



SECTION 1042

HIGHWAY SIGN MATERIAL

1042.1 Scope. These specifications cover the material used in signs and fastening devices, and the fabrication of the signs.

1042.2 Material. Material shall be of new stock and shall conform to the following unless otherwise shown on the plans.

1042.2.1 Signs.

Item	Specification
Aluminum Flat Sheets	ASTM B 209, 6061-T6 or 5052-H38
Aluminum Extruded Sign Panels	ASTM B221, 6063-T6

1042.2.2 Sign Appurtenances.

Item	Specification
Aluminum Post Clip	ASTM B 108, 356-T6
Aluminum Bolts	ASTM B 211, 2024-T4 or 6061-T6
Aluminum Nuts	ASTM B 211, 2024-T4, 6061-T6, 6262-T9 or 2017-T4
Aluminum Flat Washers	ASTM B 209, or Alclad 2024-T4 or 2024-T4
Aluminum Lock Washers	ASTM B 211, 7075-T6
Aluminum Lock Nuts (Nylon Insert)	ASTM B 211, 2017-T4
Aluminum Edge Molding	ASTM B 221, 6063-T6
Stainless Steel Bolts, Nuts, Screws and Washers	ASTM A 320 or SAE J405D, Austenitic Steel, Min Yield 30,000 psi (206 MPa)
Vulcanized Fiber Washers Commercial Grade	ASTM D710 Gray

1042.2.3 A manufacturer's or supplier's Certification of Metal used for signing material listed above shall be furnished to the engineer, at the fabrication plant at the time of inspection of the material. The contractor shall furnish the engineer the fabricator's certification in accordance with [Sec 903.3.5.2](#).

1042.2.4 Structural signs shall be fabricated of minimum 0.081 inch (2.1 mm) extruded aluminum panels and mounted as shown on the plans. Maximum allowable deviation from flatness shall not exceed 0.010 inch per inch (0.25 mm per 25 mm) width of the panel. Shop drawings for approval of the engineer will be required for any variations in the assembly or mounting details.

1042.2.5 Flat sheet signs shall be fabricated as shown on the plans from sheet aluminum of the specified thickness. Flat sheet signs shall have no holes except those drilled or punched for proper mounting.

1042.2.6 Nylon washers recommended by the sign sheeting manufacturer shall be used between the bolt heads and sign faces on flat sheet aluminum signs. The washers shall be for use with 3/8-inch (9.5 mm) bolts and have a minimum outside diameter of 3/4 inch (19 mm), and a nominal thickness of 1/16 inch (1.5 mm).

1042.2.7 Reflective Sheeting. Reflective sheeting shall have a precoated pressure sensitive adhesive or a tack free heat activated adhesive backing, neither of which shall require additional adhesive coats on the reflective sheeting or application surface. The protective liner attached to the adhesive shall be easily removed by peeling without soaking in water or other solvents. The adhesive shall form a durable bond to clean substrates and shall adhere securely under all atmospheric conditions of field exposure. Reflective sheeting applied to cleaned aluminum test panels shall adhere securely after 48 hours of aging, at temperatures of -20 F to 150 F (-29 to 65 C). The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when struck by foreign objects. Reflective sheeting shall have sufficient strength and flexibility so that the sheeting can be handled, processed and applied according to the manufacturer's recommendations without appreciable stretching, tearing, cracking or other damage. The sheeting surface shall be readily screen processed and compatible with recommended transparent and opaque screen process colors. The reflective sheeting manufacturer shall furnish information as to the type of solvent or solvents that may be used to clean the surface of the sheeting without detrimental loss of brightness and durability.

1042.2.7.1 Type 1 reflective sheeting shall meet the requirements of ASTM D 4956, Type 1, Class 1 or 2, except as noted herein.

1042.2.7.1.1 Type 1 reflective sheeting shall be enclosed lens glass-bead sheeting.

1042.2.7.2 Type 3 reflective sheeting shall meet the requirements of ASTM D 4956, Type III, Class 1 or 2, except as noted herein.

1042.2.7.2.1 Type 3 reflective sheeting shall be encapsulated glass-bead sheeting.

1042.2.7.3 Type 7 reflective sheeting shall meet the requirements of ASTM D 4956, Type IV, Class 1 or 2, except as noted herein.

1042.2.7.3.1 Type 7 reflective sheeting shall meet or exceed the minimum coefficient of retroreflection requirements as shown in Table I, expressed as candelas per footcandle per square foot (candelas per lux per square meter).

TABLE I Type 7 Reflective Sheeting Minimum Coefficient of Retroreflection								
Observation Angle, Degrees	Entrance Angle, Degrees	White	Yellow	Red	Green	Blue	Orange	Brown
0.2	-4	430	350	110	45	20	250	24
0.2	+30	235	190	48	24	11	110	10
0.5	-4	200	160	45	20	9.8	100	8
0.5	+30	135	85	26	10	5	50	3

1042.2.7.3.2 Type 7 reflective sheeting shall meet the luminance factor (daytime luminance) requirements as shown in Table II.

Table II		
Color	Reflectance Limits (%Y) Y	
	Min	Max
Whites**	40	--
Red	3.0	15
Orange	14	30
Yellow	24	45
Green	3.0	15
Brown	1.0	9.0
Blue	1.0	10

**Silver white is an acceptable color designation.

1042.2.7.4 For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficient of retroreflection (Ra) shall not be less than 70 percent of the original values for the corresponding color.

1042.2.7.5 Reflective sheeting, except for construction signs, shall be submitted by the manufacturer to the National Transportation Product Evaluation Program (NTPEP) for two years of 45-degree south-facing outdoor exposure. Reflective sheeting for construction signs shall be submitted by the manufacturer to NTPEP for an exposure time of one year. Results shall be published by NTPEP and available for MoDOT review. For all NTPEP test decks, reflective sheeting shall have a coefficient of retroreflection not less than 50 percent of the original reading for Type 1 or 80 percent of the original reading for Type 3 and Type 7.

1042.2.7.5.1 Preliminary approval will be based upon satisfactory NTPEP test results for reflective sheeting and additional verification testing for reflectance and chromaticity as required.

1042.2.7.5.2 Continued approval will be based upon satisfactory field performance.

1042.2.8 Fluorescent Reflective Sheeting. Fluorescent reflective sheeting shall be in accordance with [Sec 1042.2.7](#) and ASTM D 4956, Type IV, Class 1, except as noted herein.

1042.2.8.1 Coefficient of Retroreflection. Reflective sheeting shall meet or exceed the minimum coefficient of retroreflection requirements as shown in the following table, expressed as candelas per footcandle per square foot (candelas/lux/m²). Coefficient of Retroreflection values will be the mean of test rests obtained from readings taken with orientation angles of 0 degrees and 90 degrees.

Reflective Sheeting - Minimum Coefficient of Retroreflection, Ra				
Observation Angle, Degrees	Entrance Angle, Degrees	Orange	Yellow Green	Yellow
0.2	-4	200	325	240
0.2	+30	85	205	150
0.5	-4	80	235	165
0.5	+30	50	110	75

1042.2.8.2 Color Specification Limits and Luminance Factor. Fluorescent reflective sheeting shall meet the color specification limits (daytime) and luminance factor (daytime) requirements shown below.

Fluorescent Reflective Sheeting Color Specification Limits (Daytime) - Luminance Factor, Y%										
	1		2		3		4		Luminance Factor (Y)	
	x	y	x	y	x	y	x	y	Min	Max
Orange	.583	.416	.523	.397	.560	.360	.631	.369	28	---
Weathered Orange	.583	.416	.523	.397	.560	.360	.631	.369	20	45
Yellow Green	.387	.610	.460	.540	.421	.486	.368	.539	60	---
Weathered Yellow Green	.387	.610	.460	.540	.421	.486	.368	.539	50	---
Yellow	.498	.412	.557	.442	.479	.520	.438	.472	40	---

Note: The four pairs of chromaticity coordinates will determine the acceptable color in terms of the CIE 1931 Standard Colorimetric System measured with CIE Standard Illuminant D65.

1042.2.8.3 Specular Gloss. Fluorescent reflective sheeting shall have a specular gloss of not less than 50.

1042.2.8.4 Reflective Sheeting for Work Zones. Fluorescent Orange reflective sheeting for work zones shall be submitted for one year of exposure on NTPEP test decks.

1042.2.8.5 Manufacturer and Brand Name Approval. Prior to approval and use of material, the manufacturer shall submit to Project Operations NTPEP test results from all test decks and certification showing specific test results that the material are in accordance with this specification. In addition, the manufacturer shall submit to Project Operations samples representing the reflective sheeting tested by NTPEP, and inks. These samples shall be accompanied by a product data sheet, an MSDS, technical bulletins on sign fabrication, and any special fabrication instructions relative to the reflective sheeting submitted. Samples of reflective sheeting shall be a minimum of 13 x 13 inches (330 x 330 mm).

1045.2.8.5.1 Preliminary approval will be based upon satisfactory NTPEP test results for reflective sheeting and additional verification testing for reflectance and chromaticity as required.

1045.2.8.5.2 Continued approval will be based upon satisfactory field performance.

1042.2.9 Type of Characters. Letters, numerals, arrows, symbols, borders and other features of the sign message shall be of the type, size and series shown on the plans or as specified by the engineer. Completed letters, numerals and other units shall be formed to provide

continuous stroke width with smooth edges and shall present a flat surface free of warp, blisters, wrinkles, burrs and splinters. Units of the sign message of the type shown on the plans shall meet the requirements for the specified type. Type L-1 and L-3 characters shall not be intermixed on a single sign face unless otherwise shown on the plans or as approved by the engineer.

1042.2.9.1 Type L-1, Screen Processed Characters. The letters, numerals, arrows, symbols and borders shall be applied to the background of the sign by direct or reverse screen process. Messages and borders of a color darker than the sign field shall be applied to the reflective sheeting by direct process. Messages and borders of a color lighter than the sign field shall be produced by the reverse screen process. Inks used in the silk screen process shall be of the type to produce the desired color and durability when applied on reflective sheeting. Silk screen inks shall be used in accordance with the manufacturer's recommendations. The ink shall produce the desired color when applied on reflective sheeting background and shall dry within 8 hours to a good film without running, streaking or sagging. The screening shall be done in a manner which results in a uniform color and tone, with sharply defined edges of legend and border, and without blemishes on the sign field that will affect intended use. Signs after screening shall be air-dried or baked in accordance with the manufacturer's recommendations to provide a smooth hard finish. Any signs on which blisters appear during the drying process will be rejected.

1042.2.9.2 Type L-3, Direct Applied Characters. The letters, numerals, symbols, borders and other features of the sign message shall be cut from the color and type of sheeting shown on the plans and applied to the sign field in accordance with instructions of the manufacturer of the sheeting.

1042.2.9.3 The following variations in dimensions of letters and numerals, regardless of character type, will be acceptable with all measurements made to the nearest 1/8 inch (3 mm).

Nominal Height, in. (mm)	Variation in Height, in. (mm)	Variation in Width, in. (mm)
4 thru 12 (100 thru 300)	-1/8 to +3/8 (-3 to +9.5)	-1/4 to +1/4 (-6 to +6)
Over 12 (Over 300)	-1/8 to +3/8 (-3 to +9.5)	-3/8 to +3/8 (-9.5 to +9.5)

The design height of rounded letters or numerals shall be 1/64 inch per inch (0.4 mm per 25 mm) of height greater than normal height, both on top and bottom of letter or numeral, where rounded. The loop portion of letters such as f, g and y, shall conform to the dimensions shown on the plans with the allowable tolerance.

1042.2.10 Reflectors used in delineators shall consist of a clear and transparent plastic face, herein referred to as the lens, and an opaque back fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit permanently sealed against dust, water and water vapor. The reflector lens shall be made of methyl methacrylate. The lens shall consist of a smooth front surface free from projections or indentations, other than for identification, and a rear surface bearing a prismatic configuration such that it will effect internal reflection of light. Fifty samples of each size will be selected by the engineer at random from each shipment for the various tests. Sample size and acceptance practice will be the same regardless of the size of the shipment unless otherwise specifically permitted by the engineer.

(a) Reflectors shall have a minimum coefficient of luminous intensity as shown in the following table, expressed as candelas per footcandle (lux) in accordance with MoDOT Test Method T8. A white or pastel acrylic opaque plastic back will not be required if the lens is permanently and durably sealed against dust, water and water vapor in a manner approved by the engineer.

ENGLISH				
Observation Angle, Degrees	Entrance Angle, Degrees	Minimum Coefficient of Luminous Intensity		
		Crystal *(White)	Amber	Red
1/10	0	115	70	30
1/10	20	45	25	12
1/3	0	50	30	12
1/3	20	20	12	5
METRIC				
Observation Angle, Degrees	Entrance Angle, Degrees	Minimum Coefficient of Luminous Intensity		
		Crystal *(White)	Amber	Red
1/10	0	10.7	6.5	2.8
1/10	20	4.2	2.3	1.1
1/3	0	4.7	2.8	1.1
1/3	20	1.9	1.1	0.5

(b) The color of the reflector lens shall be as shown on the plans. Failure to meet the coefficient of luminous intensity minimum shall constitute failure of a reflector and failure of more than two reflectors of the 50 subjected to test shall be cause for rejection of the lot.

(c) When tested in accordance with MoDOT Test Method T68, the reflectors shall show no evidence of water or water vapor inside the reflector. Any evidence of water or water vapor in a reflector shall constitute failure and failure of more than two reflectors shall be cause for rejection of the lot.

(d) When tested in accordance with MoDOT Test Method T68, the reflectors shall show no significant change in shape or general appearance. Failure of one sample shall be cause for rejection of the lot.

1042.3 Sign Fabrication. A sign shall consist of aluminum flat sheets or extruded panels reflectorized on the face side with all letters, numerals, symbols, borders, corners and route shields mounted on the face, and shall include all necessary mounting devices as shown on the plans. Signs with an area of 30 square feet (3 m²) or more are structural (ST) and shall be fabricated with extruded panels. Signs with an area of less than 30 square feet (3 m²) are sheet (SH) signs and shall be fabricated with flat sheet.

1042.3.1 The signs shall be reflectorized as follows.

1042.3.1.1 All aluminum substrate shall be given a chromate conversion coating conforming to the requirements of ASTM B 449, Class 2, and shall be prepared by one of the Treatment Sequence Options described in ASTM B 449, Appendix X2.

The chemicals and solvents shall be applied in strict accordance with the directions of the manufacturer. Sufficient laboratory facilities to test and control the concentration of the solutions used shall be maintained at the treating plant. A log of the concentration of treating solutions shall be maintained. Treated panels shall be handled with clean mechanical devices or workers with clean gloves. Panels shall be stored in a dry, clean area free from dust, acid fumes or vapors. Where aluminum is shipped to a secondary location for reflectorizing, adequate precautions shall be taken to ensure that the material arrives at destination uncontaminated.

1042.3.1.2 Reflective sheeting used for background, letters, numerals, arrows, symbols, borders and other features of the sign message shall be from a single manufacturer.

1042.3.1.3 Reflective sheeting splices on structural signs shall be kept to a minimum. Only sheeting manufacturer's rolled overlap splices shall be used with no more than one allowed per panel. Reflective sheeting shall be placed horizontally on the individual extruded panels with approximately 3/8 inch (9 mm) overlap on each edge. No reflective sheeting will be permitted over the butt joints of adjacent extruded panels. The sign panels shall be clear coated or edge sealed after application of the reflective sheeting, if recommended by the sheeting manufacturer. The completed sign shall have good color matching of reflective sheeting and be free from cracks, tears, blisters, bubbles and wrinkles.

1042.3.1.4 Reflective sheeting applied to standard flat sheet signs shall have no splices except on signs where the smallest dimension is greater than 4 feet (1200 mm). One vertical overlap splice approximately 1/4 inch (6 mm) wide will be acceptable on standard flat sheet signs where the smallest dimension is greater than 4 feet (1200 mm). Any special flat sheet signs requiring splicing other than noted for the standard flat sheet signs shall be as approved by the engineer. The sign panels shall be clear coated or edge sealed after application of the reflective sheeting, if recommended by the sheeting manufacturer. If clear finish is used, the finish shall be applied after screening of messages and borders. If edge sealer is used, the sealer shall be applied to all splices and edges. The completed sign face shall be free from cracks, tears, blisters, bubbles and wrinkles.

1042.3.2 Nuts on panel bolts shall be torqued to 220 - 230 inch-pounds (25 - 26 N-m).

1042.3.3 Periodic shop inspection of sign fabrication will ordinarily be made at the fabricating shop, but in some cases may be waived and complete inspection made when the fabricated signs are delivered to the site of the work. The engineer shall be notified well in advance of beginning of shop work so adequate arrangements may be made for inspection. It is understood that whether or not shop inspection is made, workmanship and material which do not conform to the requirements of the specifications and recognized good practice may be rejected at any time prior to acceptance of the work.

1042.3.3.1 The contractor will be charged with transportation costs of sign inspectors for trips made from Jefferson City to points to which they must travel for shop inspection work. The routine shop inspection work will include inspection and sampling of material, inspection of treatment and fabrication processes, and of any signs completed at time of inspection. In general, two round trips for one inspector will be required. Transportation costs will be deducted by the Commission from monies due the contractor.