Designation: ~~D2485 – 18~~ D2485 – 22

Standard Test Methods for Evaluating Coatings For High Temperature Service[1]

This standard is issued under the fixed designation D2485; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 These test methods cover the evaluation of the heat-resistant properties of coatings designed to protect steel surfaces exposed to elevated temperatures during their service life. Two test methods are described as follows:

Method A—Interior Service Coatings

Method B—Exterior Service Coatings

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

1.3 *This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 5.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A36/A36M Specification for Carbon Structural Steel

A283/A283M Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

A285/A285M Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength

B117 Practice for Operating Salt Spray (Fog) Apparatus

D522 Test Methods for Mandrel Bend Test of Attached Organic Coatings

D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products

D823 Practices for Producing Films of Uniform Thickness of Paint, Coatings and Related Products on Test Panels

D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)[3]

D2200 Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces

G7 Practice for Natural Weathering of Materials

[1] These test methods are under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and are the direct responsibility of Subcommittee D01.27 on Accelerated Testing.

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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] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

3. Summary of Test Methods

3.1 Panels suitably coated with the material under test are evaluated under one or both of two test methods depending on the intended usage.

3.1.1 *Test Method A, Interior Service Coatings*—Coated panels are heated for 24 h in a muffle furnace at a temperature agreed upon between the purchaser and the seller. One panel is plunged into water and the other cooled and then subjected to a bend test.

3.1.2 *Test Method B, Exterior Service Coatings*—Coated panels are subjected to temperatures that increase in steps from ~~205~~205 °C to ~~425°C (400~~425 °C (400 °F to ~~800°F).~~800 °F). One panel is subjected to salt spray for 24 h, and one is exposed outdoors for 12 months.

3.2 When tests are completed, the panels are examined for evidence of film degradation including rust formation, blistering, loss of adhesion, dulling, and chalking.

4. Significance and Use

4.1 Some coating systems are developed for use over steel that is exposed to high temperatures during service life. This method provides an accelerated means of determining the performance of these coating systems. Testing of coatings designed for interior service, and of coatings designed for exterior (weather-exposed) service is included.

5. Apparatus

5.1 Automatic spray equipment as described in Practices D823 (Method A) or any other suitable method that will give the required uniformity of film and film thickness.

5.2 Muffle furnace capable of maintaining the temperatures described in 7.2 and 7.3.

5.2.1 **Warning—**Due to the high temperatures involved in operating the muffle furnace, extreme caution ~~should~~shall be used.

5.3 Salt spray apparatus as described in Practice B117.

6. Panel Preparation

6.1 *Type*—Panel dimensions shall be established by prior agreement between the purchaser and the seller. Use panels of 6.4 mm (¼ in.) hot-rolled steel conforming to Specification A36/A36M or Specification A283/A283M, or when appropriate, Specification A285/A285M for the water quench test in Test Method A, and for all tests under Test Method B. For the bend test in Test Method A, the panels must be thin and soft enough to be bent as described in Test Methods D522.

6.2 *Cleaning*—Clean the panels for both test methods in accordance with Practice D609, Methods B or D. Then, using a fine silica sand (graded to pass through a No. 40 (425-µm) sieve), blast the panels for Method B to "white" metal (removing all mill scale and rust) so that the panels comply with grade A SP-5 of Standard D2200. Other blast media and blast methods are acceptable if agreed upon between the buyer and the seller. Blast-cleaned panels cannot be subjected to the bend test because they are too thick to bend.

6.3 *Coatings Applications*—Apply the coatings by automatic spray, Method A of Practices D823, or by any other suitable method that will assure the required uniformity of film thickness. The number of coats, technique, and cycle for drying between coats of multicoat systems, limits of dry film thickness, and drying time before exposure shall be established by prior agreement between the purchaser and the seller. Determine dry film thickness in accordance with Test Methods D1186. Allow coatings that air dry at ambient temperature to dry for 168 h at a temperature of ~~24~~24 °C ± ~~2.5°C (75~~2.5 °C (75 °F ± ~~5°F)~~5 °F) prior to exposing to test conditions. Bake coatings that require heat conversion in accordance with the recommendation of the supplier.

7. Procedure

7.1 *Sampling*—When panels have been coated at another location, select at random from different packages two specimens for each method of each type of coating under investigation.

7.2 *Test Method A:*

7.2.1 Place **one panel** each of the two types described in 6.1 and 6.2 coated with each paint under test in a muffle furnace maintained at the test temperature mutually agreed upon between the purchaser and the seller, and allow to remain for 24 h. At the end of this time plunge one of the panels immediately into water maintained at ~~21~~21 °C ± ~~2.5°C (70~~2.5 °C (70 °F ± ~~5°F).~~5 °F). After removing from the water, examine the coating film for evidence of film failure including dulling, blistering, cracking, and loss of adhesion. Allow the second panel to cool at a room temperature of ~~24~~24 °C ± ~~2.5°C (75~~2.5 °C (75 °F ± ~~5°F)~~5 °F) for 1 h, then rapidly bend at 180 degrees over a 12.7-mm (½-in.) diameter steel mandrel with coated side uppermost in accordance with Test Methods D522, Method B. Examine this panel in the bent area for evidence of film degradation such as cracking and loss of adhesion.

7.3 *Test Method B:*

7.3.1 Expose duplicate coated panels finished with the materials under test to the elevated temperature test schedule mutually agreed upon between the purchaser and the seller. In the absence of such a specified schedule use the following:

7.3.2 Place the panels in a muffle furnace maintained at a set point of ~~205°C (400°F)~~205 °C (400 °F) for 8 h, then increase the temperature to ~~260°C (500°F)~~260 °C (500 °F) for 16 h. Increase the temperature in ~~55°C (100°F)~~55 °C (100 °F) increments, alternating the time periods indicated, to the final temperature maximum previously agreed to between the purchaser and the seller. Thus the schedule would be:

~~205~~205 °C ± ~~3.5°C (400~~3.5 °C (400 °F ± ~~6°F)~~6 °F) for 8 h
~~260~~260 °C ± ~~5.0°C (500~~5.0 °C (500 °F ± ~~9°F)~~9 °F) for 16 h
~~315~~315 °C ± ~~6.5°C (600~~6.5 °C (600 °F ± ~~12°F)~~12 °F) for 8 h
~~370~~370 °C ± ~~8.0°C (700~~8.0 °C (700 °F ± ~~14°F)~~14 °F) for 16 h
~~425~~425 °C ± ~~9.5°C (800~~9.5 °C (800 °F ± ~~17°F)~~17 °F) for 8 h

NOTE 1—Many high temperature paints depend upon service conditions to provide the extreme heat required to cure or sinter their films. If these paints are never exposed to the extreme heat, they may be found to be unsuitable. Consequently, it is good practice to make observations also at temperatures less than the expected service temperatures.

NOTE 2—The set point is the value programmed into the muffle furnace temperature controller by the user. The ± values above indicate the maximum allowable operational fluctuation of the temperature displayed on the controller during equilibrium conditions in the furnace. This operational fluctuation is not an indication of uniformity in the furnace.

7.3.3 Remove the test panels and make a visual inspection following exposure at each temperature level for evidence of failure, including peeling, cracking, blistering, abnormal discoloration, or loss of adhesion, using ASTM standards where possible. Disregard such failures up to 6.4 mm (¼ in.) in from the edges of the test panels.

7.3.4 At the end of the complete exposure, remove the panels from the oven or muffle furnace and allow to air cool at ambient temperature for a minimum period of 1 h. As described in 7.3.3, inspect for evidence of failure due to the high temperature exposure.

7.3.5 If both panels of each pair pass the heat test satisfactorily, use them, respectively, for salt spray (fog) testing and exterior exposure testing.

7.3.5.1 Place one panel of each pair in a salt spray cabinet operated in accordance with the requirements of Practice B117, for a period of 24 h. At the conclusion of the exposure period, examine each panel for rusting or any other evidence of corrosive attack.

7.3.5.2 Expose the second panel of each pair on an insulated-type rack, as described in Practice G7, or as agreed upon between the purchaser and seller, for a period of 12 months. Make a visual inspection after 6 months and after termination of the exposure. The site to conduct the test and the angle of the exposure rack ~~should~~shall be agreed upon between the purchaser and the seller, and ~~should~~ is recommended it relate to the end-use application of the coating.

8. Report

8.1 Report the following information: