982.1 GENERAL REQUIREMENTS

A certificate of compliance shall be furnished for each material item and shall state that the item conforms to the required specification, with reference being made to the appropriate specification number.

982.2 SPECIFIC REQUIREMENTS

A. Signs:

1. **Sheet Aluminum:** Sheet aluminum shall meet the requirements of ASTM B 209 for alloy 5052-H38 or 6061-T6. The aluminum shall be properly degreased and etched or treated with a light, tight, amorphous chromate coating. Sheet aluminum thickness requirements shall be based on the maximum horizontal inplace dimension of each sheet aluminum sign in accordance with the following:

HORIZONTAL DIMENSION OF IN PLACE SIGN BLANK	REQUIRED SIGN BLANK THICKNESS
(English Units)	
18" and less	0.063"
Over 18" thru 30"	0.080"
Over 30"	0.100"
(In Metric)	
457 mm and less	1.60 mm
Over 457 mm thru 762 mm	2.03 mm
Over 762 mm	2.54 mm

Sheet aluminum for signs used to overlay other sign surfaces shall have a thickness of 0.063 inch (1.60 mm). Cutout aluminum backing for removable letters, numerals, symbols, and borders shall be a minimum of 0.032 inch (0.81 mm) thick aluminum sheet of 6061-T6 or 3003-H14 alloy. Route markers for use on guide signs shall be 0.063 inch (1.60 mm) thick aluminum sheet of 6061-T6 alloy. The sheared edges of blanks shall be straight and free from tears and raggedness.

2. **Extruded Aluminum:** Extruded aluminum shall meet the requirements of aluminum alloy 6061-T6 or 6063-T6 (ASTM B 221). No more than one six inch (150 mm) wide panel shall be used in any sign.

3. **Sign Molding:** Side trim molding shall be an aluminum extrusion designed for the sign panel extrusion with which it is used and shall conform to ASTM B 221 for alloy 6063-T6 or alloy 6061-T6. The sign molding shall be of the same color as the sign face it accompanies.

4. **Connections:** U Clamp connections shall be fabricated from ASTM A 36 steel. The steel shall be galvanized in accordance with ASTM A 123. Fabrication shall be completed prior to galvanizing.

Z-bars and Angles used to mount sheet aluminum signs and Type IV delineators shall be aluminum alloy 6061-T6 (ASTM B 308).

Post clips for wide flange posts shall be aluminum alloy SG70A-T6 (ASTM B 108).

Bolts, nuts, and washers for mounting signs to aluminum backing hardware shall be aluminum, conforming to the following:

Bolts - alloy	2024-T4	(ASTM B 211)
Hex Nuts - alloy	6262-T9	(ASTM B 211)
Lock Nuts - alloy	2017-T4	(ASTM B 211)
Washers - alloy	2024-T4	(ASTM B 209)

Bolts and nuts used for attaching signs or sign backing hardware to wood posts shall conform to ASTM A 307. Bolts, nuts, and washers shall be galvanized in accordance with ASTM A 153.

B. Perforated Tube Posts and Flanged Channel Posts:

Post material shall meet impact performance (change in momentum) requirements for small sign supports contained in the current AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic signals."

Anchor plates for Perforated Tube Posts and Flanged Channel Posts shall be galvanized in accordance with ASTM A123, or painted with a dark green high quality enamel. The steel plates shall be trapezoidal in shape with bases of 6 and 12 inches (150 mm and 300 mm), a depth of 6 inches (150 mm), and shall be either 10 gauge, 1/8” (3 mm), or ¼” (6 mm) in thickness. The steel shall meet the requirements of ASTM A36 or ASTM A1011 Structural Steel grade 36. Bolt holes of 3/8” (9 mm) shall be provided centered on the plate with a spacing of 4 inches (100 mm).

1. **Perforated Tube Posts:** Perforated tube posts shall conform to ASTM A1011 Structural Steel Grade 50 (340).

Posts shall be a square tube formed of 12 gauge steel, 0.105 inch (2.67 mm) thick, rolled to size. The tubing shall be molded so the weld or flash does not interfere with telescoping. The posts shall be hot dipped galvanized with a 1.25 ounce per square foot (400 grams per square meter) coating conforming to ASTM A653. As an alternate, the post shall be given a triple coated protection by application of hot dip galvanized zinc conforming to ASTM A 53, followed by a chromate conversion coating and a polyurethane exterior coating, with inside surfaces given corrosion protection by in-line application of zinc base organic coating after fabrication.

The posts shall be punched, bored, or have knockouts with 7/16" (11.1 mm) diameter holes on one inch (25 mm) centers of all four sides for the entire length of the posts. The post sections shall be straight, with a smooth uniform finish and a minimum amount of play between telescoping sections. Holes and cutoff ends shall be free of burrs and ragged edges. Bolts, nuts, and washers shall conform to ASTM A 307 and shall be galvanized.

2. Flanged Channel Posts: Posts and bases shall be a flanged channel section fabricated from either hot rolled carbon steel bars or carbon steel bars and shapes produced from standard rail steel. The posts and bases shall meet the minimum physical properties of ASTM A499, Grade 60 (400) except that the minimum yield strength shall be 70,000 psi (480 MPa). The post shall meet chemical properties of ASTM A1 for rails 30 pounds per foot (44.64 kg/m) and heavier.

The weight of posts shall be as specified and shall be 2.00, 3.00, or 4.00 pounds per foot (2.98, 4.46, and 5.95 kilogram per meter) plus or minus 5.0 percent before punching. The posts and bases shall be painted with a high quality baked on dark green enamel. All punching, boring, cutting, or shearing shall be performed prior to painting. The posts shall be punched with continuous 3/8-inch (9.5 mm) diameter holes on one inch centers for the entire length of the post. The first hole shall be one inch from the top.

The post may consist of two parts, a sign post and a base post. The sign post lengths shall be supplied in one foot (300 mm) increments up to 20 feet (six meters). The base posts shall be 42 inches (1075 mm) in length and have at least 18 holes in the basepost, starting one inch (25 mm) from the top and continuing in one inch (25 mm) increments.

The posts shall be machine straightened and have a smooth uniform finish, free from defects affecting strength, durability, or appearance. The allowable tolerance for straightness shall be ¼ inch in 5 feet (6 mm in 1500 mm).

Drive caps for use with sledges shall be made of cast alloy steel conforming to AISI 4140 available in sizes as follows:

a. Drive caps for sign posts shall weigh 17 pounds (7.7 kg) and be formed to fit base posts of 2.0, 3.0, and 4.0 pounds per foot (2.98, 4.46, and 5.95 kg/m).

b. Drive caps for delineator posts shall 4 pounds (1.8 kg), and be formed to fit delineator posts of 1.12 pounds per foot (1.67 kg/m).

Retainer spacer strap material shall be steel as specified for use by the post manufacturer.

Bolts, nuts, washers, and spacers shall be cadmium plated in accordance with ASTM A 165 or zinc plated in accordance with ASTM B 633. The splice hardware shall consist of two fully threaded, 5/16 inch by 1-1/2 inch, grade 9, plated hex head bolts, with flat washers and hex nuts per post. In addition, two 3/4 inch by 3/4 inch by 3/8 inch (two 19.0 mm by 19.0 mm by 9.5 mm) plated spacers shall be used per post to stiffen the splice connection. Each spacer shall be drilled and tapped with 5/16 inch by 18 UNC threads. The spacer shall be fabricated from hot rolled carbon steel bars conforming to ASTM A 36 or AISI M 1020. A grade G flanged lock nut (5/16 inch, 18 thread) may be substituted for the lock washer and hex nut.

C. Steel Posts:

1. Structural steel posts and stiffeners shall conform to ASTM A 36. Pipe posts shall conform to ASTM A 53 Type E or S, Grade B, or ASTM A 501.

2. Steel posts (structural and pipe) and stiffeners shall be galvanized in accordance with ASTM A 123. Welding, punching, and boring of the steel posts shall be done before galvanizing.

3. Cantilever structural supports shall be fabricated steel in accordance with the following:

   a. Shapes, plates, bars, sheets, and strips equal to or over 0.23 inches thick shall conform to ASTM A709, Grade 36, Sheets and strips under 0.23 inches thick shall conform to ASTM A570 Grace 36.

   b. Pole and tubular members shall conform to ASTM A709 Grade 36 and Grade 50, A53 Grade B, A242, A570, or A595 Grade A or B. A595 material shall be limited to 3/8 inch maximum thickness. Structural support material with a thickness of 1/2 inch to 2 inches, shall satisfy Charpy V-Notch toughness test requirements of 15 ft. lbs at 40 degrees F. For material over 2 inches, contact the Office of Bridge Design for Charpy impact requirements.

4. High-strength bolts for structural steel joints, including nuts and washers, shall conform to ASTM A325 in accordance with Section 972.

D. Wood Posts: Wood posts shall be either West Coast Douglas Fir, Western Red Cedar or Western Larch. They shall be construction grade in compliance with the Standard Grading Rules of the Western Wood Products Association. Posts shall be surfaced four sides and full pressure treated in accordance with Section 950. When the posts are cut after treatment, the cuts shall be swabbed with two applications of hot preservative.

E. Fixed Base Assemblies:

1. **Base Plates:** Base plates shall conform to ASTM A36. The base plates shall be galvanized in accordance with ASTM A123. Welding, punching, and boring of the base plates shall be done before galvanizing.

2. **Anchor Bolts:** Anchor bolts and nuts shall conform to the requirements of ASTM A 307. Bolts, nuts, and washers shall be galvanized in accordance with ASTM A153.

F. Slip Base Assemblies:

1. **Base Plates and Friction Fuse Plates:** Base plates and friction fuse plates shall conform to ASTM A 36. The plates shall be galvanized in accordance with ASTM A 123. Welding, punching, and boring of the plates shall be done before galvanizing.

2. **Bolts, Nuts and Washers:** Bolts, hex nuts, and washers used in conjunction with base plates or friction fuse plates shall conform to ASTM A 325, except ½" and 5/8" bolts conforming to

ASTM A 449 are permissible instead of ASTM A 325. Bolts, hex nuts, and washers shall be covered with zinc coating (hot dip galvanized) per ASTM A 153.

3. **Shims:** Shims used in conjunction with base plates or friction fuse plates shall be covered with a zinc plating (electro-deposited zinc) as per ASTM B 633.

G. Reflective Sheeting:

1. **Grade:** The reflective sheeting shall be of high intensity (Type III or IV) conforming to AASHTO M 268 (ASTM D4956).

2. **General Characteristics:** The reflective sheeting shall be free from ragged edges, cracks, and extraneous materials. There shall be no more than four splices per 50 yard (45 meter) length. Splices shall be made by overlapping the sheeting a minimum of 3/16" (5 mm).

3. **Fabrication:** The background for signs shall be sheet reflective material applied to aluminum backing. The preparation of the aluminum surface and the sheeting application shall be in complete compliance with the recommendations of the manufacturer.

4. **Application:** Reflective sheeting shall be applied to properly prepared aluminum (degreased and etched or treated with a light, tight, amorphous chromate coating) with mechanical equipment in a manner prescribed by the sheeting manufacturer.

   Sign faces comprising two or more pieces or panels of reflective sheeting must be carefully matched for color during sign fabrication to provide uniform appearance and brilliance, day and night. Alternate, successive width sections of either sheeting or panels must be reversed and consecutive to insure that corresponding edges of reflective sheeting lie adjacent on the finished sign.

   Reflective sheeting for extruded aluminum sign panels shall be of the pressure sensitive type. Splicing of the sheeting will not be allowed except those splices permitted the sheeting manufacturer by Section 982.2 H.2. The sheeting shall be rolled over the edge of the extrusion ¼ inch (6 mm) to prevent an open surface on the finished sign face.

   Reflective sheeting for sheet aluminum signs shall be of the pressure sensitive or heat activated type. Splicing of the sheeting will not be allowed except those splices permitted the sheeting manufacturer by Section 982.2 H.2. Splices will not be permitted on signs which are screen processed with transparent color.

5. **Legend:** Message and borders shall be type, reflective material, and color specified. Nonremovable copy may be screen processed or direct applied.

   a. **Removable Copy:** (For use on extruded aluminum signs.) Letters, numerals, symbols, borders, and route markers shall be demountable, cut-out legend consisting of reflective sheeting applied to flat sheet aluminum backing. Letters, numerals, symbols, and borders shall be fabricated using a minimum of 0.032 inch (0.81 mm) thick aluminum sheet of 6061-T6 or 3003-H14 alloy. The aluminum shall be properly degreased and etched or

treated with a light, tight, amorphous chromate coating. Each letter, numeral, symbol, border, and route marker shall be supplied with 9/64-inch (3.57 mm) mounting holes at no greater spacing than eight inches (200 mm) on center and shall be secured to the sign surface with 1/8-inch (3.18 mm) aluminum blind rivets. The heads of the rivets shall be painted the color of the legend. The finished letters, numerals, symbols, borders, and route markers shall be clean cut, sharp, and have essentially a plane surface.

b. Nonremovable Copy: (For use on sheet aluminum signs.)

1) Screen Process: Message and borders shall be processed on reflective sheeting using mechanical equipment, materials, and operational methods and procedures as prescribed by the sheeting manufacturer. Processing shall be accomplished by the direct or reverse screen method using opaque or transparent processing material as required. Screening may be accomplished either before or after application of the sheeting to the base panels, conditional upon the method recommended by the sheeting manufacturer. Freehand painting will not be permitted on any part of the finished sign face.

2) Direct Applied: Cut-out message and borders shall be reflective sheeting or opaque lettering film applied directly to clean, dust free, reflective sheeting background. Message and borders shall be applied in accordance with the operational methods and procedure prescribed by the sheeting manufacturer. The finished letters, numerals, symbols, and borders shall be cut with smooth regular outline, free from ragged or torn edges.

Mounting holes will not be drilled or punched in any part of the nonremovable copy.

6. Color: The reflective sheeting shall meet the color specification limits and luminance factors listed in Tables 1-4 when tested in accordance with ASTM E1347 or ASTM E1349. Fluorescent retroreflective materials shall be tested in accordance with ASTM E991. The reflective sheeting shall maintain the colors and luminance factors provided in the appropriate tables throughout its service life.

Table 1

	Chromaticity Coordinates (corner points)
Color	

	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.430	0.390	0.518	0.434	0.570	0.382
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Blue	0.078	0.171	0.150	0.220	0.210	0.160	0.137	0.038

Daytime Color Specification Limits for Retroreflective Material With CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65.

Table 2

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.475	0.452	0.360	0.415	0.392	0.370	0.515	0.409
Red	0.650	0.348	0.620	0.348	0.712	0.255	0.735	0.265
Orange	0.595	0.405	0.565	0.405	0.613	0.355	0.643	0.355
Brown	0.595	0.405	0.540	0.405	0.570	0.365	0.643	0.355
Yellow	0.513	0.487	0.500	0.470	0.545	0.425	0.572	0.425
Green	0.007	0.570	0.200	0.500	0.322	0.590	0.193	0.782
Blue	0.033	0.370	0.180	0.370	0.230	0.240	0.091	0.133

Nighttime Color Specification Limits for Retroreflective Material With CIE 2° Standard Observer and Observation Angle of 0.33°, Entrance Angle of +5° and CIE Standard Illuminant A.

Table 3

	Chromaticity Coordinates (corner points)								Luminance Factor (Y %)	
	1		2		3		4			
Color	X	Y	X	Y	X	Y	X	Y	Min.	Max.
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	25	None
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442	45	None
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540	60	None
Fluorescent Green	0.210	0.770	0.232	0.656	0.320	0.590	0.320	0.675	20	30

Daytime Color Specification Limits and Luminance Factors for Fluorescent Retroreflective Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65.

Table 4

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
Fluorescent Orange	0.625	0.375	0.589	0.376	0.636	0.330	0.669	0.331
Fluorescent Yellow	0.554	0.445	0.526	0.437	0.569	0.394	0.610	0.390
FluorescentYellow-Green	0.480	0.520	0.473	0.490	0.523	0.440	0.550	0.449
Fluorescent Green	0.007	0.570	0.200	0.500	0.322	0.590	0.193	0.782

Table 4: Nighttime Color Specification Limits for Fluorescent Retroreflective Material With CIE 2° Standard Observer and Observation Angle of 0.33°, Entrance Angle of +5° and CIE Standard Illuminant A.

H. Concrete Footings: Concrete footings shall conform to the requirements of Section 462.

I. Delineators:

1. **Description:** Delineators shall be adhesive coated reflective sheeting permanently bonded to sheet aluminum backing.

   The aluminum shall be 6061-T6 (ASTM B 209) 0.063 inch (1.60 mm) thick sheet properly degreased and etched, or treated with a light, tight, amorphous chromate coating.

   Type I Object Marker shall consist of a yellow 18" x 18" (450 mm x 450 mm) reflector unit.

   Type II Object Marker shall consist of a 6" x 12" (150 mm x 300 mm) or size specified reflector unit.

   Type III Object Marker shall consist of a 12" x 36" (300 mm x 900 mm) reflector unit.

2. **Reflective Sheeting:** The reflective sheeting shall be either super high intensity or very high intensity. Super high intensity is defined as that which meets the standards of Type V, VII, or VIII as defined by AASHTO M268 (ASTM D4956). Very high intensity is defined as that which meets the standards of Type IX as defined by AASHTO M268 (ASTM D4956).

   In exception to the requirements stated above, the reflective sheeting shall maintain the colors provided in the appropriate tables contained in Section 982.2.G.6 throughout its service life.

3. **Fabrication:** The aluminum shall be 6061-T6 or 5052-H38 0.063 inch (1.60 mm) thick sheet conforming to ASTM B 209. The aluminum shall be properly degreased and etched or treated with a light, tight, amorphous chromate coating.

   The reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.

4. **Shape and Holes:** Delineators shall be punched or sheared to size with ¾ inch (20 mm) radius corners. Mounting holes shall be as follow:

a. The 4" x 4" (100 mm x 100 mm) delineators shall have two ¼" (6 mm) holes, four inches (100 mm) center to center on a diagonal line between opposite corners.

b. The 4" x 8" (100 mm x 200 mm) delineators shall have two ¼ inch (6 mm) holes, five inches (125 mm) center to center along the vertical axis.

5. General Requirements: The finished delineators shall be free of burrs, scratches, or damaged reflective sheeting and shall have essentially a plane surface.

6. Delineator Posts: Posts shall be flanged channel section fabricated from hot rolled carbon steel bars or carbon steel bars and shapes produced from standard rail steel. The posts shall meet the minimum physical properties of ASTM A499, except that the minimum yield strength shall be 70,000 psi (480 MPa). The posts shall meet the physical properties of ASTM A499 and the chemical properties of ASTM A1 for rails 30 pounds per foot (44.56 kilograms per meter) and heavier.

The posts shall be painted with a baked on high quality dark green enamel. All punching, boring, cutting, or shearing shall be done prior to painting. Prior to any punching or boring, the weight of the post shall be a minimum of 1.12 pounds per foot (1.67 kilograms per meter) with a tolerance of plus or minus five percent. The post length shall be as specified within a tolerance of plus or minus one inch (25 mm). The delineator post shall be punched or bored with thirty ? -inch (9.25 mm) diameter holes on 1.0 inch (25.4 mm) centers beginning 1.0 inch (25.4 mm) from the top of the post.

The bottom of the post shall be pointed for ease of installation. The posts shall be machine straightened and have a smooth uniform finish, free from defects affecting strength, durability, or appearance. The allowable tolerance for straightness shall be ¼ inch in 5 foot (6 mm in 1500 mm).