SECTION M.18
SIGNING

M.18.01--Overhead Sign Support:

1. Pipes and Flanges

A. Overhead Truss Supports

Pipes for end support posts shall conform to the requirements of ASTM A 53, Grade B. Pipes for all overhead truss members and end support web members shall conform to the requirements of ASTM A 53, Grade B.

68 kg and 136 kg ASA Flanges for truss chord splices shall be lap joint type and shall conform to the requirements of ASTM A 181, Grade II. 182 kg ASA lap joint flanges for truss chord splices shall conform to the requirements of ASTM A 105, including the Supplementary Chemical Requirements of Table 1 and the Mechanical Properties of Table 2, of ASTM A 105.

B. Overhead Cantilever Supports

Pipes for posts, truss chords and truss web members shall conform to the requirements of ASTM A 53, Grade B.

Flanges for splices between outer and inner sections of truss chords shall be 68 kg ASA Flanges, lap joint type, and shall conform to the requirements of ASTM A 181, Grade II. Special flanges and attached plates for truss chord to post attachment shall conform to the requirements of ASTM A 588.

2. Stainless Steel plates shall conform to the requirements of ASTM A 240, Type 304.

3. Base plates and attached stiffener plates shall conform to the requirements of ASTM A 588.

4. All other elements except bolts and nuts shall conform to the requirements of ASTM A 36.

5. After complete fabrication, each of the fabricated steel sections of all sign supports shall be hot-dip galvanized in accordance with the requirements of ASTM A 123.

6. Nuts for anchor bolts shall conform to the requirements of ASTM A 563, Grade DH, self locking type. Washers for anchor bolts shall conform to the chemical requirements of ASTM A 325, Type 1, and shall be quenched and tempered. Nuts and washers for anchor bolts shall be hot-dip galvanized in accordance with the requirements of ASTM A 153, Class C. Nuts for anchor bolts shall be tapped oversize, after galvanizing, in accordance with ASTM A 563, Section 5.3, and shall be provided with a lubricant in accordance with the requirements of ASTM A 325.

High-Strength bolts, nuts and washers shall conform to the requirements of ASTM A 325, and shall be hot-dip galvanized in accordance with the requirements of ASTM A 153, Class C.

All nuts for high strength bolted connections including nuts for anchor bolts shall be "prevailing torque-reusable type" locking nuts.

7. All U-Bolts shall conform to the requirements of ASTM A 36 and shall be hot-dip galvanized in accordance with the requirements of ASTM A 153.

8. Square head bolts for supporting electrical equipment shall conform to the requirements of ASTM A 307.

9. Stainless Steel bolts shall conform to the requirements of ASTM A 193, Class 1, Grade B8. Stainless steel nuts shall conform to the requirements of ASTM A 194, Grade 8. Stainless steel lock washers shall conform to the requirements of ASTM A 167, Type 302.

M.18.02--Anchor Bolts:

Anchor bolts shall conform to the requirements of ASTM A 449.

Leveling nuts and nuts for anchor bolt assemblies shall conform to the requirements of ASTM A 563, Grade DH. Leveling nuts and anchor bolt assemblies shall be hot-dip galvanized in accordance with the requirements of ASTM A 153, Class C. Leveling nuts shall be tapped oversize, after galvanizing, in accordance with ASTM A 563, Section 5.3, and shall be provided with a lubricant in accordance with the requirements of ASTM A 325.

The Pedestal grout leveling template shall conform to the requirements of ASTM A 36 and shall be a minimum of 12.5 mm in thickness.

M.18.03--Vacant

M.18.04--Vacant

M.18.05--Vacant

M.18.06--Vacant

M.18.07--Delineators

1. Reflectors: The reflectors used in the delineator units shall have a reflective area, herein referred to as the lens, and a heat sealable plastic coated metallic foil back fused to the lens under heat and pressure around the entire perimeter of the lens to form a unit permanently sealed against dust, water and water vapor. The back and edge of the plastic shall be enclosed in an aluminum housing with a grommeted center mounting hole. Reflectors shall be either silver-white, amber or red as required.

The reflective lens shall be methyl methacrylate conforming to the requirements of FS L-P380B, 1968.

The lens shall consist of a smooth front surface free from projections or indentations other than a central mounting hole and identification with a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

a. Testing:

Definitions:

Entrance Angle shall mean the angle at reflector between direction of light incident on it and direction of reflector axis.

Observation Angle shall mean the angle at reflector between observer's line of sight and direction of light incident on reflector.

Specific Brightness shall mean candela returned at the chosen observation angle by a reflector per square millimeter of reflecting surface for each lux of illumination at the reflector.

Optical Testing Procedure--The reflector shall be tested at observation angle station 1/10? and at entrance angle degrees 0? and 20? on the Esna Reflex Photometer at the photometric distance of 3 m.

The specific intensity of each reflex reflector intended for use in delineators shall be equal to or exceed the following minimum values with measurements made with reflectors spinning.

OBSERVATION ANGLE DEGREE	ENTRANCE ANGLE DEGREE	SPECIFIC INTENSITY CANDELA PER LUX		
		SILVER-WHITE	AMBER	RED
1/10?	0?	11	6.6	2.7
1/10?	20?	4.4	2.6	1.0

Seal Test--Samples shall be submerged in a water bath at the room temperature. The submerged samples shall be subjected to a vacuum of 127 mm of Hg for 5 minutes. The submerged samples shall then be restored to atmospheric pressure and remain submerged for 5 minutes more. The samples shall then show no water intake upon examination.

2. Metal Delineator Posts:

The "Standard Metal Delineator Posts" having a mass of approximately 1.7 kg per meter shall be made of structural steel conforming to the requirements of ASTM A 36. The posts shall conform to the dimensions shown on the plans. After delineator mounting holes have been made, the posts shall be galvanized in accordance with ASTM A 123.

3. Bridge Rail Mounting Brackets:

The bracket shall be made of 3.2 mm Aluminum Alloy 6061-T6 fabricated to the dimensions shown on the plans and shall be fastened to the metal bridge rail with two 10 mm diameter X 16 mm long cadmium plated steel box head self-tapping screws. Fasteners shall conform to the requirements indicated on the plans.

M.18.08--Paint for Sign Panel Overlay: The paint to be used for the finished coat shall be an extremely durable, highest quality, semi-gloss green enamel for use on plywood and metal highway signs and shall be resistant to air, sun and water.

It shall consist of pigments of the required fineness and composition ground in the required vehicle by a suitable grinding machine to the required fineness. All pigments, resins, oils, thinners and driers used shall be of the best quality, free from adulterants of any kind, and shall comply with the requirements below.

	Min.	**Max.**
Enamel Composition		
Pigment, %	40	—
Vehicle, %	—	60
Volatile matter in vehicle, % by mass	—	55
Coarse particles and skins retained on 45 µm screen, based on pigment, %	—	0.5
Viscosity, Krebs units at 25 ^{o}C	65	75
Mass per liter, kg	1.3	—
Fineness of grind (North Standard)	5	—
Pigment Composition		
Chrome green, %	57	—
Extender pigment, %	—	43

The chrome green shall be Imperial A 4464 Velvet Green or approved equal.

The extender pigments shall consist of any one of the following or combination thereof: magnesium silicate, barium sulfate, or diatomaceous silica. A ratio of 50 percent magnesium silicate and 50 percent diatomaceous silica has been found to produce the desired semi-gloss.

Vehicle--The vehicle shall contain not less than 45 percent solids by mass and shall be composed of a long oil soya modified alkyd resin solution or solutions, petroleum solvent thinners and driers. Rosin or rosin derivatives shall not be present. The alkyd resin solution or solutions shall conform to FS TT-R-266, Type I, Class A of latest issue.

Specular Gloss--The enamel shall be flowed on a tin panel and allowed to dry for 24 hours before measuring. The specular gloss at 60? angle of incident, ASTM D-523 shall be between 35 and 45.

Color--Standard color chips may be obtained from the Connecticut Department of Transportation Testing Laboratory, 280 West Street, Rocky Hill, Connecticut.

Setting and Drying Time--This enamel shall set to touch in less than 5 hours. It shall dry hard and tough in not more than 24 hours.

Flash Point--Not below 30? C when determined by the Pensky-Martin Closed Flash Tester.

Water Resistance--The enamel shall be flowed on a tin panel and allowed to dry for 48 hours. After being immersed for 18 hours in distilled water, it shall show no blistering or wrinkles upon removal and shall show no dulling or change in color after two hours recovery.

Skinning--This enamel shall not skin over within 48 hours in a three-quarters filled, closed container. Small amounts of antiskinning agents, wetting agents, suspension agents, and anti-drier absorption agents may be added at the discretion of the manufacturer.

Working Properties--The enamel shall be well ground, shall not settle in the container, and shall be capable of being broken up with a paddle to a smooth uniform enamel of good brushing consistency, and shall have good flowing, covering and leveling properties.

M.18.09.01--Reflective Sheeting: Reflective sheeting materials shall appear on the Department's Approved Product List for the application intended.

M.18.09.02--Reflective Sheeting: Bright Wide Angle Retroreflective

1. **Description:** The retroreflective sheeting shall have a smooth surface with a distinctive interlocking diamond seal pattern and datum orientation marks visible from the face. The sheeting shall be precoated with a pressure sensitive adhesive backing protected by a removable liner. Bright wide angle retroreflective sheeting material shall appear on the Department's Approved Products List for the application intended.

2. **General Characteristics and Packaging**: The retroreflective sheeting as supplied shall be of good appearance, free from ragged edges, cracks and extraneous materials, and shall be furnished in either rolls or sheets.

   When furnished in continuous rolls, the average number of splices shall not be more than 3 per 50 meters of material with a maximum of 4 pieces in any 50 meter length. Splices shall be butted or overlapped and shall be suitable for continuous application as furnished. When furnished as cut sheets or sign faces, the sheeting shall be packaged flat in accordance with commercially accepted standards. The sheeting shall be packed in accordance with commercially accepted standards. Each carton shall clearly stipulate the brand, quantity, size, lot or run number and color. Stored under normal conditions the retroreflective sheeting as furnished shall be suitable for use for a minimum period of one year.

M.18.10--Demountable Copy: The materials for this work shall conform to the following:

1--Reflex Reflector:

Demountable copy consisting of plastic reflectors mounted in embossed aluminum frames shall be used where shown on the plans. All letters, symbols, and borders shall be demountable copy of the size and design conforming to the Manual of Signs and Pavement Marking of the National System of Interstate and Defense Highways.

Demountable copy with plastic reflex-reflectors shall consist of reflectors securely supported by individual embossed metal frames. The metal frames shall be fabricated of no thinner than 1 mm sheet aluminum for copy and 0.8 mm aluminum for border. Both shall be thoroughly cleaned after fabrication and treated for protection against corrosion. The frame shall be neatly finished in a workmanlike manner and shall have embossed edges.

Frames shall be painted with three coats of white baking enamel. Metal part of the letters, digits, symbols, and borders shall withstand 50 hours of salt spray in accordance with the requirements of ASTM B117 with no evidence of rusting or pin holing. The frames shall be fastened to the panel background with aluminum rivets. Rivets shall be of the pull through type and of the size and number designated by the demountable copy manufacturer. Wherever a directional arrow is to be installed on a sign, the arrow shall be installed in the field.

The round reflectors shall consist of a clear, transparent face, hereinafter called the lens and a plastic back of identical material fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit permanently sealed against dust, water, or water vapor. Reflector units assembled with gaskets will not be acceptable.

Seal Test--Samples shall be submerged in a water bath at room temperature. The submerged samples shall be subjected to a vacuum of 127 mm of Hg for 5 minutes. The submerged samples shall then be restored to atmospheric pressure and remain submerged for 5 minutes more. The samples shall then show no water intake upon examination.

The lens shall consist of a smooth front surface free from projections or indentations other than for identification and a rear surface having a configuration that will effect internal reflection of light without the aid of plating or separate reflector.

The specific brightness of reflex or reflex reflectors shall be equal to or exceed the following minimum values when measurements are made with the reflectors spinning.

Entrance Angle Degrees	**Observation Angle Degrees**	**Specific Brightness Candela power (mm^2) Lux**
0^o	$1/10^o$	14.0
20^o	$1/10^o$	5.6

For the purpose of testing optical performance, as designated herein, the following definitions are established:

Entrance Angle-Angle at the reflector between direction of light incident on it and direction of reflector axis.

Observation Angle-Angle at the reflector between observer's line of sight and direction of light incident on reflector.

Specific Brightness-Candela returned at the chosen observation angle, per square millimeter of reflecting surface for each lux of illumination, at the reflector.

Optical Testing Procedure--The reflector shall be tested at observation angle station 1/10? and at entrance angle degrees 0? and 20? on the Esna Reflex Photometer at a photometric distance of 3 m.

2--Type III Reflective Sheeting:

Demountable cutout letters, digits, border, corner radii and copy accessories shall consist of adhesive coated reflective sheeting permanently adhered to flat aluminum backing. The reflective sheeting shall conform to Section M.18.09.01.

The design of letters and accessories shall conform to FHWA Standards for use on National System of Interstate and Defense Highways.

Aluminum backing shall be a minimum of 0.8 mm thick aluminum sheet of 3003-H14 alloy. Aluminum sheeting shall be properly treated according to sheeting manufacturer's specifications.

The demountable copy shall be fastened to the sign panel with aluminum rivets. Rivets shall be of the pull through type and of the size and number designated by the demountable copy manufacturer.

3--Non-Reflective Plastic Sheeting:

Description: Demountable cutout letters, digits, border, corner radii and copy accessories shall consist of adhesive-coated, non-reflective plastic sheeting permanently adhered to flat aluminum backing.

The material shall consist of a flexible, pigmented, plastic film completely precoated with a solvent or heat-activated, tack-free adhesive. The adhesive shall be protected by a treated paper liner which shall be removable without soaking in water or other solvents. The non-reflective plastic sheeting shall conform to the following:

Property Requirements:

A. Thickness: The thickness of the plastic film with adhesive shall be a minimum of 76 µm and a maximum of 114 µm.

B. Film: The unapplied or applied film shall be readily processed with, and insure adequate adhesion of, process inks recommended by the manufacturer.

1. Flexibility: The material shall be sufficiently flexible to permit application over and conform to moderately contoured surfaces.

2. Gloss: The film shall have an initial 60-degree gloss value of 35 (minimum), when tested in accordance with ASTM D 523, measuring at least three portions of the film to obtain uniformity.

C. Adhesive: The precoated adhesive shall form a durable bond to smooth, clean, corrosion and weather-resistant surfaces, shall be of uniform thickness, non-corrosive to applied surfaces and shall have no staining affect on the film.

D. Adhesion: The material, applied according to Paragraph I "Preparation of Test Panels" shall have sufficient bond to prevent removal from the panel in one piece without the aid of a physical tool.

E. Exterior Exposure: The material shall withstand three years' vertical, south-facing exterior exposure at a sight acceptable to the Engineer, showing no appreciable discoloration, cracking, crazing, blistering, delamination, or loss of adhesion. A slight amount of chalking is permissible.

The film shall not support fungus growth.

F. Dimensional Stability: The material shall show no more than 397 µm shrinkage in any direction from edge of the panel when prepared in accordance with Paragraph I after being subjected to a temperature of 65 ?C for 48 hours.

G. Heat Resistance: The material, applied according to Paragraph I, shall be heat-resistant enough to retain adhesion after one week at 65 ?C.

H. Solvent and Chemical Resistance: The material, when prepared in accordance with Paragraph I, shall withstand immersion in the following liquids at 21-32 ?C, showing no appreciable decrease in adhesion, color or general appearance.

Liquids	Time/Hours
Reference Fuel (MIL-F-8799A) (15 parts xylol - 85 parts mineral spirits by mass)	1
Distilled Water	24
SAE #20 Motor Oil	24

I. Opacity: When applied, the material shall be sufficiently opaque to hide a contrasting black printed legend and white surface.

J. Preparation of Test Panels : Test panels shall be prepared using a 165 mm x 165 mm piece of the plastic film, applied to a clean 150 mm x 150 mm aluminum panel, premasked or as recommended by the manufacturer, trimmed evenly at the edge of the panel, and aged for 48 hours at 21-32 ?C.

K. Shelf-Life Storage: The material shall withstand one year's shelf life when stored in a clean area free from exposure to excessive heat, moisture and direct sunlight.

L. General Characteristics and Packaging: The plastic film shall be furnished in rolls, cut sheets or characters, as may be specified. The film, as supplied, shall be free from ragged edges, streaks, blisters, foreign matter or other surface imperfections which would make it unsuitable for the intended usage, and shall be readily cut with scissors, knife, blade, shears or other production tools. Complete and detailed instructions for mounting the plastic film shall be supplied with each package of material.

M. Quality Assurance: For the non-reflective plastic sheeting a Certified Test Report conforming to 1.06.07 shall be submitted.

M.18.11--Sign Panels -Extruded Aluminum:

Sign panels (extruded aluminum) shall be of the butt type, alloy 6063-T6 ASTM B221. Several extruded sections shall be joined with panel nuts, bolts, and washers to achieve the desired sign size. The extruded aluminum panels shall be of 150 mm and 300 mm heights to achieve sign panel vertical dimensions in increments of 150 mm, however, no more than one 150 mm panel shall be used on any one sign. The mass and section properties of the 150 mm and 300 mm extruded panels shall be as indicated on the plans.

On the vertical axis (the 150 mm or 300 mm dimension), the panel face shall be in the same plane within 0.4 mm in any 150 mm. Extruded sections shall be mounted horizontally, and the panel faces shall be flush after the erection of the sign is complete.

Cleaning: Extruded aluminum sign panels shall be thoroughly cleaned and degreased by total immersion in an alkaline solution which is controlled and titrated to the solution manufacturer's recommendations. Immersion time shall be sufficient to completely remove all grease, dirt or other contaminants. After cleaning, the panels shall be thoroughly rinsed with clear running water.

Pretreatment: Sign panels shall be treated with a light, tightly adherent chromate conversion coating, free of any powdery residue, ranging in color from a silvery iridescent to a pale yellow, conforming with ASTM B449, Class 2, 108-377 mg/m^2, with 269 mg/m^2 as the optimum coating weight.

M.18.12--Panel Bolt Assemblies and Post Clip Assemblies:

Panel Bolt Assembly: Aluminum hex head bolt, hex nut and washer shall be as shown on the plans and shall be used to unite several panels sections to conform to the designed sign size. Nuts shall be drawn tight. Bolt holes may be drilled or blanked to finished size.

Thread fit for bolts shall conform to class 2-A fit of American Standard Association.

Post Clip Assembly: Aluminum post clips square head bolt, lock nut and washer shall be as shown on the plans.

The shank of the post clip bolts shall fit tightly against the sign support flange after nuts have been tightened. The clip bolts shall be torqued to 25.4 N·m when using dry, clean, unlubricated threads.

M.18.13--Sign Face--Sheet Aluminum: Sheet aluminum sign blanks shall be constructed of sheet aluminum, alloy 6061-T6 or alloy 5052-H38. Sheet aluminum sign blanks shall conform to ASTM B209. They shall be degreased and etched in accordance with the recommendations of the sheeting manufacturer or treated with a light, tightly adherent chromate conversion coating, free of any powdery residue, ranging in color from silvery iridescent to a pale yellow, conforming to ASTM B449, Class 2 (108-377 mg/m^2) with 269 mg/m^2 as the optimum coating. The thickness shall be as specified on the plans.

M.18.14--Metal Sign Posts: Metal sign posts, square tubular supports and parapet mounted sign supports shall conform to the requirements as noted on the plans. The size, shape and mass of posts and supports shall be as specified in the plans.

After fabrication of the posts and supports, including hole punching or drilling, they shall be galvanized as noted on the plans.

M.18.15--Sign Mounting Bolts: Bolts used for sign mounting shall be of aluminum alloy 2024-T4. Self-locking nuts shall be of aluminum alloy 2011-T3, 2014-T4 or 2017-T4. Aluminum alloys shall conform to the requirements of ASTM B211.