EXPECTED IMPLEMENTATION JANUARY 2015

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**650 VEHICULAR TRAFFIC SIGNAL ASSEMBLIES.**
**(REV 8-20-14) (FA 9-4-14) (1-15)**

SECTION 650 is deleted and the following substituted:

## SECTION 650
## VEHICULAR TRAFFIC SIGNAL ASSEMBLIES

**650-1 Description.**

Furnish and install vehicular traffic signal assemblies as shown in the Plans and Design Standards. For additional requirements related to mounting and attaching the assemblies, see Section 659.

**650-2 Materials.**

**650-2.1 General:** Use vehicular signal assemblies listed on the Department's Approved Product List (APL). Vehicular traffic signal assemblies must meet the requirements of Section 603 and the Institute of Transportation Engineers (ITE) Standard for Vehicle Traffic Control Signal Heads.

Provide vehicular traffic signal assemblies as a complete and functioning unit. Components include, but are not limited to, signal housing, LED signal module, visors, backplates, lenses, and assembly hardware.

All sections of multi-section assemblies must be from the same manufacturer.

Fastening hardware such as bolts, screws, nuts, washers, latches, and studs must be must be SAE Type 316 or 304 stainless steel.

Horizontal signal assemblies must be constructed so the door hinges, when installed, are located on the bottom of the signal assembly. Vertical mounted five-section cluster assemblies must be constructed so that the door hinges, when installed, are located along the outside edges of the complete assembly and each section opens away from the horizontally adjacent section.

Vehicular traffic signal assemblies must be permanently marked with the manufacturer's name or trademark, part or model number and date of manufacture or serial number.

**650-2.2 Twelve Inch Signal Head Assemblies:** Construct the assembly of materials and alloys specified in the ITE Standard for Vehicle Traffic Control Signal Heads.

The top and bottom opening of each signal head section must include a circular 72-tooth serrated connection (2 inch nominal I.D.) capable of providing positive positioning and alignment in 5 degree increments. When assembled and tightened, these connections must prevent rotation or misalignment of the signal head as well as misalignment between sections. The serrated area must start at the outside of the 2 inch hole and be at least 1/8 inch wide. The teeth must have a minimum depth of 3/64 inch between peaks and valleys, be free from burrs or other imperfections, and provide positive locking with the grooves of mating sections, framework, and brackets. The serration on the top circular connection of a signal section must have a valley at the 0 degree position and the serration on the bottom circular connection must have a peak at the 0 degree position, both aligned perpendicular to the front of the section.

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Connections must permit the assembly of a multi-section signal with the front of each section aligned within 1 degree.

Provide at least two latching points with latch pads and manual Type 316 or 304 stainless steel latching devices that are tamper resistant.

Each signal section must have four backplate mounting attachment points on the back of the signal, on or no more than three inches from each section corner. Attachment points must be capable of accepting No. 10-16x3/8 inch or No. 10-24x3/8 inch Type 316 or 304 stainless steel screws for attaching backplates.

Tri-stud washers used between signal sections must have a minimum thickness of 0.090 inches. For five-section cluster assemblies, tri-stud washers used to attach the top signal section to the multi-signal bracket and the multi-signal bracket to the bottom four signal sections must have a minimum thickness of 3/8 inches. When fastened together, washer distortion is not allowed.

Design each signal section to prevent the accumulation of standing water within the assembly. All sections comprising a single multi-section assembly must be securely fastened together to form a rigid and weather-proof unit.

**650-2.2.1 Doors:** Construct each signal section with at least two hinges for mounting a door. Hinge pins must be captive. Doors must remain captive and secure at all times and be capable of either left or right swing. The door latch must hold the door tightly closed. The door must include slotted pads that allow the door to be opened and closed by engaging or disengaging the latching device. The outside face of the door must include four holes equally spaced around the circumference of the lens opening for the attachment of a visor. The lens opening in the door must have a diameter of 11 to 11-1/2 inches.

**650-2.2.2 Visors:** The rear of the visor must have four tabs, notches, or holes for securing the visor to the signal housing door. The visor mounting method must permit the visor to be rotated and secured at 90 degrees for horizontal signal head installations. All visors must have a minimum length of 9-1/2 inches, and a minimum downward tilt of 3.5 degrees measured from the center of the lens. Tunnel visors must encircle and shield the lens from 300 degrees, plus or minus 10 degrees. Louvers may only be used in combination with full circle visors. Light must not escape between the visor and the door.

**650-2.2.3 Gaskets:** Gaskets must be constructed of weather-resistant material and be glued or sealed where they meet to provide one continuous length of gasket capable of providing a weatherproof seal for the signal assembly. Provide seals between the housing and door, between the lens and the door, and between any other mating surfaces where dust and moisture could enter. Gasket material must meet NEMA 250 and be constructed of temperature stabilized material that prevents any residue from collecting on the internal surfaces of the signal head.

**650-2.2.4 Terminal Blocks:** Provide at least one five-connection terminal block in all three or more section signal head assemblies and at least three five-connection terminal blocks in all five section signal head assemblies. Terminal block connections in the signal assembly must not require any tools other than a screwdriver.

Mount terminal blocks to the signal housing with Type 316 or 304 passivated stainless steel hardware. Use only non-corrosive wire attachment screws approved by the Department.

**650-2.2.5 Color and Finish**: The housing, doors, visors and backplates must be powder coated dull black (Federal Standard 595-37038) with a reflectance value not exceeding

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25 percent as measured by ASTM E1347. For polycarbonate heads, the black color must be incorporated into the plastic material before molding.

The finish on interior and exterior surfaces of aluminum signal head assemblies, visors, doors, and housing, must be painted in accordance with Military Standard MIL-PRF-24712A or American Architectural Manufacturers Association-2603-02 and must meet the requirements of ASTM D3359, ASTM D3363, and ASTM D522. Surface erosion, flaking, or oxidation must not occur within the normal life expectancy under typical installation conditions.

**650-2.2.6 Polycarbonate Signal Housings and Visors:** Construct signal housing assembly, door, and visors of UV stabilized polycarbonate plastic with a minimum thickness of 0.1 inches, plus or minus, 0.01 inches, with the following physical properties:

a) Specific Gravity: 1.17 minimum, as per ASTM D792

b) Vicat Softening Temperature: 305-325 F (152-163 C), as per ASTM D1525

c) Brittleness Temperature: Below -200 F (-129 C), as per ASTM D746

d) Flammability: Self-extinguishing, as per ASTM D635

e) Tensile Strength, yield: 8500 PSI (58 MPa) minimum, as per ASTM D638

f) Elongation at yield: 5.5-8.5 %, as per ASTM D638

g) Shear, strength, yield: 5500 PSI (38 Mpa) minimum, as per ASTM D732

h) Izod impact strength, [notched, 1/8 inch]: 15 ft-lb/in (800 j/m) minimum, as per ASTM D256

i) Fatigue strength at 2.5 mm cycles: 950 PSI (6.5 MPa) minimum, as per ASTM D671

**650-2.2.7 Backplates (Standard and Retroreflective):** Backplates may be constructed of either aluminum or polycarbonate. Minimum thickness for aluminum backplates is 0.060 inch and the minimum thickness for polycarbonate backplates is 0.120 inch. The required width of the top, bottom, and sides of backplates must measure between five to six inches. Color of backplates must be black in accordance with 650-2.2.5. Backplate thickness measurement must not include the retroreflective sheeting thickness.

Provide backplates with a minimum of four corner mounting attachment points per signal section (for example, a three-section signal assembly would have 12 mounting points). Attachment points must not interfere with the operation of traffic signal section doors. Backplate outside corners must be rounded and all edges must be de-burred.

Provide louvers for all backplates. Louver orientation must be vertical on sides and horizontal on top and bottom of the backplate and must be at least 1/2 inch from the inner and outer edge of the backplate panel. Universal backplates must fit all traffic signals listed on the APL.

Mount the backplate securely to the signal assembly with Type 316 or 304 passivated stainless steel installation hardware. All backplates must be marked in accordance with 650-2.1, on the long sides of the backplate.

Backplates with retroreflective borders must be constructed of aluminum. Use only Type IV yellow retroreflective sheeting listed on the APL. Place a 2 inch border on the entire outer perimeter of the backplate panel, no closer than 1/2 inch from louvers. No sheeting is allowed over any louvered area.

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**650-2.2.9 Light-Emitting Diode Optical Unit:** The LED optical unit must conform to the requirements of ITE's latest LED Purchase Specification, "Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Circular Signal Supplement" with the following exceptions.

**650-2.2.9.1 Physical and Mechanical Requirements:** Retrofit LED signal modules must be compatible with all traffic signal housings listed on the APL. The rear of the LED signal module must be marked in accordance with 650-2.1.

**650-2.2.9.2 LED Signal Module Lens:** The lens must be tinted with an appropriate color (red, amber, or green) to reduce sun phantom affect and enhance on/off contrast. The tinting must be uniform across the face of the lens and be free from streaks, wrinkles, chips, bubbles, or other imperfections. If a polymer lens is used, a surface coating must be incorporated to provide abrasion resistance.

**650-2.2.9.3 Minimum Maintained Luminous Intensity Values:** Red and green modules must meet the current requirements of ITE's Performance Specification, Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Circular Signal Supplement, dated June 27, 2005. Yellow modules must be 1.7 times brighter than the ITE specification.

**650-2.2.10 Electrical:** Electrical conductors for LED signal modules must be a minimum of 36 inches in length. Each lead from the LED module must be terminated with insulated slide-on terminals. The conductors must be color coded to identify the color of the module as follows:

a) White must identify the neutral lead.

b) Red circular signals must be identified with a red lead, yellow circular signals with a yellow lead, and green circular signals with a green lead.

c) Red arrows must be identified with a red and black tracer lead, yellow arrows with a yellow and black tracer lead, and green arrows with a green and black tracer lead.

**650-2.2.11 Qualification Loading Requirements:** Vehicular traffic signal assemblies must withstand 740 pounds loading (flexure) and 7400 pounds loading (tension). Alternatively, test results that demonstrate a complete assembly (such as from catenary wire to bottom of signal) is capable of withstanding 150 miles per hour wind speeds and meet the requirements of the Department's Structures Manual, Volume 3 without structural damage that would breach the serviceability of the signal (i.e., the traffic signal continues to function properly and indication can be seen by approaching motorists) are acceptable evidence of load testing.

**650-3 Installation.**

**650-3.1 Preassembly:** Pre-assemble the signal heads when more than one signal section is required prior to installation at the site. Furnish signal heads with LED modules, backplates, and visors. Use tunnel visors unless otherwise specified in the Contract Documents. Install the LED circular module in the door so that the UP arrow or the word UP or TOP is in the up orientation of the signal housing. Install the LED arrow modules in the signal housing door in the direction of the intended use.

**650-3.2 Positioning of Signals:** Consider the locations of the installed signals as shown in the Plans as sufficiently flexible as to allow for unanticipated field conditions at the site. The Engineer will direct any variations from the locations shown. Position adjacent signal faces no closer than 8 feet apart measured horizontally at 90 degrees to the traffic flow between centers of faces.

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Regardless of the results of any scaled dimensions, consider the location shown in the Plans to be approximate. Position a signal face mounted on a span wire or mast arm as near as practical to the line of the driver's normal view.

Ensure that all sections are of the same manufacturer and the section assemblies are uniform in appearance and alignment.

**650-3.3 Clearances:** Unless directed otherwise by the Engineer for unusual circumstances at the site, provide a vertical clearance of not less than 17 feet-6 inches and not more than 19 feet for traffic signals placed over the roadway. Measure such clearance for each span directly under the most critical signal assembly (in regards to clearance) for that span. Place signal assemblies on each span as near as practical to the same elevation as the critical signal assembly.

Ensure that the lowest point on pedestal-mounted and side-mounted signal heads is 12 feet above finished grade at the point of their installation.

**650-3.4 Aiming of Signal Indication:** For proper lateral orientation, aim signals after installing and before locking them in position.

**650-3.5 Wiring Connections:** Do not splice signal cable. Connect the proper signal cable to the terminals in each signal head in order to provide the proper signal indication display when the cables are connected to the signal controller. Wire a separate neutral circuit and return it to the controller cabinet from each vehicular movement as shown in the Contract Documents.

**650-3.6 Special Installation Requirements for Optically Programmed Signals:** Install, direct (aim), and conceal optically programmed signals in strict accordance with the instructions of the manufacturer, using the materials furnished by the signal manufacturer, and with the direction of the Engineer.

Position the signals for maximum performance in accordance with the requirements shown in the Plans, and install them with rigid mounting assemblies, using elbows and plumbizers of such type as will provide for stability of the position of the signals. Do not use clevises in the supporting attachments.

Seal the cable routing to the signals to provide permanent water tightness.

**650-3.7 Vertically Mounted Polycarbonate (Light-Weight) Signal Head Assemblies:** The top section of all multi-section (5-section, 3-section), vertically mounted, light-weight signal assemblies must be constructed of die cast aluminum, unless the entire 3 (or more)-section polycarbonate signal assembly is specifically approved and listed on the APL as a 12 inch polycarbonate 3 (or more)-section vehicle assembly.

Single section signals may be constructed of die cast aluminum or polycarbonate.

**650-3.8 Backplates:** Install louvered backplates on all signal head assemblies.

**650-3.9 Sealing Installed Signal Head Assembly:** Ensure that the installed signal head assembly is sealed to exclude dust and moisture. Drill two, 1/4 inch drain holes in the bottom of the installed signal head assembly.

**650-3.10 Concealing Signals Not in Use:** Where traffic signals are installed and not put into service immediately, or placed out-of-service temporarily, conceal the signal head assembly by securely placing burlap bags or other covering approved by the Engineer over a weather resistant covering of non-transparent material open at the bottom to prevent condensation buildup.

**650-3.11 Installation Sequence:** Install all traffic signal assemblies at any intersection as a single operation unless a staged operation is approved by the Engineer.

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**650-3.12 Emergency Signal Heads:** For new emergency fire stations signals, install 12 inch signal heads for all three indications. For existing 8 inch emergency fire station signals, retrofit with 8 inch LED modules. The 8 inch LED optical unit must conform to the requirements of the ITE's Performance Specification, Vehicle Traffic Control Signal Heads - Light Emitting Diode (LED) Circular Signal Supplement.

**650-4 Warranty.**

Ensure that the signal housings, modules, backplates, and any other signal assembly components have a manufacturer's warranty covering defects for a minimum of three years from the date of final acceptance in accordance with 5-11 and Section 608. Ensure the warranty includes providing replacements, within 30 calendar days of notification, for defective parts and equipment during the warranty period at no cost to the Department or the maintaining agency.

Ensure that the LED signal modules have a manufacturer's warranty covering defects for a minimum of five years from the date of final acceptance in accordance with 5-11 and 608. Ensure that the warranty includes providing replacements, within 30 calendar days of notification, for any defective parts and equipment (including falling below minimum intensity levels) during the warranty period at no cost to the Department or the maintaining agency.

**650-5 Method of Measurement.**

The Contract unit price per assembly for vehicular traffic signal, furnished and installed, will consist of the traffic signal and all components necessary to make a complete unit, including mounting assemblies, backplates, visors, LED modules, labor, and materials necessary for a complete and accepted installation.

**650-5 Basis of Payment.**

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 650- 1- Vehicular Traffic Signal - per assembly.