Section 919. PERMANENT TRAFFIC SIGN AND SUPPORT MATERIALS

919.01. General Requirements. Permanent traffic signs and sign support material must meet the requirements of the MDOT Sign Support Standard Plans and this section.

Cantilever, truss, breakaway column, and aluminum structure inspection must be in accordance with section 707 and this section.

919.02. Traffic Signs. The Department classifies signs by type of sign panel material and type of sign face, as follows:

<table>
<thead>
<tr>
<th>Table 919-1</th>
<th>Sign Panel and Face Types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td><strong>Material</strong></td>
</tr>
<tr>
<td>I</td>
<td>Aluminum Extruded Sections</td>
</tr>
<tr>
<td>II</td>
<td>Plywood</td>
</tr>
<tr>
<td>III</td>
<td>0.080 in Aluminum Sheet (a)</td>
</tr>
<tr>
<td>IV</td>
<td>0.040 Aluminum Sheet (a)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Sign Face</strong></th>
<th><strong>Type</strong></th>
<th><strong>Background</strong></th>
<th><strong>Legend</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Reflectorized</td>
<td>Reflectorized</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Reflectorized</td>
<td>Non-reflectorized</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Non-reflectorized</td>
<td>Reflectorized</td>
<td></td>
</tr>
</tbody>
</table>

a. Corners must be rounded on aluminum sheet signs

A. Sign Panel Material and Fabrication.

1. Aluminum Extruded Sections. Provide aluminum extruded sections in a variety of widths with plain butt-type edges for connecting to adjoining horizontal sections. Sections must be one-piece with no vertical splices and have a cross-sectional shape meeting the minimum requirements specified in Table 919-2. Sections must have at least a 0.125-inch nominal thickness. Exterior corners must have a radius of at least 0.040 inch.

Sign panel sections must be extruded aluminum alloy 6063-T6, meeting the requirements of ASTM B 221. Panel sections, after fabrication, must be flat to within 0.031 inch or less per foot of length and to within 0.004 inch or less per inch of width.

Degrease aluminum extruded sign panel sections in accordance with the sheeting manufacturer's recommendations. After degreasing, surface treating, and rinsing, maintain sign panels free of grease, oil, or other contaminants.
Table 919-2
Cross-Sectional Requirements for Extruded Aluminum
Sign Sections for Type I Sign Panels

<table>
<thead>
<tr>
<th>Length of Sign Support Type</th>
<th>Moment of Inertia</th>
<th>Section Modulus</th>
<th>Elements of Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b/t</td>
<td>2l/y</td>
<td>No Free Ends</td>
</tr>
<tr>
<td>≤30 ft on Columns ≤20 ft on Cantilevers ≤30 ft on Trusses</td>
<td>≥0.94 W</td>
<td>≥0.55 W</td>
<td>8–50</td>
</tr>
<tr>
<td></td>
<td>&gt;50</td>
<td>3.4D</td>
<td>&gt;28</td>
</tr>
</tbody>
</table>

Note: b = the compression width of stiffener elements in inches.
\( t \) = the thickness of the stiffener element in inches.
\( I \) = moment of inertia of the sign section in inches\(^4\).
y = the distance from the neutral axis to the centroid of the compression width of the element.
\( W \) = the width of the sign section in feet.
\( A = \frac{W(63-b/t)}{6} \).
\( B = 1.0 \times 10^{-4} W(b/t)^2 \).
\( C = \frac{W(111-b/t)}{6} \).
\( D = 1.0 \times 10^{-4} W(b/t)^2 \).

Connect the sections horizontally with ½ inch diameter stainless steel bolts, spaced as shown on the Sign Support Standard Plans. Section connections or sign-to-post connections must have no fasteners that project through the sign panel face.

If using a 6 inch plank, position the plank second from the bottom of the sign.

Before transporting sign panels, ensure the support angles and wide flanged shapes are shop connected and remain on the sign.

2. **Plywood.** Plywood sign panels must be ¾ inch thick and have a black or natural color overlay on both sides. Panels must meet the requirements of the U.S. Product Standard PS-1-83 for Group 1 wood species, Grade B-B veneer, exterior type, high-density overlaid plywood. Inner plies must meet the requirements of Section 3.8.1, “Crossband Gaps and Center Gaps” of the U.S. Product Standard PS-1-83. Inner plies must have no continuous core gaps, tunnels, holes, or through openings that travel longitudinally or transversely through the plies, as measured from the panel edge. Crossband gaps or center gaps allowed by the U.S. Product Standard PS-1-83 must be filled with a synthetic filler repair, in accordance with Section 3.3, “Synthetic Repairs” of the U.S. Product Standard PS-1-83. Smooth and seal edges with one coat of exterior oil base paint.

Do not make vertical splices in plywood signs. The Engineer will allow horizontal splices only for gore signs. Do not splice plywood sign panels, unless otherwise shown on the sign details. Do not
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make horizontal splices through legends or symbols. Round the corners and remove burrs at corners and mounting holes.

Prepare the plywood high-density overlay surface for sheeting application by lightly abrading the surface with a product recommended by the sheeting supplier. Do not power sand. Wipe the surface with a solvent and allow to dry in accordance with the sheeting manufacturer's recommendations.

After preparing the plywood surface, ensure no grease, oil, or other contaminants come in contact with the surface.

3. **Aluminum Sheet.** Aluminum sheet for Type III and Type IV sign panels must meet the requirements of ASTM B 209 for aluminum alloy 6061-T6, 5052-H38, or 5154-H38.

   Aluminum sheet for Type III sign panels must be fabricated from nominal 0.080 inch thick aluminum sheet with mill tolerance meeting the requirements of ASTM B 209. Aluminum sheet for Type IV overlay sign panels must be fabricated from at least nominal 0.040 inch thick aluminum sheet, at least 0.037 inch thick.

   Round the corners and remove burrs at the corners and mounting holes.

   Degrease the aluminum sheet in accordance with the sheeting manufacturer's recommendations. After degreasing, surface treating, and rinsing, maintain sign panels free of grease, oil, or other contaminants.

B. **Sign Face and Legend Material.**

1. **Reflective Sheeting Material.** Select reflective sheeting for permanent signs from the Qualified Products List. Provide sheeting meeting the requirements of ASTM D 4956 and the ASTM Types specified in Table 919-3, unless otherwise required.

   Provide the Engineer with written certification that reflective sheeting meets the following requirements:

   a. Sheetling material on each sign is an approved product, obtained from the same sheeting manufacturer, and applied in accordance with the manufacturer's recommendations;

   b. Signs are manufactured in strict compliance with the sheeting manufacturer's requirements; and

   c. Each 145 foot length roll of reflective sheeting contains no splices.
Certification must include lot numbers, run numbers, shipping date, invoice number, stock number, and quantities of material for each sign shipment.

2. **Sheeting Application.** Fabricate and apply legends in accordance with the *Michigan Standard Highway Signs Manual*, or as shown on the plans.

3. **Direct Applied Reflective Legend.** Cut legends with a smooth, regular outline, free of ragged or torn edges, and with interior corners cut to $\frac{3}{16}$ inch ± $\frac{1}{16}$ inch radius.

   Apply legends in accordance with the reflective sheeting manufacturer’s recommendations.

   For Type I aluminum extruded sign sections, cut the legend components along each metal sign section joint after applying the legend.

4. **Non-Reflective Legend, Borders and Arrows.** If a black legend is required, it must be applied using ink, silkscreen method, or non-reflective sheeting. Black sheeting used for legend, borders, and arrows must be non-reflective material unless otherwise stated.

   Provide material and apply non-reflective legends, borders and arrows in accordance with the manufacturer’s specifications.

C. **Sign Hardware.** Steel shapes, bars, and plates must meet the requirements of ASTM A 36, or Department-approved equal, and be hot-dip galvanized in accordance with ASTM A 123.

   Bolts, nuts, washers, U-bolts, and straps must be stainless steel alloy meeting the requirements of ASTM A 320, for Class 1, Grade B8. Provide self-locking, nylon insert-type nuts meeting the requirements of ASTM A 320 and ASTM A 194 for Grade 8F. If using U-bolts formed from straight bar stock, ensure U-bolts are formed by cold working.

   Aluminum alloy shapes and plates must meet ASTM B 308, for aluminum alloy 6061-T6.

   Cast post clips must conform to ASTM B 108, for aluminum alloy 356.0-T6.
Table 919-3
Retroreflective Sign Sheeting Material Guidelines

<table>
<thead>
<tr>
<th>Sign Category</th>
<th>Type</th>
<th>Material Type</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow Warning Signs</td>
<td>W-series (non school related), E13-1, E13-2, E11-1, OM-1, OM-2, OM-3</td>
<td>ASTM Type IX</td>
<td>Fluorescent Yellow</td>
</tr>
<tr>
<td>School Signs</td>
<td>S1-1, S4-3, S4-5, S4-5a, school portion of S5-1, W16-7p, W16-9p, W16-2, W16-2a</td>
<td>ASTM Type IX</td>
<td>Fluorescent Yellow Green</td>
</tr>
<tr>
<td>Freeway Guide Signs</td>
<td>White legends; borders; and arrows;</td>
<td>ASTM Type IX</td>
<td>White</td>
</tr>
<tr>
<td>Freeway Guide Signs</td>
<td>Background including M8 series signs</td>
<td>ASTM Type IV</td>
<td>Green, Brown, or Blue</td>
</tr>
<tr>
<td>Non Freeway Guide Signs</td>
<td>All</td>
<td>ASTM Type IV</td>
<td>White on Green, Brown or Blue</td>
</tr>
<tr>
<td>Regulatory Signs</td>
<td>Stop, Yield, parking, black on white signs</td>
<td>ASTM Type IV</td>
<td>—</td>
</tr>
<tr>
<td>Route Markers</td>
<td>—</td>
<td>ASTM Type IX</td>
<td>—</td>
</tr>
</tbody>
</table>

919.03. Delineators. Fabricate reflectors for delineators from plastic material or reflective sheeting material, as shown on the plans. Provide the Engineer a copy of the manufacturer's certification that reflectors and posts meet the requirements of this subsection.

A. Plastic Reflectors. Reflectors for mounting on rigid post must consist of a round, clear, and transparent plastic lens, with a back fused to the lens, under heat and pressure, around the perimeter to form a unit sealed against dust, water, and vapor. The unit must have a central mounting hole and the lens must have a nominal reflecting area of 7 square inches. The lens must have a smooth outside surface and an inside configuration which provides "cube-corner" retro-reflection. The manufacturer's trademark must be legibly molded into the face of the lens.

Plastic reflectors must have plastic or aluminum housing. An aluminum or plastic grommet with an inside diameter of \( \frac{3}{16} \) inch must be expanded within the reflector mounting hole and flanged. The Contractor may use plastic reflector housing consisting of acrylonitrile butadiene styrene (ABS) plastic meeting the requirements of ASTM D 3965 with a tensile strength of at least 6,500 psi.

1. Optical Performance. At least 90 percent of the reflectors tested must meet or exceed the values specified in Table 919-4 for the required color. One hundred percent of the reflectors tested must meet or exceed 80 percent of the values specified.
Table 919-4
Specific Intensity (SI) of Plastic Reflectors for Delineators

<table>
<thead>
<tr>
<th>Color</th>
<th>Type</th>
<th>SI candelas/foot-candle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Divergence Angle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1 degree</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.2 degree</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Entrance Angle (degree)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Crystal or Silver</td>
<td>A</td>
<td>120</td>
</tr>
<tr>
<td>Yellow</td>
<td>A</td>
<td>71</td>
</tr>
<tr>
<td>Red</td>
<td>A</td>
<td>29</td>
</tr>
</tbody>
</table>

B. Reflective Sheeting Reflectors. Reflective sheeting for mounting on flexible posts must meet the material, color, and resistance to weathering requirements of ASTM D 4956 for Type IX flexible high-intensity retroreflective sheeting.

When reflective sheeting reflectors are specified, or allowed for used in lieu of plastic reflectors, use yellow (amber) sheeting in place of yellow plastic reflectors and white (silver) sheeting in place of crystal plastic reflectors. Place a 3 inch by 6 inch piece of red reflective sheeting on the back side of the flexible post showing wrong-way movement for freeway ramps, as shown on the standard plans. Apply reflective sheeting in accordance with the manufacturer’s specifications.

C. Mounting Hardware. Mounting hardware for plastic reflectors must consist of a solid aluminum pin with annular locking grooves and an aluminum crimp-type collar. Both the pin and the collar must meet the requirements of ASTM B 308, for aluminum alloy 6061.

The pin must be \( \frac{3}{16} \) inch diameter, have a \( \frac{7}{16} \) inch diameter bearing head, and have a grip length equal to the total thickness of material fastened together.

The collar must have a bearing diameter from \( \frac{3}{8} \) inch to \( \frac{7}{16} \) inch and be sized to fit the pin.

D. Posts. Provide steel or flexible plastic delineator posts, as shown on the plans. Steel delineator posts must have a nominal weight of 1.12 pounds per foot and meet the requirements of subsection 919.04 for steel posts. Select flexible plastic delineator posts from the Qualified Products List.

919.04. Steel Post Sign Supports and Square Tubular Steel Sign Supports. Steel post sign supports and square tubular steel sign supports, including sign posts, anchor sleeves, and anchor posts, must meet the requirements of ASTM A 702, for Type A or Type B.
A. **Steel Post Sign Supports.** The length of finished posts must be as shown on the plans. Posts must be straight with a smooth, uniform finish, free of cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, or other defects affecting the strength, durability, or appearance of the posts. Cross-section and bolt hole diameter and spacing must meet the requirements shown on the sign support standard plans. The centers of the holes must coincide with the centerline of the posts. The punched bolt holes must provide a smooth, even sign post face. Holes and cutoff ends must be free of burrs.

After fabrication and hole punching, hot-dip galvanize steel posts in accordance with subsection 907.03.D.

Punched and coated posts must weigh at least 95 percent of the nominal weight shown on the plans.

B. **Square Tubular Steel Sign Supports.** Square tubular steel sign supports must meet the chemical, mechanical, and geometric properties of material used in the crash tests referenced in AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals.

Sign posts, anchor sleeves, anchor posts, and connection hardware must be of the size and type shown on the Sign Support Standards.

Submit proof of compliance that the assembly was crash tested in accordance with AASHTO Standard Specifications for Luminaries and Traffic Signals. The proof of compliance must include a copy of the FHWA approval letter to the manufacturer, indicating that the FHWA interprets the crash test results as acceptable for use on federal-aid projects.

The sign post, anchor sleeve, and anchor post must be straight and have a smooth uniform finish, free from cracks and flaws or other defects affecting their strength or durability. All ends must be free from burrs and must be cut square to maintain telescoping characteristics.

Bolt holes of the diameter specified must be accurately spaced on all four sides of the sign post, anchor sleeve and anchor post. Holes must line up exactly opposite each other on opposing sides of the post in order to accommodate a bolt placed through two opposite sides. The center of the holes must coincide with the centerline of the sign post, anchor sleeve and anchor post.

The bolt holes must be punched so that the face of the sign post, anchor sleeve and anchor post will have a smooth even surface.
The sign post, anchor sleeve, and anchor post must be hot-dip galvanized, after fabrication and hole punching, in accordance with ASTM A 123 for Grade 65.

919.05. Sawed Wood Posts for Highway Signs. Sawed wood posts for highway signs must meet the requirements of section 912 and Sign Support Standard SIGN-210.

919.06. Breakaway Column Sign Supports. Structural steel for column sign supports and bolts, nuts, and washers for the structural steel joints must meet the requirements of Sign Support Standard SIGN-220.

Shims must be fabricated from brass shim stock or brass strip meeting the requirements of ASTM B 36, for copper alloy UNS No. C26000, half-hard rolled temper, or fabricated from galvanized sheeting meeting the requirements of ASTM A 526, for Coating Designation G 90.

Galvanizing runs or beads must be removed from contact surfaces of columns, plates, and washers.

Breakaway column sign supports must be welded and galvanized and must be within the dimension tolerances specified by subsection 919.07.

919.07. Cantilever Sign Supports.

A. Types E and J. Pipe for the vertical poles of types E and J supports, and horizontal arms of type E supports, must meet the requirements of ASTM A 53 for Grade B, Type E, or Type S steel pipe or the requirements of API 5L for Grade X42 to X52.

Pipe for the horizontal arms of type J, must meet the requirements of ASTM A 500, Grade B or the requirements of ASTM A 519-4140 annealed.

Gusset, flange, and base plates must meet the requirements of ASTM A 36 for structural steel. Plates must be free of sharp edges and irregularities.

B. Castings. Pole top and end cap castings must meet the requirements of ASTM A 126 for Class A castings.

C. Bolts for Arm Connections. Galvanized high-strength steel bolts, nuts, and washers for connecting arm connection flanges must meet the requirements of subsection 906.06.

D. Dimension Tolerances. Dimensional tolerances for each type of commodity must meet the requirements of ASTM A 6 or the ASTM standard applicable to the required material.
E. **Welding.** Weld in accordance with AWS D1.1, Structural Welding Code, “Steel” as amended by this section, or the contract.

F. **Galvanizing.** Galvanize steel anchor bolts for a length of at least 20 inches from the threaded end. Bolts, nuts, and washers must be hot-dip galvanized in accordance with ASTM A 153.

After welding assemblies and sign support attachments, blast clean base plates and welds to remove excess mill scale and welding slag. Blast clean other areas as directed by the Engineer. Hot-dip galvanize supports in accordance with ASTM A 123.

**919.08. Truss Sign Supports.** Before applying dead loads, trusses must be cambered so the ordinate is within the allowable tolerances at the center of the assembled truss for the span length and type shown on the plans. Ensure bearing surfaces fully contact each other in the relaxed position before tightening the flange bolts. The fabricator will determine the method of cambering the structure, with the Engineer’s approval, to ensure the method does not induce stress into the truss.

A. **Materials.** Hollow structural tubing for horizontal arms must meet the requirements of ASTM A 500 for Grade B, the requirements of ASTM A 519-4140 annealed, or the requirements of API-5L for Grade X42. Safeguard hollow structural tubing against embrittlement in accordance with ASTM A 143.

Pipe for vertical poles must meet the requirements of ASTM A 53 for Grade B, Type E, or Type S steel pipe, or the requirements of API 5L for Grade X42 to X52.

Bar, plate, and rolled structural shapes must meet the requirements of ASTM A 36. Bars, plates, and shapes must be free of sharp edges and irregularities.

U-bolts and washers must meet the requirements of ASTM A 320, Grade B8, Class 1 stainless steel. Nuts must be self-locking nylon insert-type nuts meeting the requirements of ASTM A 320 for Grade B8F.

Nuts used in the upper clamp connection of the vertical end support assembly and on all U-bolts must be of the self-locking type.

Assemble truss unit flange connections and the alternate bolted, web-to-chord connection using galvanized high-strength steel bolts, nuts, and washers meeting the requirements specified by subsection 906.06.

B. **Welding.** Weld in accordance with AWS D1.1, Structural Welding Code, “Steel” as amended by section 919 or the contract.
C. **Dimension Tolerances.** Ensure cross sections, flatness, length, straightness, thickness, and camber of material, before and after fabrication, meet the tolerance requirements of ASTM A6 and AWS D1.1.

D. **Galvanizing.** Truss units must be galvanized in accordance with ASTM A123. Blast clean base plates and welds to remove excess mill scale and welding slag before galvanizing. Blast clean other areas as directed by the Engineer.

Provide safeguards meeting the requirements of ASTM A384 and ASTM A385 to obtain high quality galvanized coatings and minimize distortion and warpage during galvanizing.

Interconnect sections of fabricated pipe work or tube assemblies with open tee or miter joints and provide each enclosed section with a vent hole at each end to provide drainage for the molten zinc and to prevent hazard to personnel engaged in the galvanizing process.

Hot-dip galvanize individual pipe, tube, and bar members in accordance with ASTM A123.

**919.09. Overhead Lane Assignment Structures.** Overhead lane assignment structures must meet the requirements of Sign Support Standard SIGN-760 and traffic signal typical plans.

**919.10. Casings for Cantilever Drilled Piles.** Casings for cantilever drilled piles must meet the requirements of ASTM A252 for Grade 2 steel. Casings must be smooth, watertight, and capable of withstanding handling stresses and external subsurface pressures. Casing must have an inside diameter at least equal to the required shaft size.