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Standard Practice for Immersion Testing of Industrial Protective Coatings¹

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1. Scope

1.1 This practice establishes procedures for the evaluation of the resistance of industrial protective coatings to immersion in chemicals.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parenthesis are for information only.

1.3 *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

C868 [Test Method for Chemical Resistance of Protective Linings](#)

D16 [Terminology for Paint, Related Coatings, Materials, and Applications](#)

D610 [Practice for Evaluating Degree of Rusting on Painted Steel Surfaces](#)

D714 [Test Method for Evaluating Degree of Blistering of Paints](#) ~~D1186~~ [Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base](#)

~~D1400~~ [Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base](#)

D2200 [Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces](#)

D3359 [Test Methods for Measuring Adhesion by Tape Test](#)

D3363 [Test Method for Film Hardness by Pencil Test](#)

D4138 [Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means](#)

D4417 [Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel](#)

D4538 [Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities](#)

D4541 [Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers](#)

D5139 [Specification for Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants](#)

D5162 [Practice for Discontinuity \(Holiday\) Testing of Nonconductive Protective Coating on Metallic Substrates](#)

D6132 [Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage](#)

D6577 [Guide for Testing Industrial Protective Coatings](#)

D6677 [Test Method for Evaluating Adhesion by Knife](#)

D7055 [Practice for Preparation \(by Abrasive Blast Cleaning\) of Hot-Rolled Carbon Steel Panels for Testing of Coatings](#)

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](#)

D7234 [Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers](#)

G113 [Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials](#)

~~ASTM Manual MNL8~~ [ASTM Manual on Maintenance Coatings for Nuclear Power Plants](#) ~~Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials~~

¹ This practice is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.46 on Industrial Protective Coatings.

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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.

2.2 NACE Standard:³

TM 0174-2002 Laboratory Methods for the Evaluation of Protective Coatings and Lining Materials on Metallic Substrates in Immersion Service

2.3 SSPC/NACE Joint Standards:⁴

SSPC-SP5/NACE 1 White Metal Blast Cleaning
 SSPC-SP10/NACE 2 Near White Blast Cleaning
 SSPC-SP13/NACE 6 Surface Preparation of Concrete

2.4 SSPC Protective Coatings Glossary⁴

2.5 Coating Encyclopedia Dictionary⁵

3. Terminology

3.1 The definitions given in Terminologies ~~G413 and~~ D16, G113 and D4538 are applicable to this practice.

4. Significance and Use

4.1 Protective coatings are used on metallic and concrete storage and processing vessels, shipping containers, dams and rail cars to protect the substrate from corrosive attack and to protect stored materials (cargo) from contamination. This method provides a means to assess the ability of a protective coating to resist degradation by chemicals and to protect the liquid cargo from contamination by either the substrate or coating, based on visual observations. Other measures of degradation, such as changes in weight or dimensions of the coating material, or chemical changes to the cargo, may be used to assess this protective ability as mutually agreed upon between contracting parties.

4.2 This standard practice covers three approaches to conducting evaluations of a lining coating materials fitness for purpose.

4.2.1 *Method A*—Evaluation of specimens under conditions of constant temperature at atmospheric pressure, (that is, without a thermal gradient).

4.2.2 *Method B*—Evaluation of specimens under conditions which provides a temperature gradient across the sample: The temperature may increase from coated side to uncoated side (Method B1) or decrease from coated side to uncoated side (Method B2).

4.2.3 *Method C*—Evaluation of specimens under conditions of constant temperature and increased pressure, (that is, without a thermal gradient).

4.3 Exposure of materials of known performance (a control) at the same time as the test material is recommended.

5. Preparation of Test Specimens

5.1 Metallic Panels:

5.1.1 Use carbon steel panels with a minimum test size of ~~5150~~ by ~~102100~~ mm (2 by 4 in.), minimum thickness ~~6.43~~ mm ($\frac{1}{8}$ in.), unless otherwise agreed upon by purchaser and supplier.

NOTE 1—Test plates with a minimum width of 25 mm (1 in.) may be used if the film thickness is sufficiently uniform to prevent edge effects.

5.1.2 Use nominal 4.8 mm ($\frac{3}{16}$ in.) thick carbon steel panels in coating tests if a temperature gradient is included in the immersion test, unless otherwise agreed upon by purchaser and supplier.

5.1.3 The minimum surface preparation is abrasive blast cleaning to Near-White Metal condition as defined by ~~ASTM Practice~~ D2200 and by SSPC-SP10/NACE 2. The abrasive and feed pressure shall be selected to produce an anchor pattern, which is compatible with the coating system and acceptable to the coating manufacturer.

5.1.4 Unless otherwise specified or agreed upon by purchaser and seller, surface preparation shall be “White Metal Blast Cleaning” according to SSPC-SP5/NACE 1, with surface profile of ~~3835~~ to ~~6090~~ micrometers (1.5 to 3.5 mils) as determined by Method C of Test Methods D4417. If the product recommendation falls outside of the range of Test Methods D4417 then prepare the test panels in accordance with Practice D7055.

5.1.5 Other metallic substrates, panel dimensions, or surface preparation are acceptable if agreeable to concerned parties.

5.2 Concrete and Cementitious Panels:

5.2.1 *Cementitious Panels*—The minimum panel size is ~~5150~~ by ~~102100~~ by ~~2512~~ mm (2 by 4 by $1\frac{1}{2}$ in.). Prepare cementitious panels by abrasive blast cleaning in accordance with SSPC-SP13/NACE 6 or by other method agreed upon between purchaser and supplier.

~~5.2.2 Concrete Blocks—Form, condition and prepare concrete blocks in accordance with the protocol described in Chapter 6 of the ASTM Manual MNL8—Form, condition and prepare concrete blocks in accordance with the protocol described in Specification D5139.~~ Prepare concrete blocks by abrasive blast cleaning in accordance with SSPC-SP13/NACE 6 or by other method agreed upon between purchaser and supplier.

³ Available from NACE International (NACE), 1440 South Creek Dr., Houston, TX 77084-4906, <http://www.nace.org>.

⁴ Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, <http://www.sspc.org>.

⁵ Available from Federation of Societies for Coatings Technology (FSCT), 492 Norristown Rd., Blue Bell, PA 19422-2350, <http://www.coatingstech.org>.

5.3 Coating Application:

5.3.1 For panels to be fully immersed, apply the coating system to all test panel surfaces that will be subjected to exposure.

5.3.2 Apply the coating system according to the manufacturer's instructions appropriate for actual or anticipated service conditions. Edges should be protected unless the intent of the experiment is to evaluate the performance of the coating on edges. For coatings to be tested under Method A (immersion with no temperature gradient) or Method C (immersion at high pressure), apply the candidate coating to the back of the panel in addition to the front and the edges to prevent effects from dissimilar coatings.

5.3.3 Dry film thickness of the coating shall be agreed upon between purchaser and seller.

~~5.3.3.1 Measure dry film thickness of coating applied to ferrous surface in accordance with Test Methods D1186~~

5.3.3.1 Measure dry film thickness of coating applied to metal surfaces in accordance with Practice D7091.

~~5.3.3.2 Measure dry film thickness of coating applied to non-ferrous metallic surfaces in accordance with Test Methods D1400~~
or

~~5.3.3.2 Measure dry film thickness of linings applied to concrete or cementitious surfaces in accordance with Test Method D6132.~~

~~5.3.3.3 Measure dry film thickness of linings applied to concrete or cementitious surfaces in accordance with Test Method D6132. Alternatively, measure dry film thickness of linings applied to concrete or cementitious surfaces by using sacrificial surfaces prepared concurrently with test specimens in accordance with Test Methods. Alternatively, measure dry film thickness of linings applied to concrete or cementitious surfaces by using sacrificial surfaces prepared concurrently with test specimens in accordance with Practices D4138.~~

5.3.4 Examine the coated surface for holidays in accordance with Practice D5162. For test plates and concrete blocks, no holidays are acceptable unless agreed upon between purchaser and seller.

6. Sampling

6.1 Test chemicals are to be representative of test materials expected in actual service.

6.2 Prepare at least two test panels or blocks per coating system for each test material.

6.3 Prepare at least one test panel or block per coating system to be used as a file specimen (control) and an unexposed reference (file specimen).

6.4 Retain an unused portion of each test medium as a blank.

7. Test Methods

NOTE 2—This standard describes three methods for immersion testing of protective coatings and linings. Section 8 provides recommended examination methods and intervals between evaluations for the methods described below.

7.1 Method A—Immersion with No Temperature Gradient:

7.1.1 Test Apparatus:

7.1.1.1 A closed vessel constructed of glass or other inert material is used with capacity to hold one or more test specimens with means to relieve pressure if operated at elevated temperatures.

NOTE 3—Slowly evaporating media may not require a closed vessel.

7.1.1.2 Specimens should be positioned so as to avoid specimen to specimen contact.

7.1.1.3 For immersion at high or low temperature, insulation of the vessel is recommended. A separate test vessel is recommended for each type of coating system being evaluated. For elevated temperature immersion, an apparatus as described in NACE TM 0174-2002, Procedure B, is recommended.

7.1.2 *Test Medium*—The test solution is selected to correspond with the anticipated service of the coating. Add enough of the fluid to immerse one half to two thirds of the test panel. The fluid level should be checked at least once every 7 days. If more than 5 % of the test fluid evaporates from the test vessel, add enough fluid to maintain the level and composition of the fluid.

NOTE 4—When solvent or water evaporates, ensure that the addition results in the same concentration as at the start of the test.

7.1.3 *Test Procedure*—Maintain a temperature of $25 \pm 3^{\circ}\text{C}$ ($77 \pm 5^{\circ}\text{F}$) unless otherwise indicated by anticipated service conditions or by specification. Ensure that there is a minimum separation of 25 mm (1 in.) between panels in the vessel.

7.2 *Method B—Immersion with Temperature Gradient*—The practice defines 2 types of temperature gradients: increasing temperature from uncoated to coated side and decreasing temperature from uncoated to coated side

7.2.1 *Method B1*—Temperature gradient with temperature increasing from uncoated to coated.

7.2.1.1 *Test Apparatus*—A special cylindrical glass test cell is used with multiple necks to provide inlets for thermometer, heater and condenser. The test panel is coated on one side with the exterior exposed to the ambient environment. This setup provides a temperature gradient across the coating.

NOTE 5—The specific equipment drawings and operation are described in Test Method C868 and NACE TM 0174-2002, Procedure A.

7.2.1.2 *Test Medium*—The test solution is selected to correspond with the anticipated service of the coating. As this is a closed system there is no need to replenish the solution during the time test specimen is immersed. After disassembly and rating of the panel, fresh medium is normally recommended.