Section 908. MISCELLANEOUS METAL PRODUCTS

908.01 General Requirements. These materials shall be manufactured and fabricated according to the plans and these specifications.

908.02 Testing. Material testing will be done according to applicable AASHTO, ASTM or Department methods.

908.03 Malleable Iron Castings. Conform to ASTM A 47, Grade No. 22010.

908.04 Steel Castings. Castings used in steel construction shall be of steel, unless cast iron or other material is specifically called for or authorized in writing. Castings shall conform to the requirements for carbon steel castings of AASHTO M 192, Class 60 or 90, as specified on the plans. All steel castings shall be heat treated by full annealing, unless otherwise provided. Blow holes appearing upon finished castings shall be located so that a straight line laid in any direction will not cut a total length of cavity greater than 1 inch in any 12 inches. Single blow holes shall not exceed 0.500 square inches in area. Blow holes shall not have a depth that will affect the strength of the casting.

908.05 Gray Iron Castings. Meet the requirements for AASHTO M 105, Class 35B. The weights of the castings shall not be less than those shown on the plans. All exposed surfaces of castings shall be completely coated with asphaltic paint. The coating shall be smooth and shall be tough and tenacious when cold, and shall not be tacky or brittle, nor have any tendency to scale off. Castings used for manholes, catch basins, leaching basins, and inlets shall be Class 35B gray iron castings. Cast iron steps and bridge deck drains shall be Class 35B.

908.06 Bronze or Copper-Alloys for Structures. Washers and bearing and expansion plates for bridges shall meet the requirements for bronze castings of ASTM B 22, Copper Alloy UNS No. C91100 or the requirements for copper-alloy plates and sheets of ASTM B 100, Copper Alloy UNS No. C51000. Bronze castings shall be free from foreign material, casting faults, injurious blow holes, and other defects. Finished parts shall have the dimensions shown on the plans within a tolerance of plus or minus 5 percent on thickness and plus or minus 0.125 inch on width or length. For mating curved surfaces, the radius of curvature shall be as specified, with a tolerance of plus 0.010 inch and minus 0.000 inch on concave surfaces, and plus 0.000 inch and minus 0.010 inch on convex surfaces. Flat machined surfaces shall meet specified dimensions with a tolerance of plus or minus 0.0005 inch per inch.

Surface roughness of bronze or steel shall not exceed 125 microinches per inch, root mean square (rms).

908.07 Sheet Lead. Conform to the requirements for desilverized pig lead of ASTM B 29.

908.08 Sheet Copper. Conform to ASTM B 370.

908.09 Cast Aluminum Alloy Posts. Cast aluminum alloy posts for aluminum bridge railing shall meet AASHTO M 193.

The manufacturer shall furnish the Department with a certified inspection report indicating that all the castings conform to the requirements of these specifications and the details shown on the plans.

908.10 Tubing, Steel Railings.

A. **Base Plate, Angle, and Post Elements.** Base plate, angle, rail splice elements, and post elements shall meet the requirements of ASTM A 36 and shall be galvanized according to ASTM A 123. The silicon content shall be less than 0.06 percent or between 0.15 percent and 0.25 percent. The base plate and post elements shall meet the Charpy V-Notch requirements as specified in subsection 906.04 at a test temperature of 10 °F.

B. **Rail Elements.** Rail elements shall conform to ASTM A 500, Grade B, as modified herein and shall be galvanized according to ASTM A 123. The silicon content shall be less than 0.06 percent or between 0.15 percent and 0.25 percent. Rail elements from all heats supplied will be tested according to ASTM E 436, Standard Test Method for Drop-Weight Tear Tests of Ferritic Steels, except as modified herein. Drop weight tear testing is not required on TS 2 by 2 rail elements. The Department will take rail test samples at the rail supplier and test prior to delivery of the rail to the Contractor. All heats of rail supplied to a project must be tested. Failed heats shall not be supplied to the fabricator, and no heat treatment will be permitted on failed heats.

   Tests will be done after all galvanizing and associated operations have been performed on the test samples. Tensile, yield, and elongation properties will be tested on approximately one out of five heats, selected randomly, by testing the galvanized specimen. If elongation results are not acceptable, a single, ungalvanized specimen shall be sampled and tested for elongation. The drop weight tear test will be conducted on each heat at a temperature of 0 °F on 2 inch by 9 inch specimens supported to achieve a 7-inch span. Galvanizing shall not be removed from specimens.

   The percent shear area will be determined by testing 9 specimens, 3 from each of 3 sides not containing a weld. The shear areas of the 3 specimens from the side with the lowest average shear area will be disregarded, and the final average based on the remaining 6 specimens. If the average percent shear falls below 50, the material represented by these tests will be rejected. However, if the average shear area is between 30 and 50, one retest will be permitted. A sampling frequency 3 times that of the first test and with no samples excluded in calculating the average will be used. Material not having a minimum average percent shear area of 50 upon retest will be rejected.

   To facilitate acceptance or rejection of material, the manufacturer of the structural shape shall, before galvanizing, identify the product with the steel heat number, or some number that is traceable to the heat number, and the manufacturer's own unique identification code. The identification shall be on only one face of the section, shall be no more than 4 feet apart, and shall not extend into the curved surface at the corners. The face marked shall not be the traffic face or its opposite.

C. **Hardware.** Railing anchor studs shall meet ASTM A 449; heavy hex nuts shall meet AASHTO M 291, Class 10S. Bolts used as rail fasteners, washers and nuts shall be AASHTO M 164, Type 1. Where round head bolts are called for, the bolts and nuts must meet the requirements of ASTM A 307. The material for the railing hand hole screws shall meet ASTM A 276, Type 304. All flat washers shall be AASHTO M 293. Lock washers shall be steel, regular, helical spring washers meeting ANSI B18.21.1 - 1972.

908.11 Hardware for Timber Construction. Machine bolts, drift bolts, and dowels shall be steel of structural grade.

Washers shall be cast iron ogee or malleable castings. Nails shall be cut or round wire of standard form. Spikes shall be cut or wire spikes, or boat spikes. Galvanizing, when required, shall meet the requirements of AASHTO M 232.

908.12 Steel Beam Guardrail Elements, Hardware, and Steel Sleeves.

A. **Steel Beam Elements and End Sections.** Steel beam sections, backup elements, buffered end sections, terminal end shoes, and special end shoes shall meet the requirements for Class A guardrail of AASHTO M 180, except that thrie beam elements used for bridge railing retrofit, and special end shoes for making connections to bridge barrier railings shall meet the requirements for Class B guardrail of AASHTO M 180.

All steel beam elements, back-up elements, and end sections shall be of the shape specified. All shall be hot-dip zinc coated after fabrication according to the requirements for Type II zinc coatings of AASHTO M 180 except that beam elements and corresponding back-up elements for guardrail Type A, B and BD may be hot-dip zinc coated before or after fabrication.

B. **Hardware.** All bolts, nuts, washers, and other hardware for guardrail shall be hot-dip zinc coated according to AASHTO M 232.

All bolts, nuts, and round washers for guardrail, other than at bridge barrier railings, shall meet the requirements of ASTM A 307, A 563 (Grade A, with Supplementary Requirements S1 of ASTM A 563), and AASHTO M 293, respectively.

Washers, other than round washers, for guardrail shall meet the requirements for circular washers in AASHTO M 293 except that the dimensions shall be as shown on the plans.

Bolts and nuts for making splices and connections of beam elements, other than at bridge barrier railings, shall meet the configuration requirements of AASHTO M 180 (bolts shall be of the Alternate No. 2 configuration).

Bolts, nuts, and washers for connections at bridge barrier railings shall meet the requirements specified for AASHTO M 164 Type 1 galvanized high-strength structural bolts with suitable nuts and hardened washers.

Wire rope and fittings for the cable anchorage shall meet the requirements of AASHTO M 30. Wire rope shall be Type II with a Class B coating.

C. **Steel Sleeves, Soil Plates, and Bearing Plates.** The steel for the sleeves and plates for wood guardrail posts shall meet the requirements specified for either structural steel plate in ASTM A 36 or hot-rolled steel sheet in ASTM A 570, Grades 36 or 40. The sleeves and plates shall be hot-dip zinc coated according to AASHTO M 111. The weight of the zinc coating on the sleeves shall average at least 2.0 ounce per square foot and no individual specimen shall show less than 1.7 ounce per square foot. On the plates, the coating weights shall average not less than 2.3 ounce per square foot and no individual specimen shall show less than 2.0 ounce per square foot.

The steel sleeve shall have 1 or 2 full penetration longitudinal welds running the entire length of the sleeve. The tolerances, after galvanizing, on the size of the steel sleeve shall be minus zero and plus ⅛ inch on the inside dimensions shown on the plans.

The tolerances on the size of the steel plates shall be minus 0.000 and plus 0.250 inch on the dimensions shown on the plans.

908.13 Steel Posts for Guardrail. The steel posts shall be of the length called for on the plans and shall be W6 by 9 sections, weighing not less than 9.0 pound per linear foot including zinc coating. Nominal 6 by 4 inch joist sections, weighing not less than 8.5 pound per linear foot, including the zinc coating, will be permitted. The steel shall meet the requirements for structural steel in ASTM A 36.

The posts shall be hot-dip galvanized according to ASTM A 123, having an average coating weight of not less than 2.0 ounce per square foot of surface area.

908.14 Reflectorized Washers for Guardrail. Reflectorized washers shall be fabricated from steel sheet not lighter than 13 gage (0.0934 inch nominal) galvanized according to ASTM A 653, Coating Designation G210. Reflective material shall be firmly bonded to the galvanized steel.

The size and shape of the washers shall conform to the details shown in the contract documents. The steel washer shall be thoroughly degreased and treated according to the sheeting manufacturer's recommendations prior to application of the sheeting. The reflective material shall be Type III reflective sheeting as specified in subsection 919.03.B.

908.15 Anchor Bolts, Nuts, and Washers.

A. **General.** The supplier or fabricator of all bolts shall furnish a Type A certification, including results of yield strength, tensile strength, elongation, reduction of area, and Charpy V-notch tests, with reference to the heat number of the steel, and to furnace lot number if heat treated. Prior to sampling, anchor bolts for cantilever and truss sign supports shall have an identification stamped in the end of the hook to identify the specific heat number and in the threaded end cross-section to identify it to a specific Department test report. Additional bolts shall be ordered to allow for testing.

B. **Sign Support and Light Standard Anchor Bolts.**

1. Anchor bolts shall be fabricated from medium carbon, hot rolled steel bars meeting the following mechanical requirements.

Yield Strength	50 ksi
Ultimate Strength	85 ksi
Elongation (2 inch gage), min*	21%
Reduction in Area, min**	30%
Longitudinal Charpy V-Notch, min	15 ft-lb at 40°F

* Elongation (8 inch gage), min 18 percent for bolts tested full section.
** Bolts over 1 to 2.5 inches, 22% min; over 2.5 to 3 inches, 20% min.

Notch toughness tests on specimens shall be performed according to Test Frequency P (Piece Testing) of ASTM A 673 and the notch shall be oriented perpendicular to the longitudinal axis of the anchor bolt. In order to meet the Charpy V-Notch impact requirements, the steel may need to be heat treated.

Anchor bolts, nuts, and washers shall be zinc coated, as indicated in the contract documents, according to AASHTO M 232. Dimensions of the bolts shall be as shown on the plans.

Threads on the anchor bolts shall be 8UN series according to ANSI B1.1 and shall meet Class 2A tolerances before coating. After coating, the maximum limit of pitch and major diameter may exceed the Class 2A limit by 0.021 inch for bolts 1 inch and smaller, and by 0.031 inch for bolts larger than 1 inch diameter. Anchor bolt threads may be cut or rolled into the round bar stock.

2. Nuts for anchor bolts shall conform to ASTM A 563, Class 10S, or ASTM A 194, Grade 2H, heavy hex. The threads shall be 8UN series according to ANSI B1.1 Class 2B tolerances; and tapped oversize after coating by not more than 0.021 inch for nuts 1 inch and smaller, or more than 0.031 inch for nuts larger than 1 inch. The nuts shall be lubricated according to supplementary S1 of ASTM A 563.

3. Washers shall conform to AASHTO M 293 for circular washers.

C. **Anchor bolts for Traffic Signal Strain Poles.** The requirements of subsection 908.15.B with the following exceptions.

1. There will be no requirement for longitudinal Charpy V-Notch.

2. Coarse pitch threads will be allowed provided that all tolerances are met.

D. **Anchor Bolts and Nuts for Other Purposes.** Anchor bolts and nuts for other purposes shall be fabricated from steel meeting the requirements of ASTM A 307. Nuts shall be heavy hexagon series.

All nuts, washers, and the exposed length of anchor bolts plus 6 inches shall be galvanized according to AASHTO M 232. Nuts shall be retapped after galvanizing according to ASTM A 563.