BRITISH STANDARD

BS EN 1931:2000
Incorporating Corrigendum No. 1

Flexible sheets for waterproofing — Bitumen, plastic and rubber sheets for roof waterproofing — Determination of water vapour transmission properties

The European Standard EN 1931:2000 has the status of a British Standard

ICS 75.140; 83.140.10; 91.100.50

National foreword

This British Standard is the official English language version of EN 1931:2000, including corrigendum February 2001.

The UK participation in its preparation was entrusted by Technical Committee B/546, Flexible sheets for waterproofing, to Subcommittee B/546/1, Bituminous roofing felts, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 12, an inside back cover and a back cover.

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This British Standard, having been prepared under the direction of the Sector Committee for Building and Civil Engineering, was published under the authority of the Standards Committee and comes into effect on 15 September 2000

Amendments issued since publication

Amd. No.	Date	Comments
13231 Corrigendum No. 1	17 September 2001	Correction to EN foreword

ISBN 0 580 36356 2

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1931

July 2000

ICS 91.100.50

Incorporating corrigendum February 2001

English version

Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of water vapour transmission properties

Feuilles souples d'étanchéité - Feuilles d'étanchéité de toiture bitumineuses, plastiques et élastomères - Détermination des propriétés de transmission de la vapeur d'eau

Abdichtungsbahnen - Bitumen-, Kunststoff- und Elastomerbahnen für Dachabdichtungen - Bestimmung der Wasserdampfdurchlässigkeit

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1931:2000 E

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 254, Flexible sheets for waterproofing, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2001, and conflicting national standards shall be withdrawn at the latest by July 2002.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard has been prepared by the Technical Committee CEN/TC 254 to determine the water vapour transmission properties of flexible sheets for waterproofing.

This standard has been prepared for applications in roofing but it may also be used in other areas where it is relevant.

This standard is intended for characterization of flexible sheets for waterproofing as manufactured or supplied before use. This standard relates exclusively to products and not to waterproofing membrane systems composed of such products and installed in the works.

1 Scope

This European Standard specifies a method for the determination of the water vapour transmission properties and for the calculation of the density of moisture flow rate g and of the moisture resistance factor μ of waterproofing sheets. It is applicable to factory made bitumen, plastic and rubber sheets for roof waterproofing.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of these publications apply to this draft European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

prEN 13416:1998, *Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Rules for sampling*

EN 12591, *Bitumen and bituminous binders - Specifications of paving grade bitumen*

3 Definitions

For the purpose of this standard, the following definitions apply.

	Symbol	Unit
3.1 Density of moisture flow rate: The mass of water vapour transmitted through a unit area of the sheet of specified thickness in a unit time under specified conditions of temperature and humidity, quantity defined by the following relation:		
$g = \frac{\Delta m}{A \times \Delta t}$	g	kg/(m².s)
where A is the exposed area of the test specimen in m² and Δt is the time interval between two corresponding weighings of the test assembly in s.		
3.2 Moisture permeance: Quantity defined by the following relation:		
$w_p = \frac{g}{(p_1 - p_2)}$	w_p	kg/(m².s.Pa)
where p_1 and p_2 are ambient partial vapour pressures at the two faces of the specimen during the test.		
3.3 Moisture permeability: Quantity defined by the following relation:		
$\delta_p = w_p \times d$	δ_p	kg/(m.s.Pa)
where d is the thickness of the test specimen in m.		
3.4 Moisture resistance factor: Quantity defined by the following relation:		
$\mu = \frac{\lambda_{ma}}{\delta_p}$	μ	
where λ_{ma} is the moisture conductivity of air and may be calculated as given under 9.1.	λ_{ma}	kg/(m.s.Pa)
3.5 Water vapour diffusion-equivalent air layer thickness: Quantity defined by the following relation:		
$s_d = \mu \times d$	s_d	m
where d is the thickness of the test specimen in m.		

4 Principle

The test specimen is sealed to the open flange of a test cup containing a desiccant. The assembly is then placed in an atmosphere with a controlled temperature and humidity. When mass take-up is linear over a period of time, the assembly is weighed periodically to determine the density of moisture flow rate through the test specimen into the desiccant.

Due to the nature of the bitumen, plastic or rubber sheets concerned, the test procedure given in this standard consists of two methods:

4.1 Method A: test procedure for bitumen sheets.

4.2 Method B: test procedure for plastic or rubber sheets.

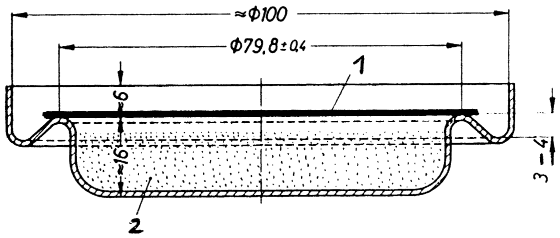
The technical content of the standard is, where relevant, adapted to these parts accordingly (e.g. clause 6, Preparation of test specimens).

5 Apparatus

5.1 Cups (Absorption atmosphere)

Use cups of pure, cold drawn aluminium of 1 mm thickness, which guarantee a free test area of 0,005 m² , total weight of specimen-mounted cup and desiccant must not exceed capability of the analytical balance used (accuracy ±0,1 mg), as represented in figure 1.

Dimensions in millimetres



Key

1 Test specimen
2 Desiccant

Figure 1 - Aluminium cup with absorption atmosphere

5.2 Mechanical gauge to determine the thickness *d* of specimen to the nearest 0,05 mm.

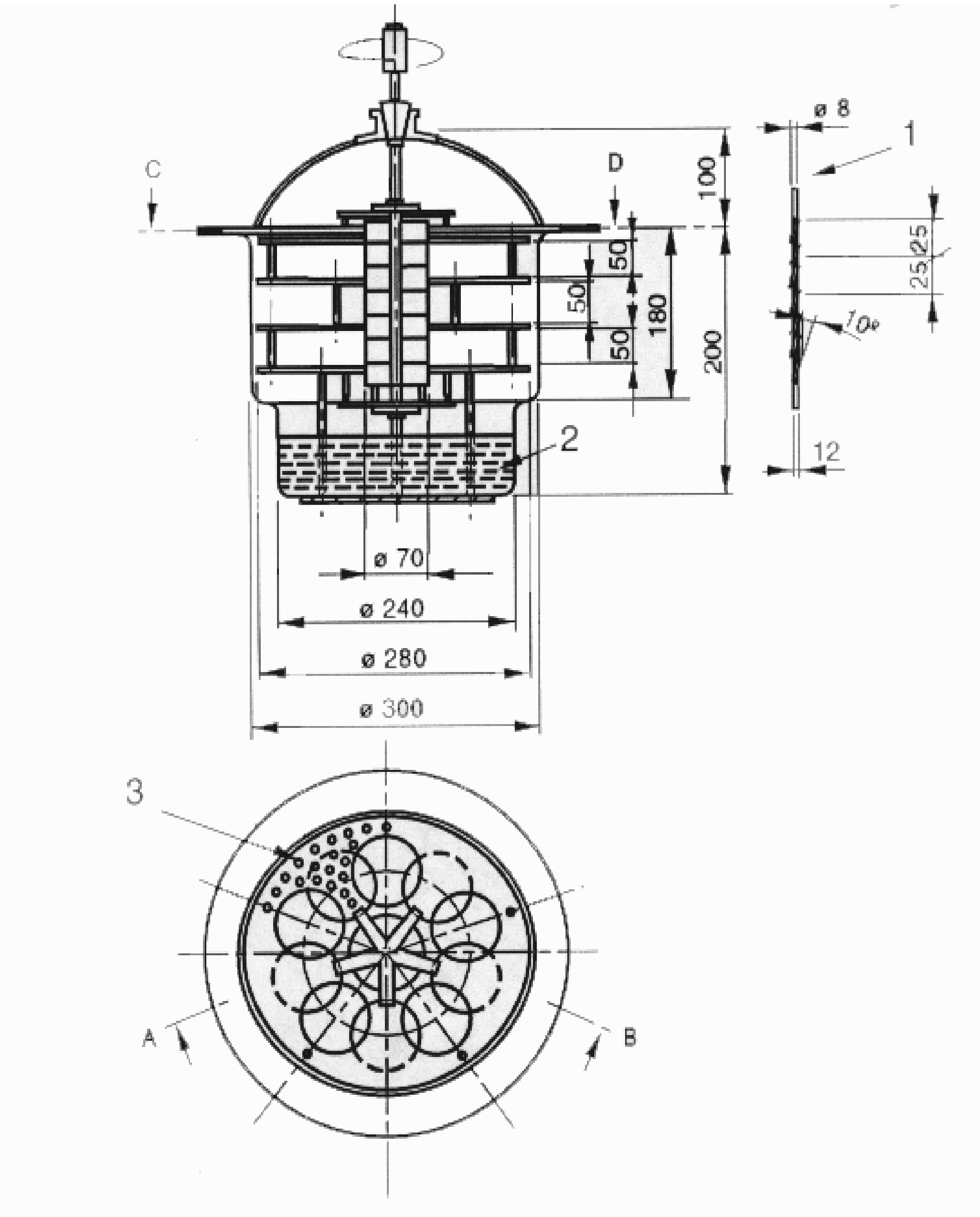
5.3 Analytical balance, capable of weighing the specimen-mounted cup (5.1) with an accuracy of ±0,1 mg.

5.4 Constant-temperature, constant-humidity chamber capable of maintaining a relative humidity of (75 ± 2) % and a temperature of (23 ± 1) °C.

Alternatively, use a room or chamber that can be maintained at (23 ± 1) °C together with a desiccator containing a sodium chloride solution, saturated at 23 °C and containing a large excess of undissolved sodium chloride.

The relative humidity at the upper test specimen surface must be kept constant during test. An air movement of 0,02 m/s to 0,3 m/s in the vaporizing atmosphere shall be produced by a propeller.

Dimensions in millimetres



Key

1 side view of the propeller with blades
2 saturated salt solution with remaining solid at the bottom
3 125 holes ∅ 8 per plate

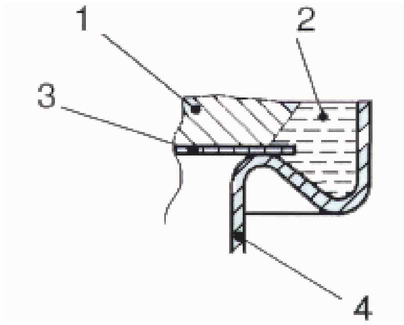
Figure 2 - Evaporation atmosphere (example of installation; shown without cups)

5.5 Desiccator: for the transfer of test specimens.

5.6 Desiccant: Anhydrous calcium chloride with particles size of about 5 mm in diameter, free of fines that will pass a 600 µm sieve. The relative humidity in the cup atmosphere shall not exceed 1 %. During the test period the total mass increase of desiccant shall not be greater than 1,5 g per 25 cm^3.

5.7 Sealant: Sealing compound to create a vapour tight seal between the specimen and the cup (absorption atmosphere), e.g. extruded sealant, type Butyl or Polyisobutylene or bituminous binder, paving grade bitumen 35/50 according to EN 12591.

Key



1 Inner template
2 Sealing compound
3 Test specimen
4 Cup according to picture 1

Figure 3 - One arrangement for sealing

5.8 Template or sizing form: auxiliary device for the sealing procedure.

If used during sealing procedure only, d_{outside} = (79,8 ± 0,4) mm.

If used also during test procedure, d_{inside} = (79,8 ± 0,4) mm.

5.9 Barometer: capable of measuring barometric pressure with an accuracy of ±1 hPa.

6 Sampling

Test samples shall be taken in accordance with prEN 13416:1998.

7 Preparation of test specimens

7.1 Procedure of sampling

Test specimens shall be taken evenly across the width of the sheet, the outer ones 100 mm away from the edges.

7.2 Number of test specimens

At least three test specimens and one reference specimen shall be taken.

7.3 Dimensions of the test specimens

Circular test specimens, which are adjusted to the dimensions of the cup (*d* ~ 90 mm). The specified free surface of test specimen of 0,005 m² is equivalent to *d* = 79,8 mm.

7.4 Conditioning of test specimens

7.4.1 Method A

Store the test specimens mounted on the cup for at least 90 days at 23 °C / 75 % R.H. before weighing the first time to the nearest 0,1 mg.

7.4.2 Method B

After the test specimens are mounted on the cup, weigh the assembly to the nearest 0,1 mg and then store at 23 °C / 75 % R.H. in the test chamber.

8 Procedure

8.1 Test conditions

Climatic chamber or evaporation area:	(23 ± 1) °C / (75 ±2) % R.H.
Convection:	0,02 to 0,3 m/s
Closed absorption area of cup:	(23 ± 1) °C / (0 + 1) % R.H.

8.2 Procedure

Place a layer of desiccant (5.6) of approximately 12 mm thickness on the bottom of the cup (5.1). Leave a space of 3 mm to 4 mm between desiccant and specimen. Seal the test specimen in the cup and weigh to the nearest 0,1 mg. Place the cup in a constant-temperature, constant-humidity chamber (5.4) maintained at (23 ± 1) °C and (75 ± 2) % relative humidity. Alternatively place the cup in a desiccator containing the sodium chloride solution and place in a room or chamber maintained at a temperature of (23 ± 1) °C.

Seal one test specimen in the cup without desiccant as a reference specimen and handle in the same way as the test specimens during the test procedure.

For waterproofing sheets with a density of moisture flow rate anticipated to be less than 1,157 4 x 10^{-8} kg/(m².s), at intervals of one week, quickly remove the cup from the chamber (5.4) and store it in the test specimen transfer desiccator (5.5) at room temperature for (30 ± 10) min; then weigh the cup to the nearest 0,1 mg. After weighing, shake the cup to mix the desiccant, then return the cup to the chamber.

NOTE: It is not necessary to place the cup in the transfer desiccator (5.5) if conditioning and testing are conducted in the same constant temperature and humidity rooms.

Plot the measured mass against time at weekly intervals and terminate the test when four consecutive points, excluding the initial weighing, lie on a straight line with a deviation of at most 5 %.

Having a variation in barometric pressure the cup may act as an "air ship" caused by buoyancy. For materials with a low density of moisture flow rate [i.e. lower than g = 5,787 0 x 10^{-9} kg/(m².s)] it is necessary to perform weighings on the days with a similar barometric pressure (±5 hPa). This is the best way to take account of the buoyancy effect caused by large day to day pressure variations.

9 Expression of results and precision of test method

9.1 Expression of results

Taking the reference into account beforehand, calculate the density of moisture flow rate, g, for every test specimen using the following equation.

$$g = \frac{\Delta m_{21}}{A \times \Delta t}$$

where:

Δm_{21} is the rate of mass change determined from the endpoints of the straight line graph in kg;

$\Delta m_{21} = (m_2 - m_1) - (m_{R2} - m_{R1})$

where:

m_2, m_1 is the mass of the test assembly, in kg;

m_{R2}, m_{R1}: is the mass of the reference assembly, in kg;

A is the exposed area of the test specimen, in m²;

Δt is the time interval between two corresponding weighings of the test assembly in s.

The mean value and the standard deviation of the density of moisture flow rate, g, for the three test specimens shall be calculated.

The moisture resistance factor, μ, is given by the equation:

$$\mu = \frac{1}{d}\left(\lambda_{ma}\frac{(p_1 - p_2)}{g} - s_a\right)$$

where:

- d is the mean value of the test specimen thickness in m;
- g is the mean value of the density of moisture flow rate in kg/(m².s), as calculated above;
- λ_{ma} is the moisture conductivity of air, depending on barometric pressure and temperature, calculated by the following relation:

$$\lambda_{ma} = \frac{0{,}083/3\,600}{R_D \times T} \times \frac{p_0}{p}\left(\frac{T}{273}\right)^{1{,}81}$$

where:

- R_D is the gas constant for water vapour: 462 Nm/(kg.K);
- T is the test temperature in K;
- p is the mean barometric pressure during test in hPa, depending on location and weather;
- p_0 is the standard barometric pressure: 1 013,25 hPa;
- p_1, p_2 are the water vapour pressures at the test specimen surfaces in Pa;
- s_a is the mean value of air layer thickness in diffusion cup underneath the test specimen in m. (If the water vapour diffusion-equivalent air layer thickness s_d > 1,0 m, s_a is not taken into account).

Simplified calculation procedure

For flexible sheets for waterproofing, s_a is not taken into account, hence the relation to calculate μ simplifies to:

$$\mu = \lambda_{ma}\frac{(p_1 - p_2)}{g \times d} \qquad \text{with } g = \frac{\Delta m_{21}}{A \times \Delta t} \text{ as described above.}$$

To ease the calculation of the moisture resistance factor, μ, according to the simplified equation, on the relation of all the constants are combined to one constant equivalent to $1{,}977\,62 \times 10^{-7}$ for 23 °C.

The equation:

$$\lambda_{ma} = \frac{0{,}083/3\,600}{R_D \times T} \times \frac{p_0}{p}\left(\frac{T}{273}\right)^{1{,}81} \text{ simplifies to } \lambda_{ma} = \frac{1{,}977\,62 \times 10^{-7}}{p}$$

At the test condition of 75 % R.H. a water vapour pressure difference of Δ_p = 2 107 Pa results. Based on this pressure difference, the moisture resistance factor, μ, is easily calculated having determined the mean barometric pressure, p, and the density of moisture flow rate, g, according to:

$$\mu = \frac{1{,}977\,62 \times 10^{-7}}{p} \times \frac{2\,107}{g \times d}$$

which simplifies to:

$$\mu = \frac{4{,}166\,8 \times 10^{-4}}{p \times g \times d}$$

9 2 Precision of test method

The total uptake of moisture by the desiccant may not exceed 1,5 g per 25 cm^3 during the measurement.

The test procedure according to this standard is most applicable for density of moisture flow rate, *g*, of at least $g = 1{,}157\,4 \times 10^{-8}$ kg/(m².s).

If the test conditions are chosen appropriately (e.g. correction of barometric pressure, long test period, constant climate) this test procedure is still applicable for values of $g = 5{,}787\,0 \times 10^{-9}$ kg/(m².s).

10 Test report

The test report shall include at least the following information:

a) all details necessary to identify the product tested;

b) a reference to this European Standard (EN 1931) and any deviation from it;

c) information on sampling in accordance with clause 6;

d) details of preparation of test specimens in accordance with clause 7;

e) test procedure indicating method (A or B) used and any deviation;

f) the actual thickness of the test specimens

- the test results of density of moisture flow rate, *g*, of each test specimen, the mean value and standard deviation
- the moisture resistance factor , μ ;

in accordance with clause 9;

g) the dates of the tests.

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ISO 1663-1981, *Cellular plastics - Determination of density of moisture flow rate of rigid materials*

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EN 1849-2:2000, *Flexible sheets for waterproofing - Determination of thickness and mass per unit area - Part 2: Plastic and rubber sheets for roof waterproofing*

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