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**Leather — Physical test methods —  
Determination of water resistance of  
heavy leathers**

*Cuir — Méthodes d'essais physiques — Détermination de la résistance  
à l'eau des cuirs épais*

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Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
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## Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 5404 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 289, *Leather*, in collaboration with the Physical Test Commission of the International Union of Leather Technologists and Chemists Societies (IUP Commission, IULTCS), in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

IULTCS, originally formed in 1897, is a world-wide organization of professional leather societies to further the advancement of leather science and technology. IULTCS has three Commissions, which are responsible for establishing international methods for the sampling and testing of leather. ISO recognizes IULTCS as an international standardizing body for the preparation of test methods for leather.

This second edition cancels and replaces the first edition (ISO 5404:2002), which has been technically revised in the following clauses and subclauses: 5.1.2, 5.2, 5.3, 6.1, 7.1.5, 7.3, 7.4, 8 and 9.

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# Leather — Physical test methods — Determination of water resistance of heavy leathers

## 1 Scope

This International Standard specifies a method for determining the water resistance of heavy leathers. The method allows determination of the penetration time, water absorption, area of penetration and water penetration rate as required. It is applicable to all types of heavy leathers.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2418, *Leather — Chemical, physical and mechanical and fastness tests — Sampling location*

ISO 2419, *Leather — Physical and mechanical tests — Sample preparation and conditioning*

ISO 2589, *Leather — Physical and mechanical tests — Determination of thickness*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1 penetration time

duration of flexing which is just sufficient to cause water to cross from the wetted (grain) surface to the other face of the test piece

NOTE The penetration time is expressed in minutes.

### 3.2 water absorption

gain in mass of the test piece due to water content during any period of the test

NOTE Water absorption is expressed as a percentage of the conditioned mass of the test piece prior to test.

### 3.3 area of penetration

sum of the areas where water has crossed from the wetted (grain) surface to the other face of the test piece

NOTE The area is expressed in square millimetres.

### 3.4 penetration rate

rate at which water is transmitted through the leather

NOTE The penetration rate is expressed in grams per square centimetre (of leather) per hour, based on the mass of water transmitted in the 10 min period after the first penetration of water.

## 4 Principle

The test piece is continuously wetted on one surface and is flexed and compressed in the same manner as the sole of a shoe during walking. This enables various aspects of heavy leather water resistance to be measured with respect to time.

## 5 Apparatus

**5.1 Test machine**, including the items described in 5.1.1 to 5.1.7. The general arrangement of the test machine is shown in Figure 1.

**5.1.1 Roller (A)**, diameter 120 mm  $\pm$  2 mm and width at least 50 mm.

**5.1.2 Platform (C)**, measuring 100 mm  $\pm$  1 mm  $\times$  40 mm  $\pm$  1 mm, with a roughened upper surface and sufficient perforations to keep the surface wet by a flow of water through the platform.

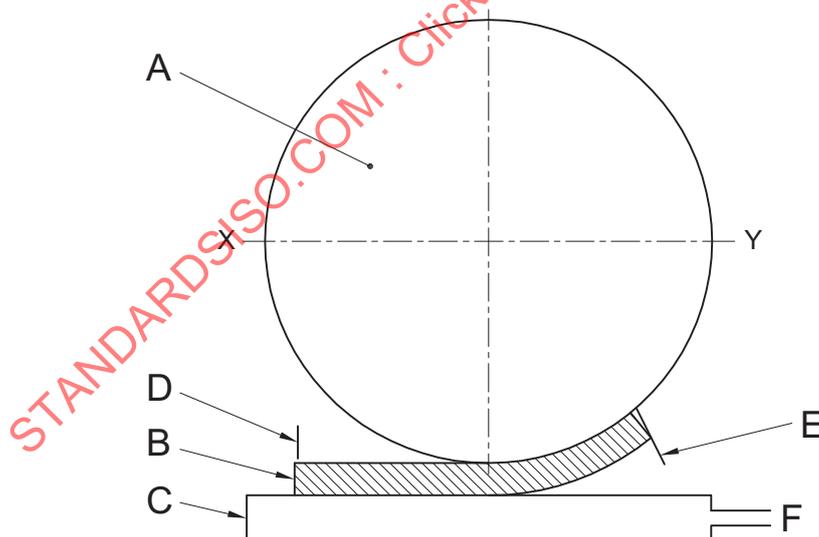
**5.1.3 Clamp (D)**, to hold one short side of the test piece (B) in a horizontal position on the platform (C).

**5.1.4 Clamp (E)**, to attach the other short side of the test piece to the roller, the attached side being parallel to the axis of the roller. The clamp is held by a weak spring to maintain the sample under slight tension. The positioning of clamps D and E shall ensure a total length of test piece on the platform of 100 mm  $\pm$  1 mm.

**5.1.5 Water supply (F)**, through the platform (C) and a means of draining away excess water.

**5.1.6 Means of moving the axis of the roller**, using a crank motion along the horizontal line XY with an amplitude of 100 mm  $\pm$  2 mm and a frequency of (20  $\pm$  1) cycles per minute about a point directly over the mid-point of the test piece. The movement of the axis causes the roller to move backwards and forwards along the test piece, raising one end and bending it to conform to the shape of the roller.

**5.1.7 Means of pressing the platform**, test piece and roller together with a force of 80  $\pm$  5 N.



### Key

- A roller
- B test piece
- C platform
- D clamp
- E clamp
- F water supply

Figure 1 — General arrangement of test machine

- 5.2 Undyed cotton gauze**, cut into rectangles of suitable dimension to be fixed on the platform.
- 5.3 Press knife**, the inner wall of which is a rectangle of suitable length to be fixed in the clamps so that the total length of the test piece on the platform is  $100\text{ mm} \pm 1\text{ mm}$  with a width of  $40\text{ mm} \pm 1\text{ mm}$ , as specified in ISO 2419.
- 5.4 Thickness gauge**, as specified in ISO 2589.
- 5.5 Absorbent cellulosic board**, thickness  $1,6\text{ mm} \pm 0,1\text{ mm}$  and mass  $1\ 200\text{ g/m}^2 \pm 300\text{ g/m}^2$ , cut into rectangles of  $(105\text{ mm} \pm 5\text{ mm} \times 60\text{ mm} \pm 5\text{ mm})$ .
- 5.6 Abrasive paper**, grade P120, as defined in the P-series grit size standard published by the Federation of European Producers of Abrasive Products.
- 5.7 Balance**, reading to 0,001 g.
- 5.8 Clock**, reading to 1 s.
- 5.9 Flexible waterproof adhesive**, for example polychloroprene, poly(vinyl chloride) or polyurethane.
- 5.10 Transparent overlay**, minimum size  $100\text{ mm} \times 40\text{ mm}$ , marked with a central matrix of  $28 \times 10$  squares of  $9\text{ mm}^2$ , as shown in Figure 2.



Figure 2 — Transparent overlay

## 6 Sampling and sample preparation

**6.1** Sample in accordance with ISO 2418. Cut at least three test pieces from the laboratory sample by applying the press knife (5.3) to the grain surface, oriented with the longer side parallel to the backbone.

If there is a requirement for more than two hides or skins to be tested in one batch, then only one test piece need be taken from each hide or skin, provided that the overall total is not less than three test pieces.

**6.2** Place the surface which is to be in contact with the ground (normally the grain surface), on a fresh piece of abrasive paper (5.6). Press the test piece against the abrasive paper with a force of  $10\text{ N} \pm 1\text{ N}$ . Roughen the leather surface by moving the test piece ten times backwards and forwards on the abrasive paper over a length of  $100\text{ mm} \pm 10\text{ mm}$  each time.

**NOTE** Thin waterproof finish applied to the grain of sole leather can greatly reduce water penetration during the test, but can be ineffective on a sole in practice because it is rapidly removed during wear. For this reason, the test pieces are roughened as described above prior to testing. The aim of this preparation is to remove the finish. If a heavier finish has been applied, then more abrasion may be required.

**6.3** Apply a coat of flexible adhesive (5.9) to the cut edges of the test piece, ensuring that there are no air bubbles within the coat. Allow to dry for  $35\text{ min} \pm 5\text{ min}$  and, if necessary, apply a second coat of adhesive.

**6.4** Condition the test piece in accordance with ISO 2419.

**6.5** If the water penetration rate is to be determined, condition the cellulosic board (5.5) in accordance with ISO 2419.

## 7 Procedure

### 7.1 General

7.1.1 Weigh the test piece,  $m_0$ , to the nearest 0,001 g.

7.1.2 Determine the thickness in accordance with ISO 2589.

7.1.3 Place the cotton gauze (5.2) on the platform and adjust the flow of water to give a flow of 7,5 ml/min  $\pm$  2,5 ml/min over the platform.

7.1.4 Lay the test piece on the gauze with the roughened surface downwards and attach the narrow ends to the platform and roller.

7.1.5 Press the test piece on the roller with a force of 80 N  $\pm$  5 N.

7.1.6 Set the roller in motion and record the time.

### 7.2 Determination of penetration time

Note the time at which water is clearly seen on the leather surface adjacent to the roller, ignoring any penetration that occurs within an area 5 mm from the edge of the test piece.

An acoustic or optical signal may be used to help detect initial water penetration, but the effective penetration of water shall be checked by visual observation.

### 7.3 Determination of water absorption

7.3.1 At the end of a specified period of time (i.e. 15 min, 30 min, 60 min or when penetration of water occurs), stop the machine, remove the test piece and blot it lightly with filter paper to remove water adhering to the surface, taking care not to force water out of the sample. Weigh the test piece,  $m_1$ , to the nearest 0,001 g.

7.3.2 If the determination of water absorption after longer periods of time is required, return the test piece to the machine and continue the test.

7.3.3 Repeat the procedure until the test is completed (see 7.5.4).

### 7.4 Determination of area of penetration

7.4.1 At the end of the first hour of testing, stop the machine and remove the test piece. Lay the transparent overlay over the upper surface of the test piece and estimate the total area of penetration by comparing the wetted areas, if any, with the areas marked on the overlay. If visual examination shows that wetting of the upper surface starts from the edge, then the test shall be regarded as invalid and repeated with a fresh test piece.

7.4.2 If a determination of the area of penetration after longer periods of time is required, return the test piece to the machine and continue the test.

7.4.3 Repeat the procedure until the test is completed (see 7.5.4).

## 7.5 Determination of water penetration rate

7.5.1 Weigh a rectangle of cellulosic board (5.5),  $m_2$ , to the nearest 0,001 g.

7.5.2 When the first penetration of water occurs, stop the machine and wipe the roller to remove any water adhering to it. Place a weighed rectangle of cellulosic board between the test specimen and roller and restart the machine. After a further 10 min  $\pm$  0,2 min, stop the machine, remove the board and reweigh,  $m_3$ . If the cellulosic board has no dry parts, the results shall be rejected and the test repeated with a fresh test piece and absorbent board, reducing the test period and correcting the calculation for water penetration rate accordingly.

7.5.3 If a determination of the water penetration rate after longer periods of time is required, return the test piece to the machine and continue the test.

7.5.4 The period during which the machine is stopped to weigh the test piece, measure the area of penetration or insert or remove absorbent boards should be as short as possible, and the fact that the machine was stopped during these periods is ignored in the measurement of the intervals:

## 8 Expression of results

### 8.1 Water absorption

The water absorption  $w_a$ , expressed as a percentage (%), shall be calculated using the formula:

$$w_a = \frac{(m_1 - m_0) \times 100}{m_0}$$

where

$m_1$  is the mass of the test piece after any test period, in grams;

$m_0$  is the initial conditioned mass of the test piece, in grams.

### 8.2 Water penetration rate

The water penetration rate,  $q_{wp}$ , in grams per square centimetre hour ( $g/cm^2 \cdot h$ ), shall be calculated using the formula:

$$q_{wp} = \frac{(m_3 - m_2)}{t \times A}$$

where

$m_3$  is the mass of the absorbent board, in grams, after any 10 min test period;

$m_2$  is the initial conditioned mass of the absorbent board, in grams;

$t$  is the period of calculation of penetration rate, in hours, i.e. 10 min after the penetration of water;

$A$  is the contact area of the test piece on the platform, i.e. 40  $cm^2$ .