

SECTION 716
SIGN MATERIALS

~~01~~SCOPE

716.01.01 MATERIALS COVERED

- A. This specification covers the kind and quality of materials used in the construction and fabrication of traffic control devices used in temporary event zones and for permanent installations.

~~02~~REQUIREMENTS

716.02.01 GENERAL

- A. The following materials shall conform to the requirements as noted:

Material	Section
Portland Cement Concrete	501
Reinforcing Steel	505

716.02.02 CERTIFICATES

- A. The Contractor shall ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency.
- B. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

716.02.03 SUBMITTALS

- A. Before fabrication is started, 5 sets of shop drawings for each overhead sign structure shall be submitted to the Engineer for approval.

~~03~~PHYSICAL PROPERTIES AND TESTS

716.03.01 REFLECTIVE SHEETING

- A. ~~Sheeting for all orange signs and devices shall be of the following class sets, as specified in the plans or the proposal, and, unless otherwise specified or approved by the Engineer, shall be Class 6 Fluorescent Orange with the exception of Type 1, Type 2, and Type 3 barricades, which shall be pre-striped white and non-fluorescent Orange sheeting.~~
- B. ~~The Fluorescent Yellow-Green sheeting shall be used on School, Bicycle, and Pedestrian signs, and related supplemental plates, or as directed by the Contracting Agency. a material approved by the Engineer, applied to approved sign substrate in accordance with manufacturer's instructions, and conform to the applicable requirements below.~~
- C. ~~Inks and films for symbols, legends and borders on sheeting shall be in accordance with the manufacturer's sheeting specification. Films shall be a durable, transparent, acrylic colored film coated with a transparent pressure-sensitive adhesive.~~
- D. ~~Protective overlay film (anti-graffiti film for non-illuminated signs), shall be a durable, solvent resistant, transparent, fluoropolymer film, coated with a transparent pressure-~~

sensitive adhesive, and applied to the finished sign in accordance with the manufacturer's sheeting specification.

E. **Non-Reboundable Signs and Devices:** Retroreflective sheeting shall conform to ASTM D4956, Type XI. The warranty for the sheeting shall be twelve years for non-fluorescent sheeting, ten years for Fluorescent Yellow and Fluorescent Yellow-Green sheeting, and three years for Fluorescent Orange sheeting.

F. **Reboundable Devices and Delineators:** Retroreflective sheeting shall conform to ASTM D4956, Type IV and Type VI with the following modifications:

1. Minimum Coefficient of Retroreflection (R_A) [$\text{cd}/\text{fc}/\text{ft}^2$ ($\text{cd}/\text{lx}\cdot\text{m}^2$)] for both Type IV and Type VI shall conform to the requirements for ASTM D4956, Type VI as shown in Table 716-1
2. Daytime color – the chromaticity coordinates and total luminance factor shall conform to the requirements as described in 23 CFR Part 655 Appendix to Subpart F.

TABLE 716-1 MINIMUM COEFFICIENT OF RETROREFLECTION (R_A)

<u>Observation Angle</u>	<u>Entrance Angle</u>	<u>White</u>	<u>Fluorescent Orange</u>	<u>Fluorescent Yellow</u>	<u>Fluorescent Yellow-Green</u>
<u>0.2°</u>	<u>-4°</u>	<u>500</u>	<u>200</u>	<u>300</u>	<u>400</u>
<u>0.2°</u>	<u>30°</u>	<u>200</u>	<u>80</u>	<u>120</u>	<u>160</u>
<u>0.5°</u>	<u>-4°</u>	<u>225</u>	<u>90</u>	<u>135</u>	<u>180</u>
<u>0.5°</u>	<u>30°</u>	<u>85</u>	<u>34</u>	<u>51</u>	<u>68</u>

G. Fluorescence Luminance Factor (L_F) for all Fluorescent sheeting shall conform to the requirements in Table 716-2.

H. Unless otherwise specified, the Contractor shall use only Type IV, Type VI, and Type XI products listed in the NDOT QPL.

TABLE 716-2 FLUORESCENCE LUMINANCE FACTOR (Y_F)

<u>Color</u>	<u>Y_F Initial Requirement</u>	<u>Y_F Minimum Requirement</u>
<u>Fluorescent Orange</u>	<u>20</u>	<u>15</u>
<u>Fluorescent Yellow</u>	<u>25</u>	<u>20</u>
<u>Fluorescent Yellow-Green</u>	<u>30</u>	<u>20</u>

~~C. Class 1 – Non-Retroreflective Plastic Film (ScotchCal or equal):~~

- ~~1. Pressure sensitive adhesive coated plastic film for sign copy and borders shall be a material recommended by the retroreflective sheeting manufacturer as compatible with the background retroreflective sheeting.~~
- ~~2. Film shall meet the requirements for Type I, Class 1 of MIL-M-43719B, "Marking Materials and Markers, Adhesive, Elastomeric, Pigmented."~~
- ~~3. Life: Shall be the same as material applied upon.~~

~~D. Class 2 – Enclosed Lens Retroreflective Sheeting (Engineer grade or equal):~~

- ~~1. Class 2 sheeting shall meet the requirements of ASTM D4956, Type I.~~
- ~~2. Life: 7 years.~~

~~E. Class 3 – Enclosed Lens Retroreflective Sheeting (Super Engineering grade or equal):~~

- ~~1. Class 3 sheeting shall meet the requirements of ASTM D4956, Type II.~~
- ~~2. Life: 10 years.~~

~~F. Class 4 – Encapsulated Lens Retroreflective Sheeting (High Intensity grade or equal):~~

- ~~1. Class 4 sheeting shall meet the requirements of ASTM D4956, Type III and/or Type IV.~~
- ~~2. Life:~~
 - ~~a. 10 years.~~
 - ~~b. 3 years for Work Zone retroreflective sheeting.~~

- ~~3. Retroreflective sheeting for work/special event zone reboundable devices (cones and delineators) shall be Class 4 sheeting.~~

~~G. Class 5 – Wide-Angle Prismatic Retroreflective Sheeting:~~

- ~~1. Class 5 sheeting shall meet the requirements of ASTM D4956, Type VII sheeting and shall have minimum coefficients of retroreflection, in units of candelas per footcandle per square foot, not less than the values shown below:~~

~~2. Life:~~

- ~~a. 10 years for fluorescent sheeting.~~
- ~~b. 12 years for non-fluorescent sheeting.~~
- ~~c. 3 years for fluorescent orange sheeting.~~
- ~~3. Class 5 fluorescent orange sheeting shall be used on all construction warning signs and devices except Type I, Type II, and Type III barricades.~~
 - ~~a. Type I, Type II, and Type III barricades shall use non-fluorescent Class 5 sheeting.~~
 - ~~b. Legends and borders for signs using Class 5 fluorescent orange retroreflective sheeting shall be in accordance with manufacturer's recommendations.~~
 - ~~c. Retroreflective sheeting for work/special event zone reboundable devices (traffic barrels/drums) shall be Class 5 sheeting.~~

~~H. Class 6 – Wide-Angle Prismatic Retroreflective Sheeting.~~

~~1. Class 6 sheeting is a wide angle retroreflective sheeting with optimized performance over a broad range of observation angles and shall meet the requirements of ASTM D4956, Type IX sheeting.~~

~~2. Life:~~

- ~~a. 10 years for fluorescent sheeting.~~
- ~~b. 12 years for non-fluorescent sheeting.~~
- ~~c. 3 years for fluorescent orange sheeting.~~

~~I. Fluorescent yellow-green reflective sheeting shall be used on the following signs only:~~

- ~~1. School Advance (S1-1).~~
- ~~2. School Bus Stop Ahead (S3-1).~~
- ~~3. School Speed Limit (S5-1).~~
- ~~4. Advance Pedestrian Crossing (W11-2).~~
- ~~5. Bicycle Crossing (W11-1).~~
- ~~6. Related supplemental plates.~~

~~J. Inks and films for legends and borders on retroreflective sheeting shall be in accordance with manufacturer's specification.~~

~~K.I.~~ **Field Performance Life Requirement:**

1. The supplier shall warranty that signs supplied shall have an effective retroreflective life of not less than that specified above.
2. The retroreflective sheeting shall be considered unsatisfactory and failing this life requirement if it has deteriorated due to natural causes to the extent that 1 or more of the following is true:
 - a. The sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night conditions.
 - b. The values for the coefficients of retroreflection for ~~Class 2 Type IV, Type VI, through and Class 6 Type XI~~ are less than 50 percent of the required values for the same sign when new in accordance with ASTM D4956.
 - c. The sign material's integrity or adhesion to the sign substrate has substantially failed.
3. Sheeting which fails the life requirement within the specified required lifetime shall be replaced by the supplier at no ~~charge~~ cost to the Contracting Agency.
4. Replaced sheeting ~~lifetime warranty~~ shall begin at time of replacement and the lifetime warranty shall be to the life requirement per sheeting type.
5. All finished signs shall be dated with the month and year of delivery in order to ascertain compliance with the life requirements.

716.03.02 BLANK

716.03.03 ALUMINUM SIGN PANELS (FOR REFLECTIVE SHEETING)

- A. Sheet aluminum for sign panels shall be of 0.100-inch aluminum alloy Alclad 5052-H38 or 6061-T6 and shall conform to ASTM B209.

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- B. Sign panels for street name signs shall be as required in the Standard Drawings.
- C. Sign panel sections shall be fabricated of standard width aluminum sheets not less than 4 feet wide, except that not more than 2 sheets for any 1 sign may be cut not less than 18 inches in width to provide sign widths to nearest 6-inch increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.
- D. The aluminum shall be free of all corrosion, white rust, and dirt.
 - 1. All sign dimensions, metal gauge, and bolt holes shall conform to the plans and these specifications.
 - 2. Blanks shall be cleaned, degreased, and chromated or otherwise properly prepared according to methods recommended by the sheeting manufacturer.
- E. Metal shall not be handled, except by device or clean canvas gloves, between all cleaning operations and the applications of the sign background material. There shall be no opportunity for the aluminum to come in contact with greases, oils, or other contaminants prior to application of the background material.
- F. All fabrication, including cutting, shall be completed prior to the cleaning process.
 - 1. Metal panels shall be cut to size and shape and shall be free of defects resulting from fabrication.
 - 2. The surface of all sign panels shall be a plane surface.

716.03.04 BLANK**716.03.05 OVERHEAD SIGN STRUCTURES AND SIGN FRAMES**

- A. The materials used in the fabrication of overhead sign structures and footings shall conform to the requirements specified below.
- B. **Sign Frames:** Bars, plates, and shapes shall be structural steel conforming to ASTM A36.
- C. **Sign Pipe Posts:**
 - 1. Pipe posts shall be welded or seamless steel pipe conforming to ASTM A53, Grade B.
 - 2. At the option of the Contractor, posts may be fabricated from structural steel conforming to ASTM A36 or ASTM A283, Grade D, except that plates more than 1 inch in thickness shall be structural steel conforming to ASTM A373.
- D. **Sign Steel Walkway Gratings:** Steel walkway gratings shall be furnished and installed in accordance with details shown on the plans and the following provisions:
 - 1. Gratings shall be the standard product of an established grating manufacturer.
 - 2. Material for gratings shall be structural steel conforming to ASTM A36.
 - 3. For welded type gratings, each joint shall be full resistance welded under pressure to provide a sound, completely beaded joint.
 - 4. For mechanically locked gratings, the method of fabrication and interlocking of the members shall be approved by the Engineer, and the fabricated grating shall be equal in strength to the welded type.
 - 5. After fabrication, gratings shall be hot-dip galvanized.
 - 6. Gratings shall be free from warps, twists, and other defects affecting their appearance or serviceability.

- a. The tops of the bearing bars and cross members shall be in the same plane.
 - b. Gratings distorted by the galvanizing process shall be straightened.
- E. Bolts and Nuts:**
1. Bolts and nuts shall conform to ASTM A307.
 2. Bolted connections shall conform to Subsection [506.03.10](#), "Bolts and Bolted Connections."
- F.** Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication.
1. Steel shall conform to ASTM A36.
 2. Galvanizing shall conform to ASTM A123.
 3. All welding shall conform to Subsection [506.03.20](#), "Welding."
- G.** Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section [710](#), "Structural and Eyebars Steel," and shall be galvanized in accordance with ASTM A153 or cadmium plated in accordance with ASTM A165, Type TS.
1. The top portion of anchor bolts shall be galvanized or cadmium plated so that the galvanized or cadmium plated portion will extend at least 2 inches into concrete.
 2. Anchor bolts shall be of the size, shape, and length shown on the plans.
- H.** All bolts, nuts, clamps, and metal washers not otherwise noted shall be galvanized or cadmium plated.
1. Cadmium plating shall conform to ASTM A165, minimum thickness as prescribed for grade Type TS.
 2. Galvanizing shall conform to ASTM A153.
- I.** Supporting frame shall be manufactured in accordance with the plans and requirements herein specified.
1. All metal parts shall be galvanized after fabrication, in accordance with Section [715](#), "Galvanizing."
 2. When permission is granted by the Engineer to zinc coat a surface by means other than hot-dip galvanizing, the metalizing process shall be used to place the zinc.
 3. Metalizing shall be performed in accordance with AWS specifications and the thickness of the sprayed zinc coat shall be at least 5 mils.
- J.** Truss frames shall be fabricated to the largest practical sections prior to galvanizing.
1. Splice locations shall be submitted to the Engineer for approval.
 2. Contractor shall not commence fabrication until such splice locations are approved.
- K.** All welding on the fabrication of the structure shall be done by welders qualified in accordance with AWS requirements using the inert-gas shielded-arc method.
1. Welds shall be free from cracks, blow holes, and other irregularities.
 2. Welds shall be wire brushed or otherwise cleaned.
 3. No field welding on any part of the structural assembly will be permitted.

716.03.06 SIGN HARDWARE, POST, AND RELATED MATERIALS

- A. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication.
1. Steel shall conform to ASTM A36.
 2. Galvanizing shall conform to ASTM A123.
 3. All welding shall conform to Subsection [506.03.20](#), "Welding."
- B. Structural I-beam steel shall be galvanized in accordance with ASTM A153 or cadmium plated in accordance with ASTM A165, Type TS.
- C. Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section [710](#), "Structural and Eyebar Steel."
1. The top portion of anchor bolts shall be galvanized or cadmium plated so that the galvanized or cadmium plated portion will extend at least 2 inches into the concrete.
 2. Anchor bolts shall be of the size, shape, and length shown on the plans.
- D. Steel pipe for posts shall conform to ASTM A53, Grade B, and shall be galvanized.
1. Galvanized steel pipe posts shall be of the diameter and length shown on the plans.
 2. The top of the posts shall be fitted with a cover.
 3. Posts showing damage shall be repaired or rejected.
- E. Wood posts shall be constructed of Douglas Fir, West Coast Hemlock, or any other equivalent stress-rated wood material, at the option of the Contractor.
1. The wood material shall be construction grade, free of heart center, minimum stress rating of 1200f, and graded in accordance with the provisions contained in Section [718](#), "Timber."
 2. Sweep shall not exceed 0.08 feet in 10 feet.
- F. Aluminum stiffeners, braces, and stringers used as horizontal supporting structural members shall be of aluminum alloy 6061-T6.
1. These extrusions shall have a continuous, inverted "T" slot.
 2. The inverted "T" shall accommodate positionable stainless steel clamping devices.
 3. The clamping devices shall provide complete freedom of alignment within the slot, forming an interlocking clamp system for fastening the sign to the post.
 4. The sign support system described herein shall conform to AASHTO *Standard Specifications for Highway Signs, Luminaires and Traffic Signals*, latest revision, and be rated for minimum wind velocities of 80 mph.
 5. All bolts, nuts, clamps, and metal washers in contact with this aluminum channel shall be Stainless Steel Type 304.
 6. The system shall be compatible with all I-beam, steel post, and wood post systems.
- G. All other bolts, nuts, clamps, and metal washers in contact with other aluminum components shall be galvanized or cadmium plated.
1. Cadmium plating shall conform to ASTM ~~A165~~[B766](#), minimum thickness as prescribed for ~~grade-Class 5~~ Type ~~TS3~~.

2. Galvanizing shall conform to ASTM A153.
- H. Cantilever arm brackets shall be used when it is desired to offset the entire length of a sign to 1 side of a post or pole.
1. Cantilever arm brackets shall consist of a stainless steel or aluminum head mounted to an extruded aluminum "TEE" section.
 2. The "TEE" section shall have a continuous slot that will accept signs up to 1/8 inch thick.
 3. If sign thickness, including aluminum sign panel and reflective sheeting, exceeds the width of the "TEE" section slot, sign panel thickness may be reduced to not less than 0.080 inch, or reflective sheeting may be eliminated in the bracket area, as directed by the Engineer.
 4. The heads shall be designed to accept 3/4-inch stainless steel banding.
 5. The "TEE"-shaped extrusions shall be made from 6061-T6 aluminum alloy.
 6. The cantilever arm brackets shall be used to support the entire length of the sign on both the top and the bottom.
 7. The sign shall be attached to the brackets using 1/8-inch rivets spaced according to the hole pattern pre-drilled on the extruded "TEE" section.
 8. The cantilever arm brackets shall be compatible with any size and shape of post or pole.
 9. The system shall be designed for use on signs up to 72 inches in length with a maximum surface area of 9.5 square feet.
 10. Signs with surface area greater than 2 square feet shall be fastened to round posts or poles using 3/4-inch by 0.030-inch stainless steel banding.
 11. When mounting to square posts or flat surfaces, compatible stainless steel threaded studs or bolts can be used as well as 3/4-inch by 0.030-inch stainless steel banding.
 12. For signs less than 2 square feet in surface area, 5/8-inch banding is acceptable.