



Designation: D1748-02 (Reapproved 2008) Designation: D1748 – 10



Designation: 366/84

Standard Test Method for Rust Protection by Metal Preservatives in the Humidity Cabinet¹

This standard is issued under the fixed designation D1748; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers the evaluation of the rust-preventive properties of metal preservatives under conditions of high humidity.

1.2 The values stated in SI units are to be regarded as the standard except where the test apparatus or consumable parts are only available in other units. In such cases these will be regarded as standard. The values given in parentheses 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 consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

A109/A109M [Specification for Steel, Strip, Carbon \(0.25 Maximum Percent\), Cold-Rolled](#)

D512 [Test Methods for Chloride Ion In Water](#)

D516 [Test Method for Sulfate Ion in Water](#)

E11 [Specification for Woven Wire Test Sieve Cloth and Test Sieves](#)

E323 [Specification for Perforated-Plate Sieves for Testing Purposes](#)

2.2 Federal Standards:³

QQ-S-698 [Steel Sheet and Strip, Low Carbon](#)

2.3 **Military Standards:⁴**
MIL-C-5646F [Cloth, Airplane](#)

MIL-C-15074E [Corrosive Preventive Compound Finger Print Remover](#)

2.4 Society of Automotive Engineers:⁵

SAE 1009C [Tee Reducer, Bulkhead on Side, Flareless Tube](#)

3. Summary of Test Method

3.1 Steel panels are prepared to a prescribed surface finish, dipped in the test oil, allowed to drain, and then suspended in a humidity cabinet at 48.9°C (120°F) for a specified number of hours. The oil fails or passes the test in accordance with the size and number of rust dots on the test surfaces of the panels.

4. Significance and Use

4.1 This test method is used for measuring the relative abilities of metal preservatives to prevent the rusting of steel panels under

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.L0.03 on Corrosion Testing of Sheet Fluids Metal Processing Fluids.

Current edition approved May 1, 2008; 2010. Published July 2008; November 2010. Originally approved in 1960. Last previous edition approved in 2002 as D1748-02(2008). DOI: 10.1520/D1748-02R08; 10.1520/D1748-10.

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 Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

⁴ Available from Standardization Documents Order Desk, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁵ Available from Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

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

conditions of high humidity. It should not be relied upon to predict the effectiveness of a metal preservative in which high humidity is not the principal factor in the rusting.

4.2 Comparisons made by this test method should normally be limited to similar metal preservative combinations designed for similar applications. The test life required for each type of metal preservative and for each intended application should be based on actual experience with that type of preservative in the intended service.

4.3 Since the precision of the test method appears to be less than desired, a number of repeat tests may be necessary to establish the test life of a given metal preservative, and repeat tests by this test method in more than one cabinet are sometimes desirable.

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4.4 The data obtained from this accelerated test is of interest only in eliminating the most unsuitable materials or for indicating a probable relative order of protection against rust under conditions of high humidity. This test method does not prescribe the exposure periods to be used for a specific product, nor the interpretation to be given to the results.

5. Apparatus

5.1 The apparatus shall conform to the details shown in the Annex A1.

6. Panel Cleaning Materials

6.1 *Aluminum Oxide Cloth*, 240-grit.

NOTE 1—Paper-backed abrasives, wet or dry, waterproof, or iron oxide abrasives are prohibited.

6.2 *Silica Sand*, white, dry, sharp, chloride free, or *aluminum oxide*, blasting grade. (The size shall be such that it meets the following sieve requirements of Specifications E11 and E323.

6.2.1 One hundred percent must pass through a No. 10 (2.00-mm) sieve.

6.2.2 Minimum of 90 % must pass through a No. 20 (850- μ m) sieve.

6.2.3 Maximum of 10 % permitted to pass through a No. 50 (300- μ m) sieve.

6.3 *Cleaners*—Select a cleaning media and method, which is safe, non-film forming and which does not in any way attack or etch the surface chemically. In addition, no Class 1 ozone depleting substances conforming to Section 602(a) of the Clean Air Act Amendments of 1990 (42USC7671a) as identified in Section 326 of PL 102-484 should be used. Use a procedure as outlined in Test Method F22 to judge the merit of the selected cleaning technique.

NOTE 2—A typical solvent found acceptable for this purpose is hexane or Stoddard solvent.

NOTE 3—The original precision was developed using a combination of petroleum naphtha and methanol. These are no longer used due to toxicity issues.

6.4 *Gauze*, lint free cotton or gauze pads.

7. Humidity Cabinet Operating Conditions

7.1 During evaluation of a sample the cabinet shall be run continuously with the following standard conditions being maintained:

Air temperature:	
Inside the cabinet	48.9 \pm 1.1°C (120 \pm 2.0°F)
Outside the cabinet	24.1 \pm 5.5°C (75.4 \pm 10.0°F)
Rate of air to the cabinet	(31.0 \pm 1 ft ³ /h) at 25.0°C and
0.878 \pm 0.028 m ³ /h	760 mm Hg
Water in cabinet:	
Level	203.0 \pm 6.4 mm (8.0 \pm ¼ in.)
pH	5.5 to 7.5
Oil content	clear with no evidence of oil
Chlorides	less than 20 ppm (Test Methods D512)
Sulfates and sulfites ^A	less than 20 ppm as sulfate (Test Method D516)
Speed of rotating	0.33 \pm 0.03 rpm
Cover	close fitting
Cloth layers in cover	shall not be torn, contaminated, nor contain droplets of water
Cover opening	to a height of 355 mm (14 in.) at the front

^A Boil the water sample with 10 mL of saturated bromine water before making the test for sulfates.

7.2 Rate of air to the cabinet, air temperature, pH, and water level shall be checked and regulated if necessary twice each day, at 7- to 8-h intervals. Remaining standard conditions shall be closely checked once each week. The pH measurement may be made with wide-range indicator paper.

NOTE 4—Values for pH outside the limits shown indicate contamination that should be investigated and corrected. A persistent low pH along with a positive sulfate test indicates that the air supply is contaminated with sulfur oxides. In this case, the water in the cabinet should be replaced, and a suitable alkali scrubber system installed in the air train.

NOTE 5—Details of the cabinet operation described in 7.1 and 7.2 and the details of panel preparation described in Section 8, must be carefully carried out. Only by such standardization can results be obtained that are significant and comparable to those run at another time or in another laboratory.

8. Panel Preparation

8.1 Remove the protective packaging from all the panels to be used for a particular day and wash away the rust preventive material in a beaker of solvent selected in 6.3 (swabbing is permissible using materials defined in 6.4). Carefully inspect each panel and use only those which comply with requirements given in A1.10. Identify each panel by an appropriate number in the right-hand lower corner, outside of the significant area, or by attaching a small metal tag to the outside wire hook after the panel is polished.

8.2 The following are pertinent to the polishing operations:

8.2.1 Do not allow the bare fingers to touch the panel. Tongs, metal hooks, or pieces of lint-free paper are suitable helpers for manipulating and holding the panel.

8.2.2 Always keep the panel on a clean, dry surface.

8.3 *Alternative Surface Finishes—Polishing:*

8.3.1 The amount of polishing of the panel by the operator conducting the humidity cabinet test should only be that required to give it a fresh, clean, and active surface. This requires only a few minutes per panel. A fast-moving belt sander should not be used since the heat of friction may change the surface characteristics of the panel. Surface finish limits for the panel are not defined here. There should be no appreciable change of the finish from the 0.25 to 0.51 μm (10 to 20 μm) obtained by the original surface grinding A1.10.1.3.

8.3.2 Divide the 240-grit aluminum oxide abrasive cloth into convenient size strips for the subsequent polishing operations. Observing the precautions given in 8.2 and 8.3, buff all four of the rounded edges with even strokes in the direction of each edge. Ream out the two holes used for suspension and wipe clean, using gauze wet with solvent selected in 6.3.

8.3.3 While polishing, place the panel on a clean, dry surface with a suitable thickness of clean paper under it to help prevent contamination. The panel may be held by hand, using paper between the fingers and the steel surface. Alternatively it may be held in a special holder such as a wooden block, having about a 1.6-mm ($1/16$ -in.) depression slightly larger in area than the 51- by 102-mm (2- by 4-in.) dimension of the panel. The abrasive cloth may be held in the palm of the hand with the fingers applying pressure to the panel. Alternatively, the aluminum oxide cloth may be held on a block of size convenient to the hand and convenient for polishing with smooth strokes without marking the ends of the panel.

8.3.4 Polish the unnumbered or leading surface of the panel with careful even strokes, always parallel to the 102-mm (4.0-in.) dimension. Use a polishing pressure of about 4.5 to 8.9 N (1.0 to 2.0 lb). Do not scratch the surface by using short or curved strokes. Ensure that the panel is held firmly so that only the abrasive cloth moves. After several polishing strokes, inspect the abrasive cloth and when necessary make another fold to expose a new and effective area. Continue to polish the leading surface until it contains a completely fresh surface. The finish should be within the range from 0.25 to 0.51 μm (9.8 to 20.0 $\mu\text{in.}$) (rms). Examine the entire surface, and if scratches or other imperfections are noted, continue polishing until corrected. In the same manner polish the second side of the panel, unless the test specification requires only one polished side per panel.

NOTE 6—It is advisable for each operator to finish several panels to determine exactly what technique is required to attain the correct surface finish using a profilometer or other surface roughness gage. After techniques have been established, the use of visual comparison standards is sufficient as a check on surface roughness.

8.3.5 Remove the dust from the abrasive operation, using clean gauze wet with solvent selected in 6.3. Finally, wipe with clean surgical gauze until there is no dark stain on a clean section of the gauze. Remove any dust in the holes by use of a pipe cleaner. (This may be followed by an ultrasonic cleaning bath procedure.) Submerge the panel completely in solvent selected in 6.3 at room temperature.

NOTE 7—The following should be carried out periodically as a check on surface cleanliness: Place the cleaned panel directly under a buret on a table free of vibrations and drafts. Place the buret so that its tip is exactly 300 mm above the panel. The buret contains distilled water and shall have a tip of proper dimensions to deliver 0.05 ± 0.01 mL of distilled water per drop. Allow one drop of distilled water to fall onto the panel surface. If the surface is absolutely clean, successive droplets on various parts of the surface will spread out completely in spots of closely reproducible dimensions. A clean panel should give a spread of 21 to 23 mm for each 0.05 mL of distilled water. This test is considered necessary and important because of variations found in different abrasive materials and the personal factors involved in the procedure require some method of check on final results. Panels used for this cleanliness check test are not suitable for use in the protection test.

8.3.6 To minimize differences in activity of the steel surfaces as a result of time in various air atmospheres, cleaning and polishing of the panels should be standardized in respect to time. For this reason, carry out the procedure described in 8.3.2-8.3.5 one panel at a time, and after each one is prepared, store it immediately in solvent selected in 6.3 at room temperature until all the panels for one day's operations are prepared.

8.3.7 Heat the solvent selected in 6.3 so that the solvent will evaporate from the panels immediately upon withdrawal from the solvent.

8.3.8 Remove remaining residue by holding the panels in a rack at 20° from the vertical and spraying downward with solvent selected in 6.3.

8.3.9 Spray the test surface, then the back of the panel, and the test surface again.

8.3.10 Rinse the panels in hot solvent selected in 6.3, and store in a desiccator until cool.

8.3.11 Use panels the same day as prepared.

8.4 *Alternative Surface Finishes—Sand or Aluminum Oxide Blasting:*

8.4.1 Blast the edges and lightly blast the backs of the panels with the blasting material.

8.4.2 Blast the unnumbered side, or test surface, of the panels to a fresh, uniformly abraded surface. (Operation 177.9-355.8 N of the blasting equipment at 40- to 80-lb pressure and holding the workpiece 50.8 to 76.2 mm (2 to 3 in.) from the nozzle is recommended.)

8.4.3 Immediately after blasting, place the panels in a beaker of nonreactive solvent or an ultrasonic cleaning bath containing nonreactive solvent.

8.4.4 Heat the solvent selected in 6.3 so that the solvent will evaporate from the panels immediately upon withdrawal from the solvent.

8.4.5 Remove remaining residue by holding the panels in a rack at 20° from the vertical and spraying downward with solvent selected in 6.3.

8.4.6 Spray the test surface, then the back of the panel, and the test surface again.

8.4.7 Rinse the panels in hot solvent selected in 6.3, and store in a desiccator until cool.

8.4.8 Panels are to be used the same day as prepared.

9. Procedure

9.1 Bring the sample oil to a temperature of $23.3 \pm 0.5^{\circ}\text{C}$ ($74.0 \pm 1.0^{\circ}\text{F}$) and pour into a clean, dry 400-mL tall-form glass beaker (for example, borosilicate glass) to a height of at least 114 mm (about 375 mL). By use of one clean suspension hook remove a panel from the methanol and hang it in the vapor space above boiling solvent selected in 6.3 for 5 min, ensuring that the panel is completely wet with the refluxing solvent.

NOTE 8—Cleaning the panel with solvent vapors is conveniently done using approximately 100 mL of solvent selected in 6.3 in a 400- to 600-mL tall-form beaker. Perform this operation in a well-ventilated hood and make sure there are no sources of ignition in the area. Heat-resistant glass beakers have been used for this purpose, but use of a metal beaker is preferred from the standpoint of possible breakage.

9.2 Then slush the panel for 10 s in a beaker of boiling solvent selected in 6.3. Withdraw it from the solvent and observe for any stains on the surfaces, with attention to any contamination from the holes. If stains are present, repeat the panel preparation beginning at 8.3.2 or 8.4.1. After 10 to 20 s in the air, place the clean panel in the sample oil and agitate for 10 s while it is submerged in the oil. Withdraw the panel with a continuous motion, drain for 10 s, and replace in the sample oil for 1 min with slight agitation. Remove from the test oil with a continuous motion, taking from 2 to 4 s. Handle the panel carefully and do not jar nor shake it. Dip the end of a second clean suspension hook into the sample oil and insert it into the second hole of the panel. Drain the panel suspended by two hooks in the box described in the Annex A1 (Fig. A1.8), at a temperature of $24.1 \pm 3.0^{\circ}\text{C}$ ($75.4 \pm 5.0^{\circ}\text{F}$) for $2 \text{ h} \pm 20 \text{ min}$, unless another draining time is specified (see Note 9). More than one panel may be dipped in one beaker of the test oil, provided the temperature of the test oil does not rise above 23.8°C (74.8°F). If this occurs, then dip subsequent panels in a second beaker of the test oil at $23.3 \pm 0.5^{\circ}\text{C}$ ($73.9 \pm 1.0^{\circ}\text{F}$).

NOTE 9—Sample holders, rates of removal of panel from the test sample, and draining time for some preservatives may differ from those given above—in accordance with particular specifications. For example, for some of the more highly compounded preservatives that have been cut back with volatile solvents, the panel is removed using two hooks at the rate of 102 mm (4 in.)/min, and a $24 \pm 1 \text{ h}$ draining period is used.

9.3 At the end of the draining period, suspend the panels in the humidity cabinet described in Annex A1, with the “back,” that is, the numbered side of the panel, trailing as the stage rotates. Allow the one or more test panels treated with the sample oil to remain in the humidity cabinet for the number of hours specified. Maintain operating conditions as specified in Section 7.

9.4 Open the humidity cabinet twice each day, concurrent with the inspections defined in 7.2 as follows: (1) For a 15-min period during the first inspection, and (2) for a 5-min period during the second inspection. Generally, it will be found convenient to do the inspection of panels during the 15-min opening, and the insertion of new panels during the 5-min opening. To standardize the effect of panel cooling and other variables, keep the cabinet open for the entire 15- and 5-min periods, even though the time required to inspect or install panels may be less. The front edge of the cover should be propped open to a distance of 356 mm (14 in.) from the top of the cabinet.

9.5 Panels being evaluated against specified times in the cabinet should not be withdrawn, except at the end of the required time. Panels used in hours-to-failure evaluations, such as in developmental studies, should be very carefully withdrawn and inspected one at a time: a panel should not leave the cabinet, except for the actual time each day required for its inspection.

10. Examination

10.1 Remove the panels at the completion of the specified time in the cabinet. Wash them with solvent selected in 6.3, and within 10 min, examine each one under a fluorescent light for pass or failure as follows:

10.2 Consider the significant area, as indicated in the Annex A1 (Fig. A1.7) of each side of each panel as a separate test surface; each panel thus represents two test surfaces. Rate each test surface as follows:

10.2.1 *Pass*—A test surface shall pass if it contains no more than three dots of rust, no one of which is larger than 1 mm in diameter.

10.2.2 *Fail*—A test surface shall fail if it contains one or more dots of rust larger than 1 mm in diameter or if it contains four or more dots of any size.

10.3 Alternately, the panels may be rated for pass or failure in accordance with the criteria stated in the specification or requirement for which the method is being used.

11. Report

11.1 The report shall include the following:

11.1.1 Hours in the humidity cabinet,

11.1.2 Number of test surfaces (or panels),

- 11.1.3 Number of passing test surfaces (or panels), and
- 11.1.4 Type of panel preparation (sandblasted, aluminum oxide blasted, or polished).

NOTE 10—This test method is intended as a detailed standardized procedure for running the humidity test. Whether a metal preservative passes or fails the test depends upon the criteria given in the specification or requirement for which the test method is being used.

12. Precision and Bias ⁶ (See 4.4)

12.1 This test method is believed to represent the best available practice. Operational procedures that might affect precision have been defined as closely as appears practicable.

12.2 Table 1 summarizes the effect of panel preparation on the repeatability and reproducibility of Test Method D1748 (95 % confidence level).

13. Keywords

- 13.1 humidity; humidity cabinet; metal preservatives; rust protection

ANNEX

(Mandatory Information)

A1. HUMIDITY CABINET APPARATUS

A1.1 Location

A1.1.1 The location of the humidity cabinet shall provide for continuous controlled operation during the test. The humidity cabinet shall be in a room maintained at a temperature between $24.1 \pm 5.5^{\circ}\text{C}$ ($75.4 \pm 10.0^{\circ}\text{F}$). The room shall be free of strong air drafts and of exposure to any acid fumes or gases known to promote corrosion, such as sulfur dioxide, hydrogen sulfide, ammonia, and so forth.

A1.2 Humidity Cabinet

A1.2.1 The equipment used in this test method is the humidity cabinet conforming to Annex A1. The general arrangement of the cabinet components is shown in Fig. A1.1. It consists of a metal-lined wooden cabinet, with the open top equipped with a hinged lid consisting of two thicknesses of desized airplane cloth. The cabinet holds approximately 94.0 L (24.8 gal) of distilled water, up to the prescribed level automatically maintained during operation. The water is heated by means of electric immersion heaters to maintain an air temperature of $48.9 \pm 1.1^{\circ}\text{C}$ ($120.0 \pm 2.0^{\circ}\text{F}$) above the water at operating conditions. The temperature is controlled by means of a thermostat located in the air space and an auxiliary thermostat located under the water level to prevent temperature overshoot. Air is introduced under the water by means of a circular manifold and air-diffuser stones. A rotating stage, from which test panels are suspended, is provided within the air space of the cabinet, and rotates at 0.33 ± 0.03 rpm. A drip pan is provided to prevent contamination of the distilled water by catching the oil and condensed water from the panels.

A1.3 Cabinet Cover

A1.3.1 The cover shall consist of a metal frame on which are tautly secured two thicknesses of desized cotton cloth conforming to Military Specification MIL-C-5646F . The cloth shall have a regular, standard, commercial finish with no added materials that would lessen its wetting-out properties. The double thickness of cloth on the cover serves to permit free exit of air from the cabinet, while preventing drippage of condensed moisture onto the test panels. The cover shall provide a tight seal all the way around the top of the cabinet. If the cover becomes warped, it shall be held down with spring clamps. The cloth should be changed at six-month intervals, or sooner, if it becomes ripped or soiled.

A1.4 Water Level Control

A1.4.1 The water level is held automatically at the 203.0-mm (8.0-in.) level, which is at the top of the shoulder of the central shaft. The level control provided with the cabinet is satisfactory if a continuous supply of distilled water is available, with the

⁶ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1136.

TABLE 1 Panel Preparation

	Sandblasted, % ^A	Al ₂ O ₃ Blasted, %	Polished, %
Repeatability	27.8	46.1	97.3
Reproducibility	141.0	71.2	264.0

^A The sandblasted panels used in obtaining the precision data all came from one source.