SECTION 996
PORCELAIN ENAMEL LAMINATED ALUMINUM PANEL SIGNS

996-1 Description.

This Section specifies the requirements for highway signs fabricated of porcelain enamel laminated aluminum panels, and includes the requirements for the porcelain enameling of the sign panels as well as the overall fabrication of the completed signs (consisting of single or multiple panels).

996-2 Porcelain Enameled Panels.

996-2.1 Basic Components: The porcelain-enamel laminated aluminum sign panels shall be fabricated of sheet aluminum, laminated to a honeycomb core and sealed completely around the perimeter with an extruded aluminum frame, to form a panel of the width, length and depth required, to the face of which porcelain enamel is fused; all in accordance with the requirements specified herein and the details shown in the plans.

996-2.2 Face Sheet: The face sheet of the panel shall be fabricated in one piece, from a 0.063 inch [1.6 mm] thick sheet of aluminum alloy 6061-H11, with an alloy 1100 cladding.

996-2.3 Back Sheet: The back sheet of the panel shall be fabricated in one piece, from a 0.040 inch [1.0 mm] thick sheet of aluminum alloy 3003-H14, conforming to ASTM B 209. The surface shall be treated with an amorphous chromate conversion coating, conforming to the requirements of MIL Specification C-5541.

996-2.4 Core Material: The core material shall be fungus-resistant phenolic impregnated paper honeycomb, of a thickness of 1 inch [25 mm]. The cell size shall be 1/2 inch [13 mm]. The weight of the paper shall be 80-pound [36.3 kg] and the impregnation shall be at least 18%, by weight.

996-2.5 Laminating Adhesive: The laminating adhesive shall be of the thermo-setting type and such as will produce a permanent oil and water-resistant bond. The manufacturer shall furnish certified copies of test reports showing that the laminating adhesive meets the above requirements and showing the results of tests thereon, made in accordance with ASTM E 72 and ASTM E 273.

996-2.6 Aluminum Perimeter Frame: Each panel section shall be provided with an extruded-aluminum perimeter frame, of channel section, the material of which shall be of Alloy 6063-T6. The top and bottom frame members shall have an integral retainer track for affixing mounting bolts to provide for blind fastening of sign panel to post support. (When vertical panels are used on signs having a horizontal finished dimension exceeding 24 feet [7.3 m], the vertical frame members shall have this integral retainer track for mounting bolts.)

An additional slot shall be milled in the top and bottom frame members, for later field insertion of post clip bolts.

The perimeter frame shall be assembled by means of self-trapping, hex head, stainless steel screws. A sealant shall be used at the corner to prevent moisture penetration.

Weep holes, 1/8 inch [3 mm] in diameter, shall be drilled in the perimeter frame, at the bottom of each panel, located approximately 3 inches [75 mm] in from either end and in the center of the panel.

996-2.7 Rivets: Rivets used to fasten panel parts shall be 1/8 inch [3 mm] self-plugging, aluminum break-stem type rivets. Rivets appearing directly on the sign background shall be of the same general color as the background.

One rivet shall be used at each corner on the face of the panel, to fasten the sheet to the perimeter panel.

The rivets used to fasten the copy to the panel shall also have a shoulder, approximately 0.150 inch [4 mm] long, to prevent crushing the copy when fastened. The holes shall not be drilled in the sign face until the Engineer has approved the layout of the legend and border on the sign face. The holes

shall be of the manufacturer's recommended diameter and shall be drilled with high-speed drills, at the locations corresponding to the mounting holes in the legend and border.

996-3 Preparation of Panels.

996-3.1 Engineer's Access to Plant: The Engineer shall have ready access to all parts of the mill and shop during the manufacture, enameling process and fabrication of the signs, to assure that the controls provided by the manufacturer are adequate to assure proper workmanship throughout manufacture and fabrication.

996-3.2 Bonding of Panels: Prior to the laminating, the face panels shall be cleaned, in tanks of sufficient size to accommodate the complete panel.

Bonding of panels shall be done in a heated flat platten press, of sufficient size to handle the entire panel at one time and with the capacity for applying a pressure of 10 psi [70 kPa] over the entire platten area.

996-3.3 Specific Requirements of the Fabricated Panels:

996-3.3.1 Strength of Honeycomb Laminate Construction: The tensile strength of the honeycomb laminate construction (composed of the materials specified in 996-2.3) shall be at least 50 psi [345 kPa], when tested in accordance with ASTM C 297 and ASTM C 481.

996-3.3.2 Surface Tolerance of Finished Panel: Each porcelain enamel panel shall be true in flatness within 1/4 inch [6.5 mm] tolerance on any 8 foot [2.5 m] length. Across the face of the panel the deviation shall not exceed 0.004 in/in [0.1 mm/25 mm] width of panel face.

996-3.4 Manufacturer's Identification: The manufacturer of the porcelain enamel panels shall apply on the back of each panel the date of the manufacture and an imprint identifying the porcelain enamel surface as being his manufacture.

996-3.5 Basis of Acceptance of Panels: Acceptance of individual panels will be based on certified test results, or other certification, furnished by the manufacturer or fabricator to the Department's State Materials Engineer, indicating that all materials used in the laminated panels and all specified fabrication details meet the requirements specified.

996-4 Process of Enameling.

996-4.1 Porcelain Enamel: The porcelain enamel shall conform to the requirements of the Specification of the Porcelain Enamel Institute, No. PEI:ALS-105 (titled "Tentative Specifications for Porcelain Enamel on Aluminum as Used for Signs and Architectural Application.")

996-4.2 Preparation of Aluminum Panels: Before the porcelain enameling process is started the aluminum sheets shall be subjected to a suitable pretreatment preparation, as described in the Porcelain Enamel Institute Bulletin AL-2A, 4th Edition (Section 11), or by other approved preparation.

996-4.3 Container and Temperature: The porcelain enameling shall be performed in a "Continous" Furnace, at a temperature not exceeding the critical temperature of the metal and only such as is necessary for the forming of an adherent vitreous state.

996-4.4 Finish Requirements:

996-4.4.1 Thickness of Enamel: The thickness of the porcelain enamel shall be not less than 0.002 inch [0.05 mm].

996-4.4.2 Strength of Panels After Enameling: The panels, after enameling, shall have a minimum yield strength of 12,000 psi [83 MPa]. (If it is apparent, however, that the enameling process materially alters the temper of the aluminum panels, such that the minimum yield point of the material is below this 12,000 psi [83 MPa] minimum, then the panels may be artificially aged or processed such as to raise the yield point to this required minimum. The process used, however, shall not be such as may be detrimental to any other requirements of the specifications.)

996-4.4.3 Finish Color and Gloss: The finish color of the porcelain enamel shall be uniform within the following tri-stimulus coefficients (developed in accordance with National Bureau of Standard Procedures C 429).

Value	Green	Blue	Yellow
x	0.25 ± 0.02	0.17± 0.02	0.50 ± 0.02
y	0.39 ± 0.03	0.17 ± 0.03	0.46 ± 0.03
y	0.06 - 0.10	0.05 - 0.08	0.42 - 0.49

An additional tolerance of ±0.01 is allowed for each value for differences between laboratories. The photometer shall be calibrated by standards near that of the color measured such as the NBS Standard tiles or the FHWA Color Tolerance Charts.

(Prior to manufacture and fabrication of the signs, 12 by 12 inch [300 by 300 mm] panel samples of the proposed finished color shall be submitted to the Engineer for approval.)

For the green and the blue colors, the finished porcelain enamel shall have a gloss reading of 50 to 70 units, at an angle of 45 degrees, when measured as described in ASTM C 346. For the yellow, such gloss reading shall be 70 to 90.

996-4.4.4 Adherence: The finished porcelain enamel shall meet the requirements specified in PEI Bulletin No. ASI: 105, with the following additional provisions:

The test shall be performed on samples of 3 by 12 inch [75 by 300 mm] size, processed with production run. Test samples shall be run every 1,000 ft^2 [90 m^2] of production cycle, or total of order; whichever occurs first.

(No production pieces having undergone spall testing shall be used in the contract work.)

996-4.4.5 Acid Resistance: When tested by the "Boiling 6% - Citric Acid Test," as described in ASTM C 283, (Standard Method of Test for Resistance of Porcelain enamel to Boiling Acid) the weight loss of the porcelain enamel shall be less than 20 mg/psi [0.031 mg/mm^2].

996-4.4.6 Finished Workmanship: The porcelain enamel on all surfaces which will be exposed to weathering shall be free of blemishes which might subsequently impair the serviceability, or will detract from the general appearance and the color-matching of the sign as may be perceptible from a distance of up to 25 feet [7.5 m].

996-5 Fabrication of Overall Sign.

996-5.1 Mounting of Panels onto Overall Sign: Where the horizontal width of a multi-panel sign does not exceed 24 feet [7.3 m] the panels shall be mounted horizontally. For widths exceeding 24 feet [7.3 m], the panels may be mounted either horizontally or vertically.

Panel dimensions shall be such that a minimum number of panels will be required for the overall sign (based on the concept of horizontal panels, in conjunction with the lines on copy, such that all copy will appear on each individual panel, with a minimum extent of copy crossover).

996-5.2 Jointing Multiple Panels: The face and edges of the panels, along the juncture between panels, shall be milled to a tolerance of ±1/32 inch [±0.8 mm] from a straight plane, such that when the two adjoining panels are assembled no gap over 1/16 inch [1.5 mm] between the panels will be discernible.

In order to obtain edge uniformity, panels may be milled up to 1/4 inch [6 mm], on each side.

996-5.3 Seam Closure: On multi-panel signs, aluminum seam-closure extrusions (as shown on the plans) shall be provided by the manufacturer. The seam-closure extrusions shall be set-in 3 inches [75 mm] from the edge of the panels, to provide clearance for rivets and frame.

996-5.4 Tolerances in Perimeter of Finished Sign: On the perimeter of the finished sign, a 1/8 inch [3 mm] tolerance from flush, between the sheets and the frame, will be allowed and all edges shall be straight within 1/8 inch [3 mm] from a straight plane.

All sharp edges which might present a hazard in handling shall be smoothed.

996-5.5 Sectional Fabrication: Signs which are too large to be shipped as a single unit may be sectionalized as approved by the Engineer. These signs shall be completely shop-assembled and, if a field

joining of panels is permitted, legend and border units which overlap the joining shall be removed and replaced in the field.