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**Basis of Acceptance.** Single Conductor Direct Burial Cable will be accepted upon the manufacturer's certification that it meets the requirements of this specification as well as being Underwriter's Laboratory approved.

**723-72 Thru 723-74 (Vacant)**

**723-75 Ground Wire**

**Scope.** This specification covers the material and quality requirements for ground wire used in highway lighting.

**Material Requirements.** Ground wire shall be #6, soft-drawn bare copper wire, 7 strand single conductor for 600 volts.

**Basis of Acceptance.** Ground wire shall be accepted upon the manufacturer's certification that it meets the requirements of this specification as well as being Underwriter's Laboratory approved. All ground wire shall also carry the Underwriter's Laboratory approval label.

**Section 724 - Traffic Signals**

**724-01 Signal Cable**

**Scope.** This specification covers the material requirements for signal cable for use with traffic signal systems and for installation in underground ducts or as an aerial cable supported by a messenger.

**Material Requirements.** The cable shall conform to the requirements of the International Municipal Signal Association (IMSA) Specification 20-1. The gauge and number of conductors shall be as specified in the plans. The conductors shall be stranded copper wire.

**Basis of Acceptance.** Acceptance of material will be based on the manufacturer's certification of compliance with these specification requirements.

**724-02 Span Wire**

**Scope.** This specification covers the material requirements for span wires used in the suspension of traffic signal heads. Span wires may be used as a single span wire or a dual span wire including a tether wire. The same wire may be used as messenger wires or guy wires.

**Material Requirements.** Span wire shall meet the requirements of ASTM B228, Grade 30 EHS.

**Basis of Acceptance.** Acceptance of span wire will be based on the manufacturer's certificate of compliance with these specification requirements, together with supplementary sampling and testing at the discretion of the Materials Bureau.

**724-03 Traffic Signal Poles**

**Scope.** This specification covers the material requirements and fabrication details for poles used for traffic signals. Traffic signal poles are classified according to the following applications:

- **A. Span Wire.** Span wire poles are used for supporting a steel cable or cables to which are attached traffic signals and overhead signs.

- **B. Mast Arm.** Mast arm poles consist of a vertical shaft and an approximately horizontal arm to which are attached traffic signals and overhead signs. These poles may also be equipped with more than one mast arm.

- **C. Post Top Mount.** Post top mount poles are used for mounting traffic signals directly on the top of...
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the pole.

**D. Bracket Mount** Bracket mount poles are used to support traffic signals and other items bracketed from or attached to the side of the pole.

**Traffic Signal Poles with Lighting Arms** - Lighting arms may also be attached to all pole types except post top mount.

**DESIGN CRITERIA.** The poles shall be designed in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, except as modified by this specification. The following elements of a pole shall be designed for the most critical orientation of the loads, applied to a traffic signal pole:

- Any tubular segments of the structure.
- Hand hole reinforcement and other hole reinforcement.
- Device used to connect cable to pole.
- Base plate.
- Mast arm to pole connections.
- Anchor bolts.

The design shall be approved, stamped and signed by a professional engineer licensed in the State of New York.

All necessary holes in the pole below the load attachment point and greater than 18 mm in diameter shall be made by the manufacturer and reinforced according to the fabrication details and contract documents. Hand holes shall be located ninety (90°) degrees clockwise, top view, from the direction of the cable load, unless otherwise specified.

For those poles on which a traffic signal cabinet will be mounted the pole manufacturer will be required to weld a cabinet wiring access coupling into the pole as part of the pole manufacturing process. This coupling shall be centered 300 mm from the bottom of the base plate and 90° clockwise (top view) from the axis of the hand hole. The coupling shall be designed to accept a standard chase nipple on the inside of the pole, and to accept 38 mm of a standard 4 NPS diameter galvanized pipe from the outside of the pole, and shall protrude no more than 12 mm on the outside of the pole. An insulated chase nipple shall be installed in the coupling on the inside of the pole. The coupling shall be designed to reinforce the hole in which it is installed.

**Wind Loads.** Poles and attachments thereto covered by this specification shall be designed for the following wind speeds in accordance with the AASHTO standard in “B” above.

- 129 km/h - Counties of Allegany, Bronx, Cattaraugus, Chautauqua, Erie, Genesee, Kings, Livingston, Monroe, Nassau, New York, Niagara, Orleans, Ontario, Queens, Richmond, Rockland, Suffolk, Wayne, Westchester and Wyoming.
- 113 km/h - All other counties.

**MATERIAL REQUIREMENTS.** The following materials, or approved alternates, as determined by the Deputy Chief Engineer, Facilities Design, shall be used for fabrication. Span Wire, Mast Arm and Bracket poles shall be galvanized steel. Post top poles may be either galvanized steel or aluminum. Acceptable aluminum materials are those contained in the current AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.”

The following are the acceptable steel materials for the signal pole components.

**Poles and Arms.** The finished pole shall be galvanized in accordance with section 719-01 Galvanized Coatings and Repair Methods, Type 1, and be made of one of the following:

- ASTM A500, Grade B or ASTM A501.
- ASTM A53, Grade B pipe.
- ASTM A53, Grade B pipe, with a minimum yield of 330 MPa guaranteed by the manufacturer and documented by the submission of certified copies of physical tests performed on the lots of material from which the poles were manufactured.
• ASTM A252, Grade 2 or Grade 3.
• ASTM A252, Grade 2, with a minimum yield of 330 MPa guaranteed by the manufacturer and documented by the submission of certified copies of physical tests performed on the lots of material from which the poles were manufactured.
• ASTM A572M, Grades 290, 345, 415 or 450.
• ASTM A595, Grade A.
• ASTM A618, Grade I, II or III.
• ASTM A588M.
• ASTM A513, with a minimum yield strength of 248 MPa guaranteed by the manufacturer, and documented by the submission of certified copies of physical tests performed on the lots of material from which the poles were manufactured.
• ASTM A607, Grade 400 Class 2.

Bases. The base shall be galvanized under the same specification as the pole, and made of one of the following:
• ASTM A27M, Grade 65-35, mild to medium strength carbon steel castings.
• ASTM A36M.
• ASTM A588M.
• ASTM A572M, Grade 290, 345, 415 or 450.
• ASTM A633M (Any Grade).

Anchor Bolts, Nuts and Washers
Bolts and nuts shall meet the requirements of one of the following specifications:
• ASTM F568M Class 4.6 (Bolts and Nuts)
• ASTM F568M Class 8.8 (Bolts)
• ASTM A576 (bolts) Grades 1021 and 1025 with a minimum elongation of 18 percent in 50 mm tested in accordance with ASTM A370. The guaranteed minimum yield strength shall be stated by the manufacturer.
• ASTM A675M Grades 485 through 620 (Bolts).
• ASTM A563M Grades A, B, C, D, or DH (Nuts).
• ASTM A687 (Bolts).
• ASTM A36M (Bolts) modified to a minimum yield of 379 MPa, minimum tensile of 448 MPa and minimum elongation of 18 percent in 50 mm, tested in accordance with ASTM A370.
• ASTM A194, Grade 2H (Nuts)

The type and grade of steel for nuts shall be compatible and of comparable strength to the steel used for the bolts. Washers shall be plain hardened washers.

Nuts, washers and a minimum of the top 300 mm of anchor bolts shall be hot-dipped galvanized, in accordance with the requirements of section 719-01, Galvanized Coatings and Repair Methods, Type II.

Connection Devices
• ASTM A36M.
• ASTM A588M.
• ASTM A325M.

Pole Caps and Anchor Bolt Covers. Pole caps shall be galvanized steel, galvanized cast iron, aluminum or zinc alloy AG40A. Anchor bolt covers shall be galvanized steel, galvanized cast iron, or aluminum. Galvanizing shall be done in accordance with the requirements of §719-01, Galvanized Coatings and Repair Methods, Type II.

FABRICATION
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Bases and Hardware. The base plate shall be welded to the pole by an acceptable weld in accordance with the New York State Steel Construction Manual.

All anchor bolts, nuts and washers required for each pole shall be supplied by the pole manufacturer. Anchor bolts are to be anchored using double nuts and plates or threaded plates and shall be designed by the fabricator. Anchor bolts shall be long enough to embed at least 30 bolt diameters into the concrete foundation. "L" bends will not be allowed. The number of anchor bolts and the bolt circle diameter shall be determined by the fabricator unless specified in the contract documents. Each anchor bolt shall be equipped with 2 nuts and one or more washers for attaching the pole plus those necessary to provide end anchorage to the anchor bolt.

Washers will not be required when the holes on the base plate are within the following tolerances:

- Hole diameter not more than 3 mm greater than the bolt, for bolt diameters less than 25 mm.
- Hole diameter not more than 6 mm greater than the bolt, for bolt diameters equal to or greater than 25 mm.
- Hole diameter not more than 9 mm greater than the bolt, for bolt diameters equal to or greater than 50 mm.

Anchor bolt covers shall be furnished. These shall be affixed to the base or shaft with stainless steel cap screws.

Shafts and arms shall be equipped with end caps secured with stainless steel set screws.

Shafts. Shafts shall be round or multi-sided shapes.

Shafts shall be equipped with hand holes except for poles intended for transformer base mounting. Hand holes shall be centered approximately 600 mm above the base end of the pole. The maximum hand hole size shall not exceed 100 mm x 165 mm. Poles shall be equipped with a grounding terminal accessible through the hand hole. Grounding terminals are not necessary if there is no hand hole.

Holes for wiring fittings shall consist of a pipe coupling of the specified diameter and where feasible shall be shop installed. Hand holes and holes for wiring fittings located near the base of the pole shall be reinforced with metal at least equal to the area removed.

Shafts may be fabricated in any of the following shapes and styles:

A. Round Continuously Tapered. Shafts shall be fabricated with not more than one longitudinal seam which shall be continuously welded and ground or rolled flush. Shafts shall have a uniform wall thickness and shall taper uniformly, starting at the butt end, decreasing in diameter at the rate of not more than 12 mm, but not less than 6 mm per meter of length.

B. Round Step Tapered Construction. Shafts shall be fabricated from round pipe sections with not more than one longitudinal seam, joined by a hot-swaged shrink fit, continuously seal welded to prevent entrance of water. Stepped, round shafts shall achieve a tapered effect equal to a maximum rate of 12 mm and a minimum of 6 mm per meter of length by use of decreasing diameter round pipe sections.

C. Multi-sided Continuously Tapered Construction. The multi-sided pole shall conform to the requirements as set forth above under round continuously tapered construction, except that it shall have no more than 2 longitudinal seams which shall be continuously welded and ground or rolled flush. Square or hexagonal shafts will not be allowed.

D. Round Untapered. Poles 8 meters or less in length may be round untapered with not more than one longitudinal seam.

Welding. All welding shall be performed in accordance with the New York State Steel Construction Manual.

Poles with Lighting Arms. Poles with lighting arms shall be constructed in accordance with the configuration in the contract documents and this specification.

Except for bracket-mount traffic signal poles, lighting arms may be of either the single member type or of the truss type if type is not specified. When specified for bracket-mount traffic signal poles, lighting arms
shall be of truss-type design with upper and lower members joined near the luminaire end of the arm. Lighting arms of the truss-type design with upper and lower members joined near the luminaire end of the arm shall be braced with one or two vertical struts depending on the length of the arm. Arms may be either galvanized steel or aluminum.

**Span Wire Poles**

**A. Design Load.** The design load for span wire poles shall be the Group II or III load per AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals” Section 1.2.6, given in the contract documents and applied at a point 450 mm below the top of the pole. Allowable unit stresses shall be as specified in the above AASHTO specification.

**B. Physical and Mechanical Properties.** Span Wire poles shall conform to the following requirements.

- Minimum Wall Thickness - 3 mm
- Maximum Deflection - To be computed at a point 450 mm from the top of the pole, shall be a maximum of 50 mm per meter of pole length and a maximum deflection rate of 17 mm per 500 Newtons.
- Maximum Pole Diameter at the Base - 58 mm per meter of pole length.

**C. Pole Marking.** The following information shall be stamped on the base plate or ground sleeve in 12 mm letters to such a depth as to be clearly visible through subsequent galvanizing:

<table>
<thead>
<tr>
<th>Desired Information</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole Length in whole meters</td>
<td>10 m</td>
</tr>
<tr>
<td>Load in 10 kN Increments</td>
<td>20 kN</td>
</tr>
<tr>
<td>Manufacturers Name or Logo</td>
<td></td>
</tr>
<tr>
<td>Month and Year of Manufacture</td>
<td>1178</td>
</tr>
</tbody>
</table>

**D. Span Wire Connecting Hardware.** The manufacturer shall supply the necessary device for connecting each span wire to the pole. For polygonal poles this device may be either a galvanized thimble eyebolt or a circumferential pole clamp. For round poles, only thimble eyebolts shall be used. The design strength shall be 70% of yield strength of the connecting device. The yield strength shall be determined using a cable load aligned 85 degrees to the vertical axis of the pole.

**Mast Arm Traffic Signal Poles**

**A. Design Loads.** Each part of the structure shall be proportioned for the combination of loads producing the maximum effect, using unit stresses increased for the material and group loads as described in section 1.2.6 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. The wind speed, locations, dimensions, weights, and projected areas of the signals, signs, and supports shall be as specified in the contract documents.

**B. Mast Arm Shapes.** Arms shall be round or multi-sided shapes and have the same cross-sectional shape as the shaft.

**C. Arm Construction.** Mast arms of any length may be constructed by any of the methods indicated under Material Requirements paragraph, B, 1, d, Pole Construction. They may be of two piece construction with a telescoping joint secured by thru-bolt and locknut.

**D. Mast Arm to Shaft Connection.** The mast arm shall be secured to the shaft by a minimum of four bolts. The mast arm shall be equipped with a flange plate welded to the butt end of the mast arm.

A flange plate shall be attached to the shaft using vertical and horizontal gusset plates both top and bottom and at each side.

Flange plates on shaft and mast arms shall have a hole with a smooth cable guide for wiring.

**E. Physical and Mechanical Properties.** Mast arms and shafts shall conform to the following
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requirements:
- Minimum Wall Thickness - 3 mm.
- Maximum Deflection at Design Load.
  Shaft - 42 mm per meter of length.
  Arm - 42 mm per meter of length.
- Maximum Diameter at base of shaft or arm.
  Shaft - 58 mm per meter of length.
  Arm - 58 mm per meter of length.

F. Poles with Multiple Arms. Poles with multiple arms shall be constructed in accordance with the arm configuration in the contract documents.

G. Pole Marking. The following information shall be stamped on the top of the base plate or ground sleeve in 12 mm letters to such a depth as to be clearly visible through subsequent galvanizing.

<table>
<thead>
<tr>
<th>Desired Information</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Thickness</td>
<td>8 mm</td>
</tr>
<tr>
<td>Minimum Yield Strength</td>
<td>345 MPa</td>
</tr>
<tr>
<td>Manufacturers Name or Logo</td>
<td>-</td>
</tr>
<tr>
<td>Month and Year of Manufacture</td>
<td>10/77</td>
</tr>
</tbody>
</table>

Post Top Mount and Bracket Mount Traffic Signal Poles. These poles shall be proportioned for the combination of loads producing the maximum effect, using unit stresses increased as indicated for the material and group loads as described in section 1.2.6 of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.” The wind speed, location, weights, dimensions and projected areas shall be as given in the contract documents.

BASIS OF ACCEPTANCE. Acceptance for poles and mast arms covered by this specification will be based on the following, as appropriate:

All Poles and Arms
- Submission of fabrication details for each pole intended for a worst case configuration of the load as specified in the contract documents approved, stamped and signed by a Professional Engineer licensed and registered to practice in New York State.
- Submission of the manufacturer’s certificate of compliance with these specification requirements and the approved fabrication details.

Span Wire Poles
- The acceptance requirements for All Poles and Arms, given above, shall apply.
- Submission of mill certifications for all structural materials.
- Appearance of the manufacturer’s name on the Department’s list of approved manufacturers.

724-04 TRAFFIC SIGNAL HEADS

SCOPE. This specification covers the material and fabrication requirements for vehicular and pedestrian traffic signal heads, including flashing signals and flashing beacons.

STANDARD SIGNAL HEADS

Material Requirements. Only virgin metal shall be used in making either sand castings or die castings, and where specified, the manufacturer shall furnish standard test bars, poured of the metal of which the castings are made, and a certified chemical analysis of the ingot from which the castings are made.

A. Housing. Unless otherwise specified, all traffic signal head housings shall be made of Aluminum alloy of one of the following compositions:
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1. Aluminum Sand Castings. All aluminum sand castings shall be made of ingot, in accordance with ASTM B26, Alloy B443.0 or AC72A.

2. Aluminum Die Castings. All aluminum die castings shall be made of ingot, in accordance with ASTM B85, Alloys SC84A, SC84B, SG100A, SG100B, or S12B.

B. Suspension Components. All suspension components, brackets, clamps, trunnions, arms, elbows, crosses, etc., shall be made of one of the following materials:

1. Malleable iron. Malleable iron material shall be made in accordance with ASTM A47/A47M.

2. Steel pipe. Steel pipe shall be made in accordance with ASTM A 53.


4. Aluminum Die Castings. Aluminum die castings shall be made in accordance with ASTM B85, Alloy SC 84B.

5. Aluminum pipe. All aluminum pipe shall be made in accordance with ASTM B429.

C. Fasteners. The following items shall be made of non-magnetic stainless steel, Type 303 or 304, in accordance with ASTM A296 (latest revision).

- All set screws.
- The U/J-bolts, rivet and their related nuts, washers and cotter pin in the span wire lamp.
- The eye-bolt, rivet, tightening bolt and their related nuts, washers, and cotter pin in the balance adjuster.

D. Pipe Arms. Pipe arms shall be made of steel pipe in accordance with ASTM A120 (latest rev.)

Wind Load. Signal heads, mounting brackets, attachments and fittings shall be designed for a wind load pressure for at least a 145 km/h wind in accordance with AASHTO standard specifications for “Structural Supports for Highway Signs, Luminaires and Traffic Signals.”

Painting. All aluminum traffic signal heads, bracket arms, and mounting attachments shall be painted by first applying a chromate conversion coating and then electrostatically applying a polyester powder coating.

Threads and threaded parts shall not be coated and shall be protected from the coating process at the time of application.

The chromate conversion coating shall be applied and conform to the requirements of ASTM B449, Standard Practice for Chromate Treatments on Aluminum, Class 2 coating. The conversion coating shall be allowed to dry thoroughly and shall be free of entrapped air and contaminants. After drying the chromated surface shall be coated with a polyester powder coating.

The polyester powder shall be electrostatically applied and cured in accordance with the coating manufacturers recommendations. If preheating of the aluminum substrate is required, care shall be taken to prevent damage to the chromate coated surface by not exceeding a preheat temperature of 71°C. The polyester coating shall be applied at a uniform thickness between 0.060 mm and 0.090 mm. The polyester powder used shall have the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>Test Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>D3451</td>
<td>1.2 Minimum</td>
</tr>
<tr>
<td>Impact Resistance</td>
<td>D2794</td>
<td>16 N•m Minimum</td>
</tr>
<tr>
<td>Pencil Hardness</td>
<td>B3363</td>
<td>H - 2H</td>
</tr>
</tbody>
</table>

The color of the finished polyester coating shall be such that a properly prepared color chip shall be a reasonable visual match to Federal Color Standard No. 595A, Color 14056. Viewing shall be done under North Standard Daylight.
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Signal Indications. Signal indications shall be as indicated in the proposal or as shown on the plans.

Wiring. All wiring shall consist of No. 18 AWG stranded copper wire with thermoplastic insulation and a 600 volt rating.

Electrical Characteristics. All equipment shall be designed for operation on 115 volts ±30 volts, 60 Hertz, single phase A.C. power unless otherwise indicated.

Mounting. Signal heads shall be arranged for mounting on span wires, mast arms, post tops or vertical pole bracket mounts as specified in the contract documents. For a span wire mounting the signal head shall be provided with a span wire clamp, balance adjuster and wire outlet fitting. The span wire clamp shall consist of a shoe, lockbar, two “U” or “J” bolts, and a rivet, with cotter pin, nuts, washers, etc., as necessary. The balance adjuster shall consist of a body with threaded eye-bolt, a tightening bolt and a rivet, with cotter pin, nuts washers, etc., as necessary. The wire outlet fitting shall have a continuous opening of a minimum nominal diameter of 40 mm for insertion of signal head wiring. The upper opening shall have a weatherproof insulating composition cover that provides for the insertion of the wiring. The cover shall be securely mounted to the fitting. The bottom opening shall be threaded, and provided with two square or hex drive set screws, located at 180 degrees to each other. The bottom of the fitting shall have integral cast serrations, or shall be notched and provided with a serrated locking ring, or shall be provided with a slotted check nut and serrated locking ring. A 12 or 18 circuit disconnect hanger shall be supplied if specified in the contract documents. The head shall be assembled so that it hangs plumb.

A. One-way Signal Head. Mounting hardware for a one-way signal head shall also include a 40 mm galvanized nipple with cast head, gasket, and steel washer for the connection between the wire outlet fitting and the top of the signal head. A metal weather-resistant cap/plug shall be provided for the unused hole in the bottom of the head. The cap/plug shall be of a threaded or flanged design.

B. Multi-way Signal Head. Mounting hardware for multi-way (2, 3 and 4-way) signal heads shall also include a center junction hub and pipe arms with tee or cross end connectors. Tee and cross connectors shall be notched for, and supplied with a serrated locking ring. No pipe/nipple shall be provided for the connection between the center junction hub and the wire outlet fitting. A 40 mm galvanized nipple with cast head, gasket and steel washer shall be supplied for the connection between the tee or cross connector and the top of the signal head. Tees and crosses will not be accepted in place of the center junction hub.

Center junction hubs shall have a threaded openings on the top and sides. The bottom of the hub shall be essentially fully open, except for the necessary thickness of the housing, and shall be securely covered by a flat plate of weather-resistant design. The plate shall be held in place by a minimum of two screws. Center junction hubs shall be provided with a square or hex drive set screw on all threaded openings, except that the top opening shall be provided with two set screws, located at 90 degrees to each other. Center junction hubs shall have a minimum nominal opening of 90 mm in diameter for round openings, or a minimum nominal side length of 90 mm for rectangular openings. Tees or crosses shall have threaded openings to accept the necessary pipe arm/signal head connections, plus at least one additional threaded opening to facilitate wiring. The extra opening shall be closed with a threaded metal pipe cap. All threaded openings on the tees and crosses shall be provided with a square or hex drive set screw.

Threaded openings on pipe arms shall be tapered. Threaded openings on other pipe fittings shall be pipe straight threads.

Flat arms or spiders shall be provided for the bottoms of multi-way signal heads, except that bottom hardware shall be omitted for multi-way one section head assemblies. Connections between the bottoms of the signal heads and the arm/spider shall be flanged or threaded to provide a locking, weather-resistant connection.

Signal heads for mast arm mounting shall be furnished with a mount consisting of upper and lower horizontal arms attaching to the top and bottom of the signal head housing. The horizontal arms shall attach
to a vertical member which in turn clamps to the mast arm. The mast arm mount shall have provision for adjusting the vertical, angular and rotational positioning of the head in relation to the mast arm so that it is plumb, in line with other signal heads and properly oriented in relation to traffic. Wiring shall be concealed within the mount.

Post top signal heads shall be furnished with a post top type sliplifter mounting. Vertical pole bracket mount signal heads shall be equipped with upper and lower horizontal brackets equipped with pole plates for attachment to the pole with stainless steel bands.

**Housing.** The housing for each face shall be of unitized sectional construction and shall consist of as many sections as necessary to provide the indications shown on the plan. All sections shall be rigidly and securely fastened together into one weather-tight signal face. An adjustable traffic signal head shall consist of two or more signal faces fastened to and supported by a pipe assembly and suitable entrance fitting.

Each housing shall be arranged with openings in the top and bottom so that it may be rotated about a vertical axis between waterproof supporting brackets or trunnions and shall be capable of being securely fastened at increments of not more than 7 degrees of rotation. The top and bottom of each housing shall have integrally cast locking rings or other provisions to provide positive interlocking and indexing.

The top and bottom of each housing shall be provided with tees or crosses equipped with pipe-plug knobs or caps which can be removed to assist in wiring.

Flat arms or spiders will be accepted as an alternative for use on the bottom of adjustable signals. One-section adjustable beacons may be supplied without bottom bracket arms.

Each housing shall be so designed that additional sections may be added. The construction shall permit the assembly of 300 mm signal sections with 200 mm sections of the same manufacturer. The assembly shall permit the joining of 200 mm sections either above or below the 300 mm sections.

**Doors.** The door shall be of cast aluminum alloy and shall be provided with four visor mounting holes located equidistant about the lens opening to allow the mounting of the visor in either a vertical or horizontal position. The holes shall be drilled and tapped, and provided with stainless steel mounting screws. Neoprene gasketing shall be provided between the body of the housing and the doors. The doors shall be suitably hinged and shall be forced tightly against the gasket and the housing by simple stainless steel locking devices. All other exterior hardware such as hinge pins, lens clips, etc. shall be of stainless steel. The locking device shall be capable of being operated without the use of tools. Hinges shall be arranged to allow convenient relamping. On the outside of the door, there shall be a rim encircling the lens opening to prevent any light leakage between optical systems.

**Visors.** The visors shall be separate and removable from the doors, held in place by stainless steel fastenings attached to the door in such a manner as to prevent the possibility of any light leakage between the door and hood which might be discernible from the side. Visors shall be of sheet aluminum, not less than 1.27 mm, and shall mount to the signal head through the use of four slotted mounting tabs which intermate with the mounting screws on the signal housing door. Unless otherwise specified in the contract documents all signal heads shall be provided with cap-type visors. The insides of visors and the entire surface of louvers or fins used in front of signal lenses shall be painted a flat black to minimize light reflection to the sides of the signals. Visors shall tilt down from the horizontal a minimum of 3.5° and shall be a minimum of 241 mm in length for 300 mm diameter lenses and 177 mm in length for 200 mm diameter lenses.

**Connection Blocks.** Each signal face shall be equipped with a 5-point heat resistant terminal block. It shall have five terminals with connectors for receptacle leads and screw terminals for field wires.

The individual connection blocks in the separate faces of a signal head shall be interconnected. In one face of each multi-face head, there shall be an additional nine terminal block to which all field wires are connected. All socket leads of all signal faces shall terminate at this nine terminal block.

**Dust-Tight Optical System.** The optical system shall be properly gasketed to exclude dust and dirt from the reflecting surface of the reflector and the inner surface of the lens. Gaskets shall be placed between the reflector and supporting member, and between the reflector holder and the inner surface of the lens.
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Reflectors. Reflectors shall conform to the requirements of “Vehicle Traffic Control Signal Heads” published by the Institute of Transportation Engineers (ITE).

Reflectors shall be made of a material that will not distort when subjected to the heat of the specified lamp. Reflectors may be either silvered glass or specular aluminum with anodic coating. Metalized plastic reflectors will not be accepted. The reflecting surface before coating shall be free of flaws. The reflective coating and the reflector shape shall be such that the light distribution and candle power intensity of the combined lamp lens reflector assembly shall meet the specification requirements in “Vehicle Traffic Control Signal Heads.”

Reflector Rings. No plastic material will be accepted for the reflector bracket or reflector ring. The reflector ring and complete reflector and socket assembly shall be pivoted between two (2) stainless steel pins in such a manner that it can be swung open for ease in servicing the signal without the use of any tools.

Lenses. Each traffic signal head shall be supplied with traffic signal lens. Lenses shall be red, yellow, or green. Lens shall be made of glass and shall conform to the requirements of “Vehicle Traffic Control Signal Heads” published by the Institute of Transportation Engineers. Except for multilane use control signals and pedestrian signals, all lenses shall be circular in shape with nominal diameters of either 200 mm or 300 mm. Each 300 mm lens shall be standard wide angle and clearly marked as such.

Lamp Receptacles. Lamp Receptacles shall conform to the requirements of “Vehicle Traffic Control Signal Heads” published by the Institute of Transportation Engineers.

Lamps. The lamp for the illumination of a 200 mm lens shall be a clear traffic signal lamp which produces a minimum of 595 lumens with an average minimum initial lumen rating of 550 lumens at a working voltage of 120-125 volts AC, has a rated life of at least 8,000 hours and is rated at no more than 60 watts.

The lamp for the illumination of a 300 mm lens shall be a clear traffic signal lamp which produces a minimum of 1,750 lumens with an average minimum initial lumen rating of 1650 lumens at a working voltage of 120-125 volts AC, has a rated life of at least 7000 hours and is rated at no more than 135 watts.

Lamps and the intensity and distribution of light from each illuminated signal lens shall conform to the requirements of “Vehicle Traffic Control Signal Heads”, and “Standards for Traffic Signal Lamps.” Both publications are available from the Institute of Transportation Engineers.

OPTICALLY PROGRAMMED SIGNAL HEADS. The following additional requirements apply to Optically Programmed Signal Heads.

General. The optically programmed signal head shall permit the visibility zone of the indication to be determined optically and require no hoods or louveres. The projected indication may be selectively visible or veiled anywhere within 15° of the optical axis. No indication shall result from external illumination nor shall one light unit illuminate a second.

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

The following components shall comprise the optical system:

A. Lamp and Lamp Collar. The lamp shall be nominal 150 watt, 120 volt AC, three prong, scaled beam having an integral reflector with stippled cover and an average rated life of at least 6000 hours. An equivalent 75 watt lamp shall be used with pedestrian indications. The lamp shall be coupled to the diffusing element with a collar including a specular inner surface.

B. Optical limiter-diffuser. The diffusing element may be discrete or integral with the convex surface of the optical limiter. The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects 275 m to 370 m distant, and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter shall be provided with positive
indexing means and composed of heat resistant glass.

**C. Objective lens.** The objective lens shall be a high resolution, planar incremental lens hermetically sealed within a flat laminant of weather-resistant acrylic or approved equal. The lens shall be symmetrical in outline and may be rotated to any 90° orientation about the optical axis without displacing the primary image.

**Construction.** Signal case and lens holder shall be predrilled for backplates and visors. Hinge and latch pins shall be stainless steel. All access openings shall be sealed with weather-resistant rubber gaskets.

**Mounting.** The signal shall mount to standard 40 mm fittings as a single section, as a multiple section face, or in combination with other signals. The signal section shall be provided with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mounting. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments. The signal shall be constructed such that it can be installed with ordinary tools and serviced with no tools.

Attachments such as visors, backplates or adapters shall conform and readily fasten to existing mounting surfaces without affecting water and light integrity of the signal.

The programmed signal head shall be arranged for rigid mounting to either a mast arm or a dual span wire assembly. It is important for proper operation of the signal that it be mounted as rigidly as practical to maintain its optical orientation with the roadway. In those cases where span wires are used it should be securely tethered to the lower span wire.

**Electrical.** Lamp fixture shall comprise a separately accessible housing and integral lamp support, indexed ceramic socket and self-aligning, quick-release lamp retainer. Electrical connection between case and lamp housing shall be accomplished with an interlock assembly which disconnects lamp housing when opened.

Each signal section shall include a covered terminal block for clip or screw attachment of field wires. Concealed No. 18 AWG, stranded and coded wires shall interconnect all sections to permit field connection within any section.

**Photo Controls.** Each signal section shall include integral means for regulating its intensity between limits as a function of individual background illumination. Lamp intensity shall not be less than 97% of uncontrolled intensity at 10 764 lx and shall reduce to 15 lx ±2% of maximum at less than eleven (11) lx over the applied voltage and ambient temperature range. Response shall be proportional and essentially instantaneous to any detectable increase from darkness to 10 764 lx and damped for any decrease from 10 764 lx.

The intensity controller shall comprise an integrated, directional light sensing and regulating device interposed between lamp and field wires. The device shall be responsive over an applied voltage of 95 to 130V, 60 Hz. temperature range of -40°C to 74°C and may provide phase controlled output voltage but shall have a nominal open circuit terminal impedance of 1500 ohms. The Photo Control shall not produce sufficient electrical noise or interference to adversely affect the operation of solid state electronic equipment used on traffic signal controllers and associated auxiliary equipment and shall not cause false tripping of conflict monitors.

**STANDARD PEDESTRIAN SIGNAL HEADS.** In addition to applicable items in STANDARD SIGNAL HEADS the following requirements apply to Standard Pedestrian Signal Heads

**General.** Pedestrian signal indications are traffic indications intended for the exclusive purpose of controlling pedestrian traffic. These indications consist of the illuminated words WALK and DON’T WALK.

When specified, these messages can be replaced with the “MAN” and “HAND” display. The indications shall be single faced and rectangular in shape with letters made visible by internal illumination and with the legend DON’T WALK above or integral with the legend WALK.

When illuminated, the WALK indication shall be lunar white. When illuminated, the DON’T WALK indication shall be portland orange. All except the letters shall be obscured by an opaque material.
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When not illuminated, the WALK and DON'T WALK indications shall not be distinguishable by pedestrians at the far end of the controller crossing.

Pedestrian signal construction and indications shall conform to the requirements of “Pedestrian Traffic Control Signal Indications” published by the Institute of Transportation Engineers, with the following modifications:

- Unless otherwise specified, the head shall be a two section unit. Lettering shall be a minimum of 114 mm.
- Lamps for the illumination of each section shall be a clear traffic signal lamp with an average initial rating of 1 280 lumens at a working voltage of 120-125 volts with a rated life of at least 8 000 hours. Lamp fixtures shall not be wired in series.
- Signal head shall be supplied with an 18 AWG, color coded wiring harness, and a four position barrier type terminal block.
- Lenses shall be made of plastic.

FIBEROPTIC PEDESTRIAN SIGNAL HEADS. In addition to applicable items in STANDARD SIGNAL HEADS and STANDARD PEDESTRIAN SIGNAL HEADS the following requirements apply to Fiberoptic Pedestrian Signal Heads.

General. The unit shall consist of a matrix of fiberoptic bundles forming two displayed messages on a rectangular background facing the same direction. One message shall indicate WALK and the other shall indicate DON'T WALK. Both messages shall have a minimum letter height of 114 mm using a series B width. If the “MAN” and “HAND” display are specified both messages shall have a minimum symbol height of 267 mm and 165 mm width.

The messages shall be clearly legible and shall attract the attention of pedestrians and be readable, under any lighting conditions varying from total darkness to bright sunlight or where high intensity background lighting is present, at distances from 3 m to the width of the area to be crossed. A visor or hood shall not be required for legibility, but shall be provided with the housing.

The messages shall be visible at full intensity anywhere within a 90 degree cone centered about the optical axis and perpendicular to the surface of the matrix display. When not energized, the signal shall be blanked out (unreadable) with no phantom images, regardless of solar intensity or direction.

The messages shall be bright in color against a flat black background.

The displays shall be made from a single row of fiberoptic bundles with a nominal 13 mm spacing between centers.

The light source shall be designed and constructed so that in case of an electrical or mechanical failure of the word DON'T the word WALK in the DON'T WALK message will remain dark.

Each message shall be displayed separately and never concurrently.

Material Requirements. One 42 watt, 10.8 volt lamp type EPT or equivalent with a rated average life expectancy of 10,000 hours shall be as the light source for each display. The lamp shall be a multi-mirror reflector quartz halogen bulb operating at an approximate color temperature of 2900 K.

Optical System. The optical system shall consist of the following:

- Weatherproof housing, door, gaskets, and visor
- Fiberoptic module with individual output attached
- Color filters for desired message colors
- Light sources
- Transformers
- Protective back cover for the module
- Electrical system including wiring

Optical Requirements. The optics shall have a glass-on-glass fiber with an 83% core to 17% cladding ratio. It shall have an average numerical aperture of .56 with a maximum transmission attenuation of 800 DB per kilometer. Each fiber shall have a .05 ±.005 mm diameter with an included acceptance angle of 68
degrees. All fiber ends shall be ground smooth and polished to an 8 \( \mu \text{m} \) finish minimum, for maximum output and bundle-to-bundle consistency. Bundled fiber strands shall be kept free from the contamination of water and polishing agents. Maximum fiber breakage per fiber bundle shall not exceed 3%. A minimum of five spare fiberoptic output bundles shall be provided for each lamp and built into the unit. Damaged output bundles shall be replaceable using these spares. The output fiber bundles located at the face of the sign shall have a minimum diameter of 1.2 mm for the “DON’T” and 1.7 mm for the “WALK” message. The input fiber bundle located at each light source shall have a maximum diameter of 19 mm. The output bundles shall be protected by a vandal resistant prismatic polycarbonate lens 3.18 mm thick. Individual fiberoptic bundles shall not be jacketed or encased.

Color filters shall be optical quality glass. The filters shall be color fast and in accordance with the I.T.E. Signal Color Specification for Chromaticity.

The prismatic polycarbonate lens shall be mounted at a pre-focused distance in the door, away from the fiberoptic panel.

All optical fiber utilized in the production of the fiberoptic unit shall be tested for:
- Core to clad fusion
- Size
- Roundness of fiber
- Optical transmission
- Brittleness

Results of these tests shall be available upon request.

**Construction.** The front panel shall be flat black aluminum alloy, minimum 3.18 mm thick, and shall have a maintenance-free black anodized, acid tested finish or an equivalent weather resistant polycarbonate.

A heavy plastic mylar water shield shall be used to prevent possible water leaks from dropping onto the lamps.

All fiberoptic transformers and lamps shall be mounted on the door of the unit. All screws, washers, nuts and bolts shall be corrosion resistant. All components shall be readily accessible when the door is opened. The only tool required for maintenance or replacement of components shall be a standard screwdriver. No moving parts are permitted in the optical system.

**Electrical.** Electrical connection shall be provided by a barrier-type terminal strip for connecting field wires.

Transformers shall be used to reduce the incoming 120 volts AC to 10.8 volts AC.

Transformers shall be rated at 48.5 volt-amps and shall have Class A insulation impregnated with a double coating of epoxy resin so as to preclude intrusion of moisture.

A separate transformer and bulb shall be used for each color, to allow connection with existing controller wiring and conflict monitors.

The transformer bracket shall be an extruded aluminum member and shall provide adequate heat sinking of transformers.

**Environmental Conditions.** The unit shall be capable of continuous operation over a temperature range of -37\(^\circ\) C to +75\(^\circ\) C.

**FIBEROPTIC DUAL INDICATION ARROW.** In addition to applicable items in STANDARD SIGNAL HEADS, the following additional requirements apply to Fiberoptic Dual Indication 300 mm Turn Arrow.

**General.** The unit shall display alternate indications, consisting of either a green or yellow directional arrow. The indication shall be clearly legible and shall attract the attention of motorists and be visible, under any lighting conditions varying from total darkness to bright sunlight or where high intensity background lighting is present, at a distance of at least 450 m under normal atmospheric conditions. A visor or hood shall not be required for legibility.

The indication shall be visible at full intensity anywhere within a 60-degree cone centered about the optical axis and perpendicular to the surface of the display.
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When not energized, the signal shall be blanked out (unreadable) with no phantom images, regardless of solar intensity or direction.

The indication shall be bright in color against a flat black background.

Each indication shall be displayed separately and never concurrently.

The borderline arrow indications shall be comprised of a dual row of fiber bundles. The indication shall be in total conformance with I.T.E. standards for Vehicle Control Signal Heads.

Material Requirements. One 42 watt, 10.8 volt lamp type EPT or equivalent with a rated average life expectancy of 10,000 hours shall be used as the light source for each indication. The lamp shall be a multi-mirror reflector quartz halogen bulb operating at an approximate color temperature of 2900 K.

Optical System. The optical system shall consist of the following:

- Weatherproof housing, door, gaskets, and visor
- Fiberoptic module with individual output attached
- Color filters for desired message colors
- Light sources
- Transformers
- Protective back cover for the module
- Electrical system including wiring

Optical Requirements. The optics shall have a glass-on-glass fiber with a 83% core to 17% cladding ratio. Each fiber shall have a .05 ±.005 mm diameter with an included acceptance angle of 68 degrees. All fiber ends shall be ground smooth and polished to an 8 \( \mu \)m finish minimum, for a maximum output and bundle-to-bundle consistency. Bundled fiber strands shall be kept free from the contamination of water and polishing agents. Maximum fiber breakage per fiber bundle shall not exceed 3%. At least two (2) spare fiberoptic output bundles shall be provided for and built into each unit. Damaged output bundles shall be replaceable using these spares. A minimum of 56 bundles shall be provided. Each optical output shall have a minimum 3.5 mm (nominal) active bundle area for maximum light transmission. All optical fiber shall be fully bias randomized by individual fiber with approximately 50% fiber allocated to the green arrow indication and 50% to the amber arrow indication for balanced and corrected color output. Individual fiberoptic bundles shall not be jacketed or encased.

Color filters shall be optical quality glass. The filters shall be color fast and in accordance with I.T.E. Signal Color Specification for Chromaticity. Any combination of colors shall be available by changing color filters installed in the unit.

All optical fiber utilized in the production of the fiberoptic units shall be tested for:

- Core to clad fusion
- Size
- Roundness of fiber
- Optical transmission
- Brittleness

Results of these tests shall be available upon request.

Construction. Complete unit shall be supplied mounted in standard 300 mm vehicle signal section.

The front panel shall be either flat black aluminum alloy, minimum 3.18 mm thick having a maintenance-free black anodized, acid tested finish or an equivalent weather resistant polycarbonate.

Output bundles shall be mounted on the front panel at 90 degrees to the surface. Mounting shall be consistent in manufacture and shall be watertight. A heavy plastic mylar (or equivalent) water shield shall be used to prevent possible water leaks from dripping onto the lamps.

All fiberoptic transformers and lamps shall be mounted on the door of the unit. All screws, washers, nuts and bolts shall be corrosion resistant. All components shall be readily accessible when the door is opened. The only tool required for maintenance or replacement of components shall be a standard screwdriver.

No moving parts are permitted in the optical system.
Front panel, with fiberoptic indication shall be rotatable to from a right, left, or vertical arrow.

**Electrical.** Electrical connection shall be provided by a barrier type terminal strip for connecting field wires.

Transformers shall be used to reduce the incoming 120 volts AC to 10.8 volts AC.
Transformers shall be rated at 48.5 volt-amps and shall have a Class A insulation impregnated with a double coating of epoxy resin so as to preclude intrusion of moisture.
A separate transformer and bulb shall be used for each color, to allow connection with existing controller wiring and conflict monitors.

**Environmental Conditions.** The unit shall be capable of continuous operation over a temperature range of -37°C to +75°C.

**STROBING SIGNAL INDICATION.** In addition to applicable items in STANDARD TRAFFIC HEADS the following additional requirements apply to Strobing Signal Indications.

**General.** The unit shall consist of a standard red signal indication with the addition of a white bar strobe presented horizontally across the red face. The strobe shall flash at a rate of approximately once per second. The indication shall be single faced and the strobe bulb, control circuitry, and all necessary appurtenances shall be enclosed in and be an integral part of a standard 300 mm aluminum signal housing. The bar strobe shall attract the attention of motorists and be visible, under any lighting conditions varying from total darkness to bright sunlight or where high intensity background lighting is present, at a distance of at least 805 meters under normal atmospheric conditions.
When the bar strobe is not energized, the indication shall operate and appear as a standard red indication.

**Optical System.** The optical system shall consist of the following:
- Weatherproof housing, door, gaskets, and visor.
- Alzak parabolic reflector or equivalent. No plastic material will be accepted for the reflector or reflector bracket.
- One bar strobe bulb with a minimum 5000 hours duty life enclosed in a dustproof, shockproof and watertight enclosure.
- 300 mm glass red lens.
- Power supply.
- Electrical system including wiring and control circuitry.
- The strobe bulb shall be a minimum of 241 mm in length to effectively span the width of the lens.

**Construction.** The unit shall consist of a standard 300 mm red vehicle signal section with a bar strobe light interposed in front of the red lens.
All power supplies and control circuitry for the strobe shall be mounted to the visor assembly and contained within a watertight enclosure(s) which shall not interfere with mounting additional signal sections to from a multiple section signal head.
The strobe bulb shall be enclosed in a dustproof, shockproof and watertight housing securely mounted in front of the red lens. The strobe housing shall contain only the strobe bulb, terminal strips and necessary connecting wires, and shall not interfere with the general visibility of the red lens, nor the ability to change the red lens in the normal manner.
All screws, washers, nuts and bolts shall be stainless steel.
All components shall be readily accessible. The only tool required for maintenance or replacement of all components shall be a standard screwdriver.

**Electrical.** Electrical connection shall be provided by a barrier type terminal strip for connecting field wires. The power supply shall be of a capacitive discharge type sufficient to fire the bar strobe bulb at a rate of approximately once per second. The power supply shall be encased in a temperature stable epoxy so as to preclude intrusion of moisture. A door switch shall be provided so that when the housing door is opened the
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switch shall disconnect AC power to the strobe power supply and circuitry and shall also completely discharge the high voltage DC capacitive charge within 10 seconds.

The high voltage power supply shall be fused using a time delay fuse. The current rating of the fuse shall be no more than 50% above the maximum current expected at 135 V AC. The fuse shall be mounted in the housing and located before the door switch in the strobe circuitry.

The barrier type terminal strip shall be equipped with male quick connect spade terminals. Insulated female spade receiver terminals shall be required for the connection of the strobe circuitry to the terminal strip.

Labeling. A CAUTION or WARNING label should be affixed to the visor assembly near the housing door opening, notifying maintenance or repair personnel of the presence of a high voltage capacitive charge within the visor assembly and that the quick disconnect should be disconnected and a check for AC or DC voltage across the strobe bulb should be performed before servicing the strobe bulb or circuitry.

STANDARD POLYCARBONATE TRAFFIC SIGNAL HEADS

General. In addition to applicable material requirements for STANDARD SIGNAL HEADS and STANDARD PEDESTRIAN SIGNAL HEADS, the following additional requirements apply to Poly carbonate Traffic Signal Heads.”

Material Requirements. The traffic signal housing, visor and door shall be made of injection molded polycarbonate resin which shall be capable of withstanding a 95 N\( \text{m} \) impact without fracture or permanent deformation.

Material used in the construction of the signal housing door, visor and lens shall be resistant to heat generated by the signal bulb. No deformation or discoloration shall be evidenced when 116 watts bulbs are used in 200 mm signal sections and 150 watt bulbs are used in 300 mm signal sections. The plastics shall be ultra-violet and heat stabilized and flame retardant.

The signal housing, door and visor shall be dark green and the color shall be fully impregnated into the polycarbonate resin.

Visor shall be made of one piece with a minimum thickness of 2 mm. The rear edge of the visor shall be provided with four mounting lugs for attaching the visor to the door using screws. The inside of the visor shall be dull black in color. Unless otherwise specified all signal heads shall be provided with cap-type visors.

Construction. The housing shall have a minimum thickness of 2.3 mm. The housing shall be of one piece construction and the door shall be of one piece construction. Both the 200 mm & 300 mm housings are to be designed in the same manner so when used in combination heads the design will match each other.

The top and bottom opening of each housing shall have integral serrated bosses that will provide positive positioning of the signal head to eliminate undesirable rotation or misalignment of the signal head between sections. Each opening accommodates standard 1.5 NPS pipe fittings and brackets.

Doors shall be hinged by two lugs and mounted to the housing using stainless steel pins. The door of each signal section shall be one-piece with a minimum thickness of 2.3 mm.

A neoprene gasket shall be provided between the body of the housing and the door. The doors shall be forced tightly against the gasket and housing by simple stainless steel locking devices. A slotted air cored neoprene lens gasket shall provide a positive seal between the lens and the signal door and between the lens and the reflector holder.

The gasket shall be an unbroken circular gasket with a "U" shaped cross section. The gasket and lens shall be held tightly into the door by four stainless steel clips and screws that shall allow easy removal of the lens and gasket from the door without removal of the door in the field.

The reflector shall be Alzak aluminum. Reflector rings shall be manufactured from die cast aluminum, hinged from one side to allow the reflector assembly to open without use of tools. The lamp receptacle shall be permanently focused to the reflector and held in place by a corrosion-resistant wire spring bail so that it can be removed without the use of tools. The center section shall contain a terminal barrier block having quick-disconnect terminals for the lamp receptacle leads and screw terminals for field wires.
**LED TRAFFIC SIGNAL MODULES.** In addition to applicable material requirements for STANDARD SIGNAL HEADS, and STANDARD PEDESTRIAN SIGNAL HEADS, the following additional requirements apply to Ball, Arrow, and Pedestrian LED Traffic Signal modules.

**General.** This specification refers to definitions and practices described in publication ST-008B "Vehicle Traffic Control Signal Heads" published by the Institute of Transportation Engineers (ITE), referred to in this document as "VTCSH", and to publication ST-011B “Pedestrian Traffic Control Signal Indications” referred to in this document as “PTCSI.” These documents are published by the Institute of Transportation Engineers (ITE). LED traffic signal modules designed as retrofit replacements for existing signal lamps shall not require special tools for installation. They shall be a single, self-contained device, not requiring on-site assembly for installation into an existing traffic signal housing. The module shall be sealed to provide a weather tight enclosure and an insulating covering for all electrical connections and electronic components, and shall fit securely in the housing. It shall connect directly to existing electrical wiring by means of push-on type connectors. Hardware for electrical connections shall be supplied.

**Material Requirements.** Materials used for the lens and signal module construction shall conform to ASTM specifications for those materials.

Each LED signal module shall be identified on the back side with the manufacturer’s trade mark, serial number, voltage rating, Volt-Ampere rating, power consumption (watts) and, if applicable, a vertical indexing indicator (i.e., “up arrow”, or the word “UP” or “TOP”).

Each LED signal module shall have a sticker stating compliance to FCC Title 47, Subpart B, Section 15 regulations.

**A. Ball and Arrow (Single and Bi-Modal) modules only:** Retrofit replacement LED signal modules shall fit into existing traffic signal housings built to the VTCSH Standard without modification to the housing. Installation of the retrofit replacement LED signal module into an existing signal housing shall only require the removal of the existing lamp components (i.e., lens, lamp module, gaskets, and reflector).

“Red” LED signal module lenses shall be tinted with the appropriate color to enhance on/off contrast. The material used to tint the lens shall not affect the luminous intensity or chromaticity and shall be uniform across the face of the lens. The “Yellow” and “Green” units shall be supplied with a clear lens. If a polymeric lens is used, a surface coating or chemical surface treatment shall be used to provide front surface abrasion resistance. The module lens shall be replaceable without the need for replacing the complete module unit.

The “Arrow” pattern produced by the Arrow LED signal modules shall conform to the VTCSH standard for color, size and shape. The Arrow LED signal modules shall not require a specific orientation or have a variance in light output, pattern or visibility for any mounting orientation.

The lens of the LED signal module shall be capable of withstanding ultraviolet light (direct sunlight) exposure for a minimum time period of five years without exhibiting evidence of deterioration.

Each Ball LED shall have a sticker attached stating compliance to the ITE Standard for Color and Luminous Intensity and each Arrow LED shall have a sticker attached stating compliance to the ITE Standard for Color as specified in the VTCSH.

**B. Pedestrian Modules (Single & Bi-Modal) only:** Pedestrian LED traffic signal modules shall be designed as a retrofit replacement for the message bearing surface of a 300 mm pedestrian traffic signal housing built to the PTCSI Standard. The Single Pedestrian module shall be designed to display a full “HAND” symbol that complies with PTCSI standard for this symbol for the size specified. The Bi-Modal Pedestrian module shall be designed to display both a full “HAND” and “WALKING MAN” symbol that complies with the PTCSI standard for these symbols for the size specified.

The “HAND” symbol shall be designed so that the entire area comprising the symbol appears illuminated. Modules with LED’s arranged to from just an outline of the “HAND” symbol will not be accepted. Modules with LED’s arranged as outlines for the “WALKING MAN” symbol will be
§724-04 acceptable.

The LED signal module shall fit into existing signal housings without the need to modify the housing or modify/remove the reflector. Installation of the retrofit replacement Pedestrian LED signal module into an existing 300 mm pedestrian signal housing shall only require the removal of the existing message bearing surface and insertion of the retrofit replacement into the area once occupied by the removed assembly.

Each pedestrian module shall have a sticker attached stating compliance to the ITE standard for chromaticity as defined in the PTCSI.

Optical

A. Ball and Arrow (Single & Bi-modal) modules only. The measured chromaticity coordinates of Ball and Arrow LED signal modules shall conform to the chromaticity requirements of Section 8.04, Limits of Chromaticity Coordinates and the associated Figure 1 of the VTCSH standard.

The light output distribution for Ball LED traffic signal modules shall be as defined in Section 11.04 and Table I of the VTCSH standard. The minimum luminous intensity values for Ball LED traffic signal modules shall be, at a line voltage of 120 ±3 volts rms, as listed in Table 1 of the VTCHS standard. Variations in operating line voltage of between 80 and 135 volts rms shall have minimal effect on luminous output of the signal module.

Ball LED signal modules shall be designed so that when operated over the specified operating ambient temperature and voltage ranges, the luminous intensity of the unit shall not fall below 85% of the minimum intensity values of the VTCHS standard.

Arrow LED signal modules shall be designed so that when operated over the specified ambient temperature and voltage ranges, the signal is clearly visible and attracts attention for a distance of at least 400 m under normal atmospheric conditions.

B. Pedestrian Modules(Single & Bi-Modal) only. The measured chromaticity coordinates of Pedestrian LED signal modules shall conform to the chromaticity requirements of Section 5.3, Color and the associated Figure C of the PTCSI standard.

Pedestrian LED signal modules shall be designed so that when operated over the specified ambient temperature and voltage ranges, the signal shall attract the attention of, and be readable to, a viewer (both day and night) at all distances from 3 m to the full width of the area to be crossed.

Performance Tests

A. All LED modules. Prior to shipment, each LED signal module shall be energized (burned-in), for a minimum of 24 hours, at rated voltage, and at a 100 percent on-time duty cycle. This test shall be conducted at the rated voltage in an ambient temperature of 60°C. Any failure within an LED signal module occurring during burn-in shall be cause for rejection.

After burn-in procedure is completed, the following additional tests shall be performed. These tests shall be performed at rated operating voltage and at 25°C unless otherwise specified.

All units shall be powered off for a period of 1 second and then powered back on. Any unit failing to turn on after power restoration shall be rejected. This test shall be performed a minimum of 10 times.

A sample of 10% of units of each configuration, Balls, Arrows or Pedestrian signal modules, on the order shall be randomly selected and tested in a flashing mode of operation, at 50 percent duty cycle with a 0.5 sec on time, and for a 24 hour period at 60°C. Any unit failing to function properly shall result in failure of the entire lot from which the sample was selected. Should this occur, the entire quantity ordered shall be tested as described above, with units not functioning properly being rejected.

Each LED signal module shall be visually inspected for any exterior physical damage or assembly anomalies. Careful attention shall be paid to the surface of the lens to ensure there are no scratches (abrasions), cracks, chips, discoloration, or other defects.

Each LED signal module shall be tested to ensure light output at 80 and 135 volts without adverse operational effects. Each LED signal under test shall be operated at each voltage level for a time period
of five minutes. Signal modules illuminating with any adverse operational effects shall be rejected.

Low bidder(s) shall provide, with each shipment, a Certificate of Compliance from the manufacturer. The certificate shall certify that the LED signal modules comply with the requirements of these specifications. In addition to the certificate, the modules shall be supplied with a list of the serial numbers of the units, copies of all applicable test reports on the LED signal modules, and signature of the person responsible for certifying the tests.

**B. Ball Modules only.** Each Ball LED signal module shall be tested for rated initial intensity. A single point measurement (at -2.5 deg. V, 2.5 deg. R or L) with a correlation to the minimum intensity requirements specified herein may be used. This test shall be performed after the burn-in procedure is completed, at rated operating voltage and at 25°C unless otherwise specified.

**Electrical**

**A. All LED modules.** All wiring and terminal blocks shall meet the requirements of Section 13.02 Wiring of the VTCSH standard. Each wire shall be approximately 1 m long.

The LED signal module shall operate with 60±3 Hz AC line voltage ranging from 80 volts to 135 volts rms. The circuitry shall prevent flicker over this voltage range. Rated voltage for all optical and power measurements shall be 120±3 volts rms.

The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high energy transients as stated in Section 2.1.6, NEMA Standard TS-2,1992.

Each LED signal module shall be designed so that there is no noticeable light output when connected to rated voltage through an impedance of 15 kohm (either resistive or capacitive).

The signal module shall be designed so that, under normal operation, an AC voltage of no greater than 10 volts rms shall be developed across the unit when it is connected in series with any value of impedance greater than 15 kohm and for any applied AC voltage between 80 and 135 volts rms that is connected across this series combination. In addition, the signal module shall be designed so that the voltage across the module shall reduce in value to less than 10 volts rms within 100msec when the module is switched off by any solid state switch or switchpack having an impedance of 15 Kohm or greater.

The individual LED light sources shall be wired so that a catastrophic failure of one LED light source will not result in the loss of illumination of more than 20 percent of the remaining LED light sources.

The LED signal module and associated on board circuitry shall meet Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

All modules shall contain filtering dedicated to prevent inducing electronic noise into the AC power lines.

Modules shall be fused using a time-delay fuse. The fuse shall be located so that it can be easily changed without the need to disassemble the module.

All printed circuit boards used in the module shall be coated with a conformal coating containing an ultraviolet tracer.

All unit types shall be operationally compatible with the traffic signal equipment that each type is designed and intended to interface with. This equipment includes all controllers, conflict monitors, current monitors, switchpack and flashers currently in use by the New York State Department of Transportation.

**B. Ball and Arrow (Single & Bi-modal) modules only.** Units shall be designed so that a normally functioning signal module will generate the needed current to prevent a Model 215 Current Monitor from detecting a loss of current over the voltage range of between 95 and 135 volts rms. The minimum current required to prevent the Model 215 monitor from detecting a loss of current is a 500 milliamp peak AC or pulsed current with a minimum pulse width of 3 msec. Signal modules designed
to specifically generate current pulses to prevent the monitor from tripping shall, as a minimum, generate 6 pulses per second. Generated current pulses shall be evenly spaced, with the first pulse generated within 100 msec after the application of AC power. (Additional information regarding the operation of the Model 215 Current Monitor can be obtained in the latest "New York State Transportation Management Equipment Specifications").

Units that have their individual LED’s wired so that the loss of one LED results in the loss of light output of four or less LEDs shall incorporate circuitry to reliably detect the total loss of LED current due to failures such as, but not limited to, open circuits and power supply problems. Upon detection of this failure, this circuit will disable any current generating circuitry within 100msec to allow detection of this failure by a Model 215 current monitor.

Units that have their individual LED’s wired so that the loss of one LED results in the loss of greater than four LEDs shall have circuitry designed to sense the loss of light output due to the failure of between 25 and 40 percent of the individual LEDs turning on. Loss of light output due to the failure of less than 25 percent of the LED’s turning on will not be detected but will be detected for the failure of any value greater than 40 percent. Upon detection of this failure, the circuit will disable any current generating circuitry within 100msec to allow detection of this failure by a Model 215 current monitor.

Total harmonic distortion (current and voltage) induced into an AC power line by a LED module operating at rated voltage shall not exceed 20 percent for units consuming greater than 15 watts at 25 deg. C and 40 percent for units consuming less than 15 watts.

The maximum apparent power of a signal module at 120±3 volts RMS shall not exceed: 30 volt-amps (VA) on a 300 mm Ball LED or 20 volt-amps (VA) on a 200 mm Ball LED or 20 volt-amps (VA) on a 300 mm Arrow LED or 15 volt-amps (VA) on a 200 mm Arrow LED.

The Ball and Arrow LED signal modules supplied to this specification shall have power factors of 0.90 or greater without the current generating circuitry included in the calculations for power factor.

C. Pedestrian Modules (Single & Bi-Modal) only. The maximum power consumed by a pedestrian LED unit shall not exceed 15 volt-amps (VA) at 120± 3 volts rms.

Environmental. All LED signal modules shall be rated for use in the ambient temperature range of -40°C to +74°C. LED signal modules shall be sealed against dust and moisture intrusion per the requirements of NEMA Standard 250-1991 for Type 4 enclosures to protect all internal LED and electrical components. LED signal modules shall be capable of operating at rated voltage in an environment of +74°C/85% RH for 1000 hours without the formation of internal condensing moisture.

BASIS OF ACCEPTANCE. Acceptance of signal heads, sections, and/or LED signal modules will be based on manufacturer’s certification of compliance with these specification requirements, a list of serial numbers of the units being supplied, copies of all applicable test reports on the signal modules, and signature of the person responsible for certifying the tests. In addition, LED module model number and manufacturer’s name must be listed either on the latest NYS Signal Approved Products List or the Qualified Products List.

724-05 THRU 724-07 (VACANT)
724-08 SHIELDED COMMUNICATION CABLE

SCOPE. This specification covers the material requirements and fabrication details of shielded communication cable for use with traffic signal systems.

MATERIALS AND CONSTRUCTION. The cable shall conform to the requirements of the International Municipal Signal Association (IMSA) specification 20-2 for polyethylene insulated, polyethylene jacketed communication cable with electrical shielding. The gauge and number of conductors shall be as specified in the plans. The conductors shall be stranded copper wire.
§724-20

BASIS OF ACCEPTANCE. Acceptance of material will be based on the manufacturer's certification of compliance with these specification requirements.

724-09 SIGNAL CABLE WITH INTEGRAL MESSENGER

SCOPE. This specification covers the material requirements for signal cable with integral messenger for use with traffic signal systems and for aerial installations.

MATERIALS AND CONSTRUCTION. The cable shall conform to the requirements of the International Municipal Signal Association (IMSA) Specification 20-3. The gauge and number of conductors shall be as specified in the plans. The conductors shall be stranded copper wire.

BASIS OF ACCEPTANCE. Acceptance of material will be based on the manufacturer's certification of compliance with these specification requirements.

724-10 SHIELDED COMMUNICATION CABLE WITH INTEGRAL MESSENGER

SCOPE. This specification covers the material requirements for shielded communication cable with integral messenger for use with traffic signal systems and for aerial installations.

MATERIALS AND CONSTRUCTION. The cable shall conform to the requirements of the International Municipal Signal Association (IMSA) Specification 20-4. The gauge and number of conductors shall be as specified in the plans. The conductors shall be stranded copper wire.

BASIS OF ACCEPTANCE. Acceptance of material will be based on the manufacturer's certification of compliance with these specification requirements.

724-11 THRU 724-14 (VACANT)

724-15 FIRE PRE-EMPTION TELL-TALE LIGHT

SCOPE. This specification covers the material requirements for fire pre-emption tell-tale light.

MATERIALS AND CONSTRUCTION. The fire pre-emption tell-tale light shall consist of a Xenon flash tube rated at 10.76 Mlx and 2000 hours life. The flash rate shall be 60 to 80 flashes per minute. The tell-tale light shall be capable of normal operation between outside temperature from -46°C to +60°C. The tell-tale light shall be contained in a vandal resistant weatherproof housing and mounting with a blue heat resistant and shatterproof globe. It shall be visible through 360° horizontally. The fire pre-emption tell-tale light shall operate from a 115 volt 60 Hz. single phase power source.

BASIS OF ACCEPTANCE. Acceptance of the fire pre-emption tell-tale light shall be based on the manufacturer's certification of compliance with these specification requirements.

724-16 THRU 724-19 (VACANT)

724-20 INDUCTANCE LOOP WIRE

SCOPE. This specification covers the material requirements for wire used in inductance loop vehicle detectors.

MATERIALS AND CONSTRUCTION. Loop wire shall be one conductor No. 14 AWG wire loosely encased in a tube in conformance to the requirements of the International Municipal Signal Association (IMSA) Specification 51-5.

BASIS OF ACCEPTANCE. Acceptance of material will be based on the manufacturer's certification of compliance with these specification requirements.
§724-21

724-21 SHIELDED LEAD-IN CABLE

SCOPE. This specification covers the material requirements for shielded lead-in cable used with inductance loop vehicle detectors.

MATERIALS AND CONSTRUCTION. The cable shall consist of No. 14 AWG conductors in conformance to the requirements of the International Municipal Signal Association (IMSA) Specification 50-2.

BASIS OF ACCEPTANCE. Acceptance of material will be based on the manufacturer's certification of compliance with these specification requirements.

724-22 ROADWAY LOOP EMBEDDING SEALER

SCOPE. This specification covers the material requirements for Roadway Loop Embedding Sealer used when installing inductance loops.

MATERIALS AND CONSTRUCTION. Roadway Loop Embedding Sealer shall be used to encapsulate Traffic Signal Loop Wires embedded in highway materials. The sealer shall be cold applied and may be a one or two component system, the viscosity of which shall be sufficient to allow the material to be either poured or placed under pressure and fully encapsulate the loop wires. The sealer shall be curable at temperatures of 4.5°C and above.

When the sealer is bonded to common paving materials, it shall have sufficient strength and resiliency to withstand stresses due to vibrations and differences in expansion and contraction as a result of temperature changes or traffic conditions. The sealer shall be compatible with the sheathing or covering of loop inductance wires.

Chemical Resistance. Cured sealer shall be resistant to most chemicals and solvents, including salts, acids, hydrocarbons, etc.

Packaged stability of each component in original unopened containers, stored in temperatures between 0°C and 38°C shall be a minimum of six months.

MATERIAL REQUIREMENTS. The material shall meet the requirements of either the Flexible or Hard designation in Table 724-22-1. Materials designated flexible require a 180° mandrel bend test at 26°C with no breaking as part of the accelerated weathering testing.

| TABLE 724-22-1 ROADWAY LOOP EMBEDDING SEALER PROPERTIES |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Property        | Test Method     | Flexible        |                   |                   |
|                 | Min. | Max. | Min. | Max. |
| Hardness, Shore | ASTM D2240     | A15 | A40 | A50 | D65 |
| Pot Life @22°C, minutes | NYSDOT 724-40E | 15 | --- | 15 | --- |
| Curing Time (back free surface) @ 22°C, hours | NYSDOT 724-40E | --- | 2 | --- | 2 |
| Tensile Strength, kPa | ASTM D412 | 345 | --- | 2800 | --- |
| Elongation, percent | ASTM D412 | 150 | --- | 20 | --- |
| Water Absorption, percent | NYSDOT 724-40E | --- | 1.0 | --- | 1.0 |
| Adhesion to Asphalt Concrete, kg | NYSDOT 724-40E | 91 | --- | 227 | --- |
| Adhesion to Concrete, kg | NYSDOT 724-40E | 23 | --- | 136 | --- |
| Extension, mm | NYSDOT 724-40E | 6.4 | --- | 3 | --- |
| Accelerated Weathering (Flexible requires additional bend test) | NYSDOT 724-40E | No cracking, checking, chalking, or shrinking |

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NEW YORK STATE DEPARTMENT OF TRANSPORTATION
STANDARD SPECIFICATIONS of January 2, 2002
BASIS OF ACCEPTANCE. Applications for approval of Roadway Loop Embedding Sealer shall be submitted to the Materials Bureau by the manufacturer accompanied by a 4L sample of the product and all pertinent sealer information including, but not limited to, manufacturer's sealant test results, sealant application procedures and safety precautions. Upon approval by the Materials Bureau, the name of the product will be placed on an "approved list" of Roadway Loop Embedding Sealers for use on asphalt and/or concrete pavements based on the compatibility of the sealer with the pavement material. The product may then be accepted on the basis of the name brand labeled on the container.

724-23 PEDESTRIAN PUSH BUTTON AND SIGN

SCOPE. This specification covers the material requirements for pedestrian push button and sign.

MATERIAL AND CONSTRUCTION. The push button unit shall be a direct push type having a cast aluminum housing. The unit shall be strongly constructed, rugged, abuse and tamper proof and suitable for operation under all weather conditions. It shall be provided with one normally-opened contact with ample contact area. The contacts shall be a material which will provide low contact resistance throughout the life of the device. The housing shall be of a design or be provided with adaptors to facilitate mounting on poles of different diameters. The unit shall have a convenient means of wiring.

The sign may be either reflectorized or non-reflectorized, with legend as specified on the plans and in accordance with Part 210 of the New York State Manual of Uniform Traffic Control Devices.

BASIS OF ACCEPTANCE. Pedestrian push button and sign shall be accepted upon the manufacturer's certification of compliance with these specification requirements.

SECTION 725 - MISCELLANEOUS METALS AND PLASTICS

725-01 COPPER FLASHING

SCOPE. This specification covers the material requirements for copper flashing.

MATERIAL REQUIREMENTS. Sheet copper for flashing shall be rolled from copper fulfilling the requirements of ASTM B5. This sheet metal shall be cold rolled soft copper.

BASIS OF ACCEPTANCE. Acceptance of this material will be based on the manufacturer's certification that the material meets the specification requirements.

725-02 STEPS FOR MANHOLES

SCOPE. This specification covers the material requirements for steps used in manholes.

GENERAL. The minimum design live load, for steps, appurtenances and fastenings, shall be a single concentrated load of 13.5 kN. The live loads imposed by persons occupying the steps shall be considered to be concentrated at such points as will cause the maximum stress in the structural member being considered.

Steps shall be designed so a worker's foot cannot slide off the end. The minimum length of the rungs shall be 250 mm.

Whenever a combination of dissimilar types of metals are used in the manufacture of steps, appurtenances and fastenings, the materials shall be treated to prevent deleterious effects.
§725-02

MATERIALS. Manhole steps shall be fabricated from one of the following:

Ferrous Metal. Steps shall conform to one of the following requirements:

- Iron Castings Class 25A, 715-05
- Malleable Iron Castings Grade 35018, 715-09
- Steel ASTM A575, Grade M 1020 galvanized in accordance with §719-01, Type 1.

The steps shall have a minimum cross sectional dimension of 25 mm exclusive of any coatings placed on them.

Non-Ferrous Metal. Steps shall conform to the following requirements:

- Aluminum Castings Alloy 356-T6, 715-03.
- Wrought Aluminum 6061-T6, 6005-T5, or 6351-T6, 715-04

When aluminum steps are used, the portion of the step which will be in direct contact with cement concrete or concrete mortar, shall be coated with a zinc chromate primer or bituminous material approved by the Materials Bureau.

Reinforced Plastic. Steps shall consist of polypropylene or other plastic material completely covering a steel core. The plastic may be extruded, cast, or molded into the standard size and shape manhole steps, and provide corrosion protection.

The plastic material shall have the following characteristics:

A. Resistance to Salt and Caustic Solutions. Resistance to the following solutions when submerged for 30 days:

- 10% Sodium Chloride
- 10% Hydrochloric Acid
- 10% Sodium Hydroxide
- 10% Sulfuric Acid

B. Flow Point. A flow point of 160°C or greater.

C. Flexibility. It shall remain flexible over a temperature range of -30°C to +120°C upon long aging.

D. Fire Resistance. It shall be non-burning, self-extinguishing, or very slow burning.

The steel core shall be not less than 12 mm diameter and shall have the following physical characteristics:

- Tensile Yield, Minimum 275 MPa
- Tensile Strength, Minimum 482 MPa

The plastic step, when cast into a concrete block the proper depth, shall withstand a minimum load of 13.5 kN applied on 625 mm² area in the center of the step without cracking or breaking the plastic coating, loosening the step in the concrete or permanently deforming the step.

Basis of Acceptance. Manhole steps shall be accepted on the basis of the manufacturer's certification of compliance with this specification. However, the Department reserves the right to take random samples at any time for testing for compliance with the requirements of this specification.

SECTION 726 (VACANT)