it is intended.

**(b) Inductive Loop Detectors:**

**(1) Saw Cut** - Make cuts compatible with construction and in the most practical, direct line between loops and junction boxes, except where parallel to, or nearly parallel to, a lane line; then locate cuts under the lane lines.

Make saw cuts 1/2 inch wide for loop wire.

Saw cuts shall have smooth bottoms, with no edges due to differences in cut depth.

Limit saw cut angles to 90 degrees or less to limit the bend in loop wire. Cuts shall not create islands of pavement less than 2.5 square feet in area.

Flush cuts thoroughly with a high-pressure water stream immediately after sawing, and before the cuttings dry. Blow cuts free of water, debris, rock, and grit with high-volume or high-pressure air. Slots may also be cleaned by means of a high-pressure water injection/vacuum extraction system. Remove all cuttings from the Project.

Dry cuts before placing wire. Remove rocks or other material that may be wedged in the cut.

Two sets of twisted pair loop wires may be installed in a single saw cut, as long as the minimum cover shown 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.

On new open-graded AC wearing courses install loops in the base lift, or in the existing surfacing if it is to be overlaid, and after milling has been completed.

In an existing open-graded AC surface, the saw cut and installation shall be as shown.

**(2) Wire** - Place a permanent plastic label on each loop feeder cable indicating the loop numbers, in indelible ink, as shown on the Loop Detector Wiring Diagram. Place labels within 4 inches of the end of the jacket at each end of the loop feeder cables.

Do not remove the outside jacket and shield of loop feeder cables more than 6 inches from the end, inside the controller cabinet. Solder all loop feeder conductor terminations from field wiring in signal controller cabinets after crimp lugs have been installed. Crimp lugs used for loop wire field terminals may be insulated or non-insulated. Terminate loop feeder shield drain wire to the cabinet input panel grounding bus nearest the feeder wire termination points.

**(3) Installation** - The Engineer will mark or approve the center point location of all loops to be installed. Do not place wire in saw cuts until the cuts have been inspected by the Engineer.

After the saw cut is cleaned of debris, place the loop wire by pushing it 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 shown or specified. Twist the loop wire pair together 4 to 6 twists for each foot from the exit point of the loop to the splice point of the loop feeder cable or termination point in the controller cabinet as shown. Use one continuous, unbroken length of loop feeder cable from the loop wire splice point to the cabinet.

After loop wire is placed and before the saw slot is sealed, install loop wire hold-downs (backer rods) made of closed-cell polyurethane. 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 12 inch centers. Hold-downs shall fit snugly in saw slots.

After placing the wire, perform loop resistance testing before filling the slots with hot-melt sealant. Install the sealant in slots according to the manufacturer's instructions. Furnish a copy of the manufacturer's specifications including application procedures. The Engineer may order a test run of any application method or material before filling saw cuts.

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 or 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.

In order to prevent heat damage to the insulation, do not allow the temperature of the sealant to exceed 410 °F during application. Install hot-melt sealants in layers to prevent damage to wire insulation. Allow each layer to cool before the next layer is installed. Do not use water to accelerate cooling. Do not seal street boxes with sealant that remains soft after setting or cooling.

Sealants that crack or pull away from the saw cuts after curing will be rejected.

**(4) Splice** - Splice loop wires to feeder cable in junction boxes. Connect loop wires to loop feeder cable with a screw on silicon grease filled wire connector. Remove 4 inches to 6 inches of feeder cable outer jacket, drain wire and shield. Do not damage the conductor insulation. Offset splices to ensure they do not make contact with each other. Strip feeder and loop conductors back about 1/2 inch. Cover the splice with a two piece plastic enclosure flooded with silicon grease.

**(5) Resistance Testing** - The resistance to ground of the loop and loop feeder combinations, tested with a 500 V wire insulation Megger tester, shall be 500 MΩ or greater when checked both before placing the sealant and after the sealant has set.

**(6) Loop Sensitivity** - Loops shall be sensitive to bicycles. After installation is complete the Engineer will test each loop.

**00990.44 Traffic Control Signs** - The type of sign and method of mounting will be as shown or specified. Signs shall conform to applicable portions of Section 00940.

**00990.46 Fire Preemption** - Fire preemption systems shall:

- Include all required control modules, detector units, detector feeder cable, wiring harness, interface circuitry and miscellaneous hardware.
- Have cable that runs continuously without splices from the detector unit to the controller cabinet.
- Not include emitter units.

**00990.47 Railroad Interconnect** - Run the circuit conductors in underground electrical conduit of the size shown. Terminate the conduit at the railroad cabinet at the location and in the manner directed by the railroad company. Extend the ends of the wire at least 3 feet beyond the end fitting of the supplied conduit. All other work inside the railroad cabinet is the responsibility of the railroad.

Do not work in the immediate vicinity of the railroad cabinet without first notifying the Engineer and receiving permission. The Agency will obtain supervisory personnel from the railroad company.

Do not place any materials or equipment in the vicinity of the tracks without observing proper clearance (see 00170.01(e)).

### Finishing

**00990.70 Testing and Turn-on** - This work includes the testing traffic signal control equipment, testing traffic signal installations, and turning on completed traffic signal installations.

**(a) Delivery of Control Equipment** - Provide manuals, diagrams, and other documents as required by the Agency. 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, at Contractor's cost, to the Contractor. Include the following information with equipment shipments:

- Contractor
- Supplier
- Manufacturer
- Location
- Contract number
- Agency for which the equipment is to be tested. For agencies other than ODOT, include a complete set of plans and specifications to which the equipment is to be tested.

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

Oregon Department of Transportation  
Traffic Systems Services Unit  
2445 Liberty St. NE  
Salem, Oregon 97303-6738

**(b) Control Equipment Testing** - The following traffic signal control equipment will be tested by the Agency for conformance with the Contract Documents before being installed:

- Controller unit
- Controller cabinet
- Power supplies

- Input devices
- Output devices
- Conflict monitors
- Flasher units
- Relays
- Preemption devices
- Auxiliary equipment in the cabinet
- Other equipment required for the operation of the installation

Control equipment will be tested at no cost to the Contractor.

The control equipment will be tested in three categories: physical, functional, and environmental as specified in the Standard Specification for Microcomputer Signal Controller. ODOT will require six weeks for completion and evaluation of the testing.

**(c) Control Equipment Failure** - A traffic signal control equipment failure is any occurrence that results in nonspecified operation of the equipment.

The Contractor will be notified of all control equipment failures, and shall make on-site repairs within five 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.

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

**(1) Twice Fail** - The control equipment fails twice in the same testing category.

**(2) Failure to Repair** - The Contractor fails to repair the control equipment within five days of receiving notification of the failure.

Pick up rejected traffic signal control equipment within 10 days of receiving the rejection notice, or it will be returned, at Contractor's cost, to the Contractor.

Replace rejected control equipment with 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.

**(e) Control Equipment Acceptance** - Traffic signal control equipment that successfully passes the testing procedure will be certified by the Agency as acceptable for installation. Acceptability for installation does not guaranty final acceptance of the completed installation.

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 operation.

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

**(f) Control Equipment Installation** - Be responsible for pick-up, delivery and installation of the controller cabinet.

The Agency will be responsible for delivery and installation of the other control equipment, such as controller units, input devices, switch packs, monitor units, miscellaneous plug-in devices and auxiliary devices not physically wired to the controller cabinet.

Other control equipment that the Agency is to install will be stored at the test facility until the signal installation is ready to be turned on.

**(g) Field Testing** - Field testing of traffic signal installations will be performed by Agency electrical crews. Notify the Engineer one week in advance of the anticipated signal completion date. The Engineer will notify the Agency's Traffic Systems Services Unit and the Agency's electrical crew of the anticipated completion date. Field testing will be performed within one week following the date of completion. The Engineer will notify the Contractor of the test results.

Information on Agency testing procedures is available from the Engineer.

**(h) Traffic Signal Turn-on** - The Engineer will establish the date and time the installation is to be turned on. The Agency will turn on the signal within one week after completion of corrections identified during field testing.

Be present at the Project Site.

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 problems with workmanship 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 responsibility of the maintaining agency.

**(i) Interconnect System Testing:**

Test each new interconnect cable circuit installed in the system. Test the complete system only when all terminations for each cable circuit are completed from the interconnect or controller cabinet at the beginning of the new cable run to the controller or interconnect cabinet at the end of the new cable run. If any test is failed, repair the circuit and repeat the entire test series for that cable circuit.

Perform all tests in the presence of the Engineer. Document the test results. When the tests are completed, furnish the test results and the test data to the Engineer. Conduct tests, as described below, for all cable conductors, including spares, the cable shield, and all field terminations.

In addition to testing the complete system, perform the following tests for each cable circuit:

**(1) Continuity** - Perform a continuity measurement for each conductor and the cable shield in the system. Conductor resistance shall not be more than 10  $\Omega$  per 1,000 feet for each cable pair and shield of the communications cable. Measure the resistance with an ohmmeter having a minimum input impedance of 10 M $\Omega$ /V. Record the resistance of each pair and furnish to the Engineer as described above.

**(2) Isolation** - Perform an isolation measurement for each conductor and cable shield in the system. Measure the insulation resistance with all connections to the conductor or shield under test removed and all other conductors in the cable grounded. Make the measurement with a DC potential of not less than 360 V nor more than 550 V, continuously applied for one minute. Insulation resistance of each cable conductor and the shield shall exceed 1,000 M $\Omega$  per mile. Use an insulation resistance (Megger) tester with a meter scale for measurements, marked with a range from 100 K $\Omega$  to 100 G $\Omega$ , and with zero and infinity also marked.

**00990.75 Warranty** - Provide a one year Contractor warranty according to 00170.85(b). This Contractor warranty does not replace or reduce other warranties, including manufacturer's warranties, that are longer than one year.

### Measurement

**00990.80 Measurement** - No measurement of quantities will be made for work performed under this Section.

### Payment

**00990.90 Payment** - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

<b>Pay Item</b>	<b>Unit of Measurement</b>
(a) Traffic Signal Installation .....	Lump Sum
(b) Traffic Signal Modification .....	Lump Sum
(c) Loop Detector Installation .....	Lump Sum
(d) Ramp Meter Signal Installation .....	Lump Sum
(e) Interconnect System .....	Lump Sum
(f) Flashing Beacon Installation .....	Lump Sum
(g) Automatic Traffic Recorder Installation .....	Lump Sum

Item (a) includes furnishing and installing all items of the traffic signal system, including the fire preemption system, the controller, the controller cabinet equipment, and the detection system.

Item (b) includes furnishing and replacing or installing items for an existing traffic signal installation.

Item (c) includes furnishing and installing a complete traffic loop detector installation for an existing installation, including required controller equipment.

Item (d) includes furnishing all items of the ramp meter signal system, including the controller and controller cabinet equipment.

Item (e) includes furnishing all the interconnect system.

Item (f) includes furnishing and installing all items of the flashing beacon system.

Item (g) includes furnishing and installing all items of the automatic traffic recorder system.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for replacement of disturbed earthwork, base, and surfacing.

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