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Standard Test Method for Temperature-Change Resistance of Clear Nitrocellulose Lacquer Films Applied to Wood[1]

This standard is issued under the fixed designation D 1211; 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 determination of the resistance to checking and cracking of clear nitrocellulose lacquer films applied to wood or plywood substrates when subjected to sudden changes from high to low temperatures.

1.2 The values stated in inch-pound 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 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 805 Methods for Testing Veneer, Plywood, and Other Glued Veneer Constructions[2]

D 2571 Guide for Testing Wood Furniture Lacquers[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 True cold-checks on solid wood show as one or more straight cracks on the applied film. Cold-checks manifest themselves in either of two ways:

3.1.1.1 Long continuous wavy lines with the grain or at various directions at angles that can be perpendicular to the direction of the grain.

3.1.1.2 Innumerable fine lines erratic in direction and length forming a network over a portion or all of the panel. This effect may be likened to crazing of the lacquer film.

3.1.1.3 On plywood the direction of the cracks will often vary because of the stresses set up by other than the top stratum. Therefore, all checks may be considered as failures, and appropriate notations on the character of the cracks must be made to assist in the interpretation. While it is recognized that cracks in the substrate may occur (veneer checking), failures observed in the lacquer coating may be due to action of moisture (humidity) or of cold, or both. Checking caused by moisture appears along the grain and is characterized by short cracks (usually not more than ½ in. (13 mm) in length) occurring either singly or in clusters. These lines or clusters may progress along the grain in a discontinuous fashion. Should either veneer checking or moisture checking be observed, the test should be discontinued, and rerun.

3.1.2 The checks may be perceptible only by visual observation of the panels at an angle, under a strong light, or the cracks may be wide enough to be readily discernible in direct daylight.

4. Summary of Test Method

4.1 Lacquer-coated wood panels are subjected first to a high temperature, followed by an exposure to low temperature, and then a return to room temperature for given periods of time, which constitutes one cycle. The method does not define the number of cycles which a lacquer must withstand, this condition being a requirement which must be agreed upon by the purchaser and the seller.

5. Significance and Use

5.1 A common type of failure of clear films applied to wood is cracking or checking that may occur over a period of time either with the grain or at an angle. This cold check test is designed to accelerate the appearance of checks or cracks by cycling the temperature.

NOTE 1—Except when elaborate precautions are taken to control the moisture content of the wood before and after finishing and during the test, failures may quite often occur as a result of dimensional changes in the wood due to moisture change rather than temperature change.

6. Apparatus

6.1 *Refrigerator (Dry Ice)*—The refrigerator should be a well-insulated box, cooled by air which has been circulated over solid carbon dioxide (dry ice). The air must strike the panels indirectly after passing over the solid carbon dioxide. The unit shall have a capacity and temperature control sufficient to cool the test panels in accordance with the requirements prescribed in Section 9.

6.2 *Mechanical Refrigerator*—As a less desirable alternative, a well-insulated mechanical refrigerator may be used having sufficient capacity to cool the test panels in accordance

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[2] Discontinued; see *1976 Annual Book of ASTM Standards*, Part 22.

[3] *Annual Book of ASTM Standards*, Vol 06.02.

with the requirements prescribed in Section 9. The refrigerator should have some means for providing air circulation. It should be understood that results obtained with a mechanical refrigerator may not correspond to results obtained with a "dry ice" refrigerator. Consequently the type of unit employed shall be stated in the report.

6.3 *Oven*—The oven shall be electrically heated and of any standard type capable of being automatically controlled and of sufficient capacity to heat the panels under test to 120 ± 5°F (49 ± 3°C) within 1 h. A circulating fan shall be installed in the oven.

7. Test Panels

7.1 Unless otherwise agreed, the test panel shall be cut from synthetic resin-bonded, five-ply plywood with faces and backs made with straight-grain walnut veneer having no sizing or other surface pretreatment. The dimensions of the test panel shall be 6 by 12 in. (152 by 305 mm), and approximately 5/16 in. (8 mm) thick.

7.2 Solid wood, heavier or lighter veneers, or other species of wood may be agreed upon by the purchaser and the seller. Type of wood and panel size should be clearly defined in the report.

7.3 The wood selected shall have a moisture content of not less than 6.0 % and not more than 8.0 % at the time of testing. The moisture content of the wood may be determined by an electric moisture gage or in accordance with Methods D 805.

7.4 Panels may be conditioned to a moisture content of 7 to 8 % under any of the following conditions:[4]

Temperature, °F (°C)	Relative Humidity, %
65 to 75 (18 to 24)	35 to 40
90 to 100 (32 to 38)	40 to 45
120 to 125 (49 to 52)	45 to 50

8. Preparation of Panels

8.1 *Five-Ply Plywood* (With faces and backs made with straight-grain, closed face walnut veneer having no sizing or other surface pretreatment) shall be prepared as follows:

8.1.1 Sand panels until smooth with No. 240 sandpaper, or equivalent.

8.1.2 Fill with representative walnut wood paste filler and allow to dry for 24 h at not less than 70 nor more than 80°F (27°C).

8.1.3 Spray a sufficient number of coats of about equal thickness of the test lacquer on the panel within an 8-h period to give a total dry film thickness of 3 ± 0.5 mil (75 ± 13 µm). Allow a minimum period of 2 h between coats. Do not edge or back the panel with any protective coating.

8.1.4 To minimize the effects of variations in the wood, apply a control lacquer of known performance to a portion of each panel in the same manner as the test lacquer. After aging, the panels may be cut (Note 2) into sections finished only with one lacquer, but each section should conform to the description given in Section 6.

NOTE 2—Cutting of panel is optional and may be contingent upon the size and capacity of the test equipment.

[4] These conditions were taken from the curve on p. 191 of the *Wood Handbook*, Forest Products Laboratory, Madison, WI.

8.1.5 The thickness of films applied to panels may be determined with reasonable accuracy by placing a metal panel adjacent to the wood panel being prepared and measuring the film thickness on the metal panel with a magnetic thickness gage. The plywood panel must be sanded and rubbed before testing and the use of waxes or oils should be closely regulated since these can make a difference in the results obtained. For sanding and rubbing procedure, see Guide D 2571.

8.2 *Panels of Five-Ply Plywood with Walnut Veneer for Complete Lacquer System*—Proceed as agreed upon by the purchaser and the seller.

8.3 *Panels of Solid Wood, Lighter or Heavier Veneers, or Other Species of Wood*—Proceed as agreed upon by the purchaser and the seller.

8.4 *General Treatment*—Except where specific agreements exist between the purchaser and the seller, all panels shall be subjected to the following treatment:

8.4.1 Prepare at least three panels for each lacquer or lacquer system and each other variable, such as type of panel, that may be under test.

8.4.2 Air-dry overnight.

8.4.3 Age finished test panels for ten days under conditions that will maintain a moisture content of 6 to 8 %.

9. Procedure

9.1 Place a predetermined number of panels, depending on the capacity of the oven and refrigerator, vertically in racks so that air can pass between all panels. The lacquered sides of the panels shall not face the walls of the heating or cooling units. Place the racks for 1 h in an oven at 120 ± 5°F (48.9 ± 3°C) in such a manner as to avoid localized overheating. At the expiration of this period, transfer the panels within 1 min to a refrigerating unit maintained at −5± 2°F (−21 ± 1°C) (unless special conditions indicate some other agreement between the purchaser and the seller). The number of panels shall be such that the time required to reach this temperature is not less than 30 min and not more than 45 min. The temperature can be measured by a thermocouple imbedded in the panel just underneath the film.

9.2 Remove the panels from the refrigerator after 1 h exposure. After allowing 15 min relaxation period, inspect the panels under a strong light. Best results will be obtained if the light source is directed from behind and over the shoulder of the observer. Circle checks with crayon, since they will often heal or at least appear to heal and become relatively invisible. Once the capacity of any given oven-refrigerator combination (number of panels that will permit specified rates of heating and cooling) has been determined, make all subsequent tests with this number of panels using dummy panels where necessary. If this precaution is not followed, rates of cooling and heating will differ each time the test is run, and reproducibility will suffer.

9.3 The period of 1 h at 120°F (49°C) followed by 1 h at −5°F (−21°C) and 30 min at room temperature (15 min relaxation period, 15 min to allow for inspection), constitutes one cycle. Repeat this cycle until failure occurs or until a prescribed minimum number of cycles has been obtained.

9.4 The failure end point is defined as the cycles on which innumerable fine lines appear as described in Section 3 or on

which a total of four checks (1 to 2 in. (25 to 50 mm) in length) or two checks (more than 2 in. (50 mm) in length) appear in the film. Exclude the outer ½-in. (13 mm) perimeter of panel when examining for failure (cracks).

9.5 Unless a laboratory operates on three shifts there will be a relaxation period every night and over week ends. The report should show when these rest periods occurred.

10. Report

10.1 Report the following information:

10.1.1 Type of construction, variety, and size of wood panels used, for example, 5-ply, 5⁄16-in. (8-mm) walnut veneer, 6 by 12 in. (152 by 305 mm),

10.1.2 Type of refrigerator, that is, "dry ice" or mechanical,

10.1.3 Finishing system and schedule of application, and

10.1.4 Number of cycles passed without failure and note of all wood failures, specifying the cycle on which such failures occurred.

11. Precision and Bias

11.1 *Precision*—Results on all three panels should fall within ± 2 cycles of the mean of all three panels. If this does not occur, additional panels shall be run until there are at least three panels which fall within this range. All panels that have been run are to be taken into consideration. This requirement also applies to panels finished with the control lacquer. Precision as stated here applies only to the test panels described in Section 7.

11.2 *Bias*—Since no accepted reference material exists, bias cannot be determined.

12. Keywords

12.1 clear lacquer; temperature cycles; wood substrates