



## Designation: D2322 – 14 (Reapproved 2023)

# Standard Test Method for Resistance of Shoe Upper Leather to Artificial Perspiration<sup>1</sup>

This standard is issued under the fixed designation D2322; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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

## 1. Scope

1.1 This test method covers the determination of the effect of perspiration on shoe upper leather. The leather is subjected to treatment with a formulation of artificial perspiration specific for breakdown of leather. Resistance to grain cracking as measured in accordance with Test Method [D2210](#) and area loss are used as the criterion of deterioration. The artificial perspiration may also affect the flexibility of the leather. However, these effects have not been fully evaluated as criteria of deterioration in this test method. This test method does not apply to wet blue.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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:*<sup>2</sup>

- [D1610 Practice for Conditioning Leather and Leather Products for Testing](#)
- [D2210 Test Method for Grain Crack and Extension of](#)

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee [D31](#) on Leather and is the direct responsibility of Subcommittee [D31.03](#) on Footwear. This test method was developed in cooperation with the American Leather Chemists Assn.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[Leather by the Mullen Test](#)

[D2813 Practice for Sampling Leather for Physical and Chemical Tests](#)

## 3. Significance and Use

3.1 This test method gives an indication of the serviceability of shoe upper leather in actual wear.

## 4. Apparatus

4.1 *Circulating-Air Oven*, capable of maintaining the required temperature within  $\pm 4$  °F ( $\pm 2$  °C).

4.2 *Bottle*, wide-mouth, ½-gal (1.9-L) with suitable airtight closure.

4.3 *Glass Tray*, 1½ in. (38 mm) deep.

4.4 *Mullen Tester*.

## 5. Reagent

5.1 A solution of artificial perspiration with a pH of 8.5 consisting of the following:

Sodium chloride, g	9.0
Urea, g	1.67
Sodium lactate (60 percent sodium lactate), g	86.0
Disodium phosphate ( $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$ ), g	0.165

Distilled water to make 1 litre of solution

Adjust the pH of the solution with lactic acid or ammonium carbonate depending on whether acid or base is required to bring pH to 8.5.

## 6. Test Specimens

6.1 Two test specimens 3 in. by 3 in.  $\pm 0.0625$  in. (76 mm by 76 mm  $\pm 1.5$  mm) each shall be cut from the sample to be evaluated. One specimen shall be the control, the other shall be for exposure to artificial perspiration. For purposes of identification, the specimen for exposure to artificial perspiration shall be punched (approximate 0.06 in. (1.5 mm) hole) on two corners.

6.2 When taking test specimens from skins or hides refer to Practice [D2813](#).

## 7. Conditioning

7.1 All specimens shall be conditioned according to Practice [D1610](#).

## 8. Procedure

8.1 Condition the control specimen at  $73\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$  ( $23\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ) and at a relative humidity of  $50\% \pm 4\%$  for 48 h and then test on the Mullen Tester for grain crack strength in accordance with Test Method **D2210**.

8.2 Measure all four sides of the punched specimen to the nearest  $\frac{1}{64}$  in. (0.5 mm) and average them. The average measurement shall be squared and used to determine the area of the specimen. Record area as *A*.

8.3 Immerse the marked specimen (**Note 1**) in the glass tray and cover with the artificial perspiration solution to a depth of  $\frac{3}{4}$  in. to 1 in. (19 mm to 25 mm). Work the specimen in the solution by folding it grain in and rolling the fold, while applying pressure with the finger tips. As many as three cycles of flexing may be required to wet the leather. If leather is still not wet through, vacuum soaking may be necessary.

**NOTE 1**—Only a single layer of specimen should be placed in the perspiration solution and care should be taken to prevent adjacent specimens from coming in contact.

8.4 After 1 h, remove the specimen and suspend in the  $\frac{1}{2}$ -gal (1.9-L) bottle over 1.7 oz (50 mL) of water. Seal the bottle containing the treated specimen (**Note 2**), and place into a circulating-air oven at  $158\text{ }^{\circ}\text{F}$  ( $70\text{ }^{\circ}\text{C}$ ) for 48 h (**Note 3**). At the end of this period of time remove the specimen from the bottle and hang up to dry at room temperature and humidity for 16 h.

8.5 Condition the specimen at  $73\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$  ( $23\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ) and at a relative humidity at  $50\% \pm 4\%$  for 48 h.

**NOTE 2**—It is important to have the jar or bottle completely sealed so that the specimens are in an atmosphere of 100 % relative humidity during the heating.

**NOTE 3**—For testing vegetable tanned leather a temperature of  $140\text{ }^{\circ}\text{F}$  ( $60\text{ }^{\circ}\text{C}$ ) should be maintained.

**NOTE 4**—Certain specimens may be so deformed as to make the Mullen determination impossible. Such specimens will be reported as having failed the test.

8.6 Remeasure the exposed specimen (see **8.2**). Record area as *B*. Then test on the Mullen Tester (see **Note 4**) for grain crack strength in accordance with Test Method **D2210**.

## 9. Calculation

9.1 Calculate the percentage change in grain crack strength as follows:

$$\text{Change in grain crack strength, \%} = [(C - E)/C] \times 100 \quad (1)$$

where:

*C* = grain crack strength of control specimen, lbf (or N), and  
*E* = grain crack strength of exposed specimen, lbf (or N).

9.2 Calculate percentage change in area as follows:

$$\text{percent area loss} = [(A - B)/A] \times 100 \quad (2)$$

where:

*A* = original area of the specimen, and  
*B* = area of exposed specimen.

9.2.1 In the event of an increase in area of the test specimen, calculate as follows:

$$\text{percent area gain} = [(B - A)/A] \times 100 \quad (3)$$

## 10. Report

10.1 Report the following information:

10.1.1 Grain crack strength, in pounds-force (or newtons), of each specimen exposed to artificial perspiration solution, and

10.1.2 Percentage changes in grain crack strength.

10.1.3 Percentage change in area shall be reported to the nearest 0.1 %.

## 11. Precision and Bias<sup>3</sup>

11.1 The coefficient of variation of measurements of grain crack strength of duplicate or adjacent specimens from the same skin by this method is not greater than 20 %.

11.2 Results of two laboratories, duplicate specimens, same skin, should not be considered suspect unless the two average results differ by more than 40 %.

## 12. Keywords

12.1 area stability; grain crack; leather; perspiration

<sup>3</sup> Supporting data for this test method has been filed at ASTM International Headquarters as RR:D31-1005.

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