



Standard Practices for Casting Preparation and Test Procedure of Porcelain Enamel-lined Pipe, Fittings, and Valves for Use in the Municipal Wastewater, Sewage, and Water Treatment Industry¹

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INTRODUCTION

Porcelain enamel (glass) lining applied to the internal surfaces of ductile iron and steel pipe and fittings have been utilized in the municipal waste water and sewage treatment and water related industries since the early 1960s as a deterrent to interior clogging in high solids process piping because of the hardness and significantly improved flow characteristics of the porcelain enameled product. The coating is applied using the wet process of porcelain enameling, whereby a slurry of wet enamel is spray applied to the properly prepared surface of the pipe, fittings, or valve component parts. The water is removed through a drying process, and the product is then heat fused to the metal by heating in a furnace at approximately 1350°F (733°C) for a sufficient time to allow fusing of the glass material to the ductile iron or steel surface. It has been found to provide far better performance and longevity in these piping systems than any organic lining material. Porcelain enamel or glass lining is not intended to be a highly corrosion-resistant, completely pinhole-free lining product but is utilized for its hardness and flow/slickness characteristics.

1. Scope

1.1 The following procedures and practices are intended to provide guidelines for processing and quality control that will provide acceptable results for the intended end use, keeping in mind the varying quality of the castings available.

1.2 The recommendations are based on what have been acceptable industry standards and experiences for over 40 years of proven product usage.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

D5162 Practice for Discontinuity (Holiday) Testing of Non-conductive Protective Coating on Metallic Substrates

D5965 Test Methods for Specific Gravity of Coating Powders

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

2.2 NACE and SSPC Standard:³

SP0188–2006 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

2.3 NAPF Standard:⁴

NAPF 500 Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

¹ This test method is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.12 on Materials for Porcelain Enamel and Ceramic-Metal Systems.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from NACE International (NACE), 15835 Park Ten Pl., Houston, TX 77084, <http://www.nace.org>.

⁴ Available from the National Association of Pipe Fabricators, 1901 N. W. 161st Street, Edmond, OK 73013, www.napf.com.

2.4 AWWA Standard:⁵

AWWA C151 Ductile-Iron Pipe, Centrifugally Cast

3. Recommendations Related to Inspection of Incoming Castings for Processing

3.1 Ductile iron pipe should be ordered as a minimum of a thickness Class 53 and be specified as “for glass lining.” Steel pipe should be ordered according to **Table 1**.

3.2 All castings received should be supplied bare, without having been previously coated or lined or otherwise exposed internally to any prior organic lining product.

3.3 The castings should be visibly inspected for excessive surface irregularities such as pinholes or larger holes, cavities, sand inclusions or voids that will not allow for proper coverage of the porcelain enamel lining.

3.4 Any indentations or subsurface defects in the casting should be minor and should not exceed a depth of $\frac{1}{8}$ in. (3.2 mm). Gradual, sloping sides with no undercut edges are permissible.

3.5 Castings should also be inspected for sharp upward protrusions, parting lines or other roughness creating any sharp edges. Grinding of these areas is permissible.

4. Pre-lining Preparation of Acceptable Castings

4.1 Minor protrusions, parting lines, or roughness may be ground flush with the adjacent internal surfaces.

4.2 Rust, loose scale, or other foreign material should be removed from the surfaces that are to receive porcelain using the appropriate media and clean, dry, oil-free air. Refer to NAPF 500 for iron or NACE/SSPC SP0188–2006 for steel for surface condition requirements.

4.3 Use dry, oil-free air to remove any residual blast media or dust from the surface to be lined with the porcelain.

4.4 Application of the porcelain material should take place within 8 h of completion of the blasting. Flash rust contamination on the blasted casting surfaces should be prevented.

5. Qualification of Porcelain Enamel

5.1 The glass lining applied to pipe and fittings shall be hard, smooth, continuous vitreous material.

5.2 The glass portion of the lining, the frit(s) used in the formulation, as supplied from the manufacturer, shall have a density of 2.5 to 3.0 grams per cubic centimeter as measured by Test Method **D5965**, Method A.

⁵ Available from the American Water Works Association, 6666 W. Quincy Ave, Denver, CO 80235, www.awwa.org.

TABLE 1 Recommended Wall Thickness for Steel Piping

Diameter	Minimum Wall
10 in. (25 cm) or smaller	Schedule 40 ^A
12 in. (30.5 cm) and larger	$\frac{3}{8}$ in. (9.5 mm) ^A

^AConsult with the lining manufacturer engineering for minimum wall thickness

5.3 The finished lining shall be able to withstand a strain of 0.001 inch/inch of the base metal without visible damage to the glass.

5.4 The lining shall be capable of withstanding an instantaneous thermal shock from ambient + 350°F (177°C) to ambient without visible crazing, blistering or spalling.

5.5 There shall be negligible visible loss of surface gloss to the lining after immersing a cut production sample in an 8% by weight sulfuric acid solution at 148°F (65°C) for a period of 10 min.

6. Application of the Wet Process Porcelain Enamel

6.1 There are some proprietary processes used by various applicators to spray deliver the porcelain material onto the surface of the ductile iron product. The method of application is not important, providing the final quality of the finished product meets acceptable limits of continuity, uniformity, and thickness.

7. Final Product Inspection and Quality Guidelines

7.1 Each pipe/fitting shall be inspected as follows:

7.1.1 Visually for voids, pinholes, crazing or fish scales that show bare metal. Such defects are cause for rejection. Any visually rejected product can be re-coated or re-blasted and re-coated.

7.1.2 For lining thickness as tested with a Type I or Type II dry film thickness gage as described in Practice **D7091**. A minimum of 10 mils (250 μ m) is required.

7.1.3 For lining hardness as measured on the MOHS Hardness scale. A minimum of 5 is required.

7.1.4 For holidays using the low voltage wet sponge testing apparatus as described in Test Method **D5162**, Method A. A documented procedure should ensure that for long pipe, testing is performed from both ends of the pipe with the diameter of the dampened sponge exceeding the diameter of the pipe so that the sponge is in full circumferential contact with the lining. Wetting agents should not be used. The sponge should be moved over the surface at a moderate rate approximately 0.3 m/s (1 ft/s) using a two pass (in and out) motion over each area. Care should be exercised near the exposed pipe ends to prevent excess water from tracking and giving a false indication. Limits for holidays are given in **Table 2**.

TABLE 2 Allowable Non-visible Holiday Indications Permitted

Fittings	Maximum Number of Holidays	Pipe	Maximum Number of Holidays ^A
...	...	3 in. (7.6 cm) diameter up to 10 ft (3.1 m) long	6
4 through 8 in. (10.2 through 20.4 cm) diameter	5	4 in. (10.2 cm) through 8 in. (20.4 cm) diameter	12
10 through 18 in. (25.4 through 45.7 cm) diameter	8	10 in. (25.4 cm) through 18 in. (45.7 cm) diameter	20
20 in. (50.8 cm) diameter and larger	10	20 in. (50.8 cm) diameter and larger	28

^AExcept as noted, these are for 20 ft (6.1 m) lengths. For shorter lengths, the maximum is proportional to the 20 ft (6.1 m) length.

7.1.5 For straightness performed using a documented procedure. The maximum deviation per pipe length is:

Fabricated (Flanged and Grooved Ends)	Bell X Spigot Pipe
% in. in 20 ft (9.5 mm in 6.1 m) 0.01875 in. per ft (0.0156 mm per cm)	% in. in 20 ft (15.9 mm in 6.1 m) 0.03125 in. per ft (0.0261 mm per cm)

7.2 The manufacturer of the lining shall be willing to negotiate in the purchase contract for random jobsite sampling to confirm correlation between factory and jobsite test results.

8. Quality Control Documentation

8.1 All pipe and fittings and valve components should be factory tested by the manufacturer. Copies of the Quality Control Test Results should accompany each shipment.

8.2 The test documents should identify each individual item tested by an identifying mark number and description, the Quality Control Sequence Number, date tested, inspector's initials, number of holidays detected, and the thickness of the lining in mils.

9. Keywords

9.1 fittings; pipe; porcelain enamel

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