



Standard Test Method for Humid-Dry Cycling for Coatings on Wood and Wood Products¹

This standard is issued under the fixed designation D 3459; 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 This test method covers the evaluation of coatings designed for use on interior wood and wood products substrates by exposure alternately to low and high humidity at an elevated temperature.

1.2 This test method is applicable to any coated material or product that is affected either entirely or partly by changes in atmospheric relative humidity.

1.3 This test method applies only to those coatings applied in sufficient quantity to form a continuous film.

1.4 The values stated in the inch/pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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:

D 714 Test Method for Evaluating Degree of Blistering of Paints²

D 1005 Test Methods for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers²

D 2691 Test Methods for Microscopical Measurement of Dry Film Thickness of Coatings on Wood Products³

E 145 Specification for Gravity-Convection and Forced-Ventilation Ovens⁴

3. Significance and Use

3.1 Wood substrates and the coatings applied to them expand and contract to different degrees as the humidity changes, causing stresses that may produce checks, cracks, splits, blisters, swelling, loss of adhesion, and various changes in surface appearance. This test method is intended for use

where the coating is applied in sufficient quantity to form a continuous film on the wood or wood product substrate. It is not possible to make any direct correlation between the results obtained from humid/dry cycling and the results expected in a specific period of time in service because of variations resulting from geographic locations, location within the building, care of the panel (such as waxing), and variations within materials involved.

4. Test Panels and Panel Preparation

4.1 Test panels shall be regular production finished panels if available.

4.2 If regular production finished panels are not available the purchaser and the seller shall agree upon the following variables: type of wood or wood substrate, sanding method(s) and paper(s), sealer(s) or toner(s), filler(s), stain, primer or basecoat, print(s), and topcoat(s), methods of application, and the number of surfaces to be coated. If rotary-cut veneered panels are used, it should also be agreed whether the veneer is to be open or close faced.

5. Apparatus

5.1 *Oven*—a gravity-convection or forced-ventilation electrically heated oven meeting the requirements of Specification E 145 and providing a continuous temperature of $122 \pm 3.5^\circ\text{F}$ ($50 \pm 2^\circ\text{C}$).

5.2 *Constant Elevated-Temperature and Constant-Humidity Chamber*, maintained at a relative humidity of $97 \pm 2\%$ and a temperature of $122 \pm 3.5^\circ\text{F}$ ($50 \pm 2^\circ\text{C}$).

5.3 *Constant-Temperature and Constant-Humidity Chamber*, maintained at a relative humidity of $50 \pm 5\%$ and a temperature of $73.5 \pm 3.5^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$).

6. Test Specimens

6.1 Test specimens shall be large enough to be representative of the material or product and to permit easy observation of possible defects. This usually means a minimum area of approximately 12 by 12 in. (300 by 300 mm).

6.2 Unexposed control specimens of each coating or coating system or product tested shall be held in reserve in a constant-temperature and constant-humidity area (5.3) to prevent any changes.

6.3 Whenever possible, comparative control specimens of a similar material or product with known service characteristics

¹ This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D 01.52 on Factory-Coated Wood Products.

Current edition approved May 10, 1998. Published September 1998. Originally published as D 3459 – 75 Last previous edition D 3459 – 97.

² *Annual Book of ASTM Standards*, Vol 06.01.

³ Discontinued; see 1992 *Annual Book of ASTM Standards*, Vol 06.01.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

should also be exposed.

6.4 Three specimens are usually adequate unless a lack of uniformity is suspected in the substrate, coating, or coating system.

7. Conditioning

7.1 Place the specimens in a conditioned room or chamber (5.3) so that air is free to circulate on all sides of each specimen so as to avoid localized overheating. Allow them to remain there 14 days.

8. Procedure

8.1 Measure the dry film thickness of the coating system on the control panel to the nearest 0.1 mil (2.5 μm) by an appropriate method such as Test Methods D 1005, D 2691, or an Optical Surfer Analyzer.⁵ The results of humid dry cycling are directly affected by the dry film thickness as well as by the coating system itself.

8.2 After conditioning measure thickness of each specimen to the nearest mil (25 μm) at a marked location about 1 in. (25 mm) from one edge and midway along one side at the beginning and after each change of conditions.

8.3 Place the specimens in the oven maintained at $120 \pm 3.5^\circ\text{F}$ ($50 \pm 2^\circ\text{C}$) (5.1) so that air is free to circulate on all sides of each specimen to prevent localized overheating. After 48 h remove the specimens from the oven and place them in the high-humidity elevated-temperature chamber (5.2) so that air is free to circulate on all sides of each specimen. Leave the specimens in the humidity cabinet 48 h. The period of 48 h of dry heat followed by 48 h of humid heat constitutes one cycle. Expose the specimens to the number of cycles as agreed upon between the purchaser and the seller.

8.4 At each change of conditions during cycling, visually inspect each specimen under a strong light and at various

angles to the light for possible damage or change. Note any change in or damage to each specimen. Damage may be found in the base material (plywood, hardboard, flakeboard, solid wood, etc.) or in the coating, in a finish or overlay on the substrate material. Some defects that may occur as a result of humid/dry cycling are as follows: checks, cracks, splits, blisters, (see Test Method D 714) raised grain, localized lumps or swelling, telegraphing of substrate through the coating, loss of particle adhesion, loss of adhesion in glue lines, change in the dimensions of the overlay, changes in surface color, gloss, or hardness, cohesion loss in the coating. If open-faced rotary-cut veneer has been used, checking may result from this fact.

9. Report

9.1 Report the following information:

9.1.1 Complete description of the test material and the comparative control material,

9.1.2 Size and number of the specimens,

9.1.3 Dry film thickness of the material under test and the control (comparison material).

9.1.4 Number of cycles agreed upon between the purchaser and the seller,

9.1.5 Any deviations from the standard procedure, and

9.1.6 Defects or changes as described under 8.4.

10. Precision and Bias

10.1 *Precision*—Since the observed changes can take several forms no numerical values have been developed, and meaningful estimates of precision cannot be given. Round-robin tests showed that cooperators can obtain satisfactory agreement in ranking of results.

10.2 *Bias*—Bias can not be determined since there is no accepted reference material.

11. Keywords

11.1 humid/dry cycle; humidity effects; wood substrates

⁵ Gardner, H. A. and Sward G. G., *Paint Testing Manual*, 14th edition, ASTM, ASTM, 1995.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 100 Barr Harbor Drive, West Conshohocken, PA 19428.