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Stretched ceilings - Requirements and test methods

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Foreword

This document (EN 14716:2004) has been prepared by Technical Committee CEN/TC BT/TF 119 “Stretched ceilings”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by June 2005, and conflicting national standards shall be withdrawn at the latest by June 2005.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

For relationship with EC Directive(s), see informative Annex ZA, which is an integral part of this standard.

It does not supersede any existing standard.

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

1 Scope

This document specifies the characteristics, specifications and test methods for stretched ceilings made up of single or multi-layer sheets, coated fabrics or fabrics made up of coated or monofilament yarn with a fastening system.

It also specifies the method of conformity assessment for stretched ceilings.

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.

EN 1875-3, *Rubber- or plastics-coated fabrics - Determination of tear strength. Part 3: Trapezoidal method.*

EN 12149, *Wall coverings in roll form - Determination of migration of heavy metals and certain other elements, of vinyl chloride monomer and of formaldehyde release*.

EN 12280-1, *Rubber- or plastics-coated fabrics - Accelerated ageing tests - Part 1: Heat ageing*.

EN 13238, *Reaction to fire tests for building products - Conditioning procedures and general rules for selection of substrates.*

EN 13501-1, *Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests*.

EN 13823, *Reaction to fire tests for building products - Building products excluding floorings exposed to the hermal attack by a single burning item*.

EN ISO 105-B02, *Textiles - Tests for colour fastness - Part B02: Colour fastness to artificial light: Xenon arc fading lamp test (ISO 105-B02:1994, including Amendment 1:1998).*

EN ISO 527-1, *Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1:1993 including Corr 1:1994).*

EN ISO 527-3, *Determination of tensile properties - Part 3: Test conditions for films and sheets (ISO 527-3:1995).*

EN ISO 846, *Plastics - Evaluation of the action of microorganisms (ISO 846:1997).*

EN ISO 1182, *Reaction to fire tests for building products - Non-combustibility test (ISO 1182:2002)*.

EN ISO 1421, *Rubber- or plastics-coated fabrics - Determination of tensile strength and elongation at break (ISO 1421:1998).*

EN ISO 1716, *Reaction to fire tests for building products - Determination of the heat of combustion (ISO 1716:2002).*

EN ISO 2286-2, *Rubber- or plastics-coated fabrics - Determination of roll characteristics - Part 2: Methods for determination of total mass per unit area, mass per unit area of coating and mass per unit area of substrate (ISO 2286-2:1998).*

EN ISO 9001, *Quality management systems - Requirements (ISO 9001:2000).*

EN ISO 11925-2, *Reaction to fire tests - Ignitability of building products subjected to direct impingement of flame - Part 2: Single-flame source (ISO 11925-2:2002).*

ISO 2528:1995, *Sheet materials - Determination of water vapour transmission rate - Gravimetric (dish) method.*

3 Terms and definitions

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

3.1
stretched ceilings
ceiling coverings comprising a continuous area obtained from one width or assembled widths kept under tension at its edges by a fastening system permitting dismantling and re-assembly

These widths may be single or multi-layered sheets, coated fabrics or fabrics made up of coated yarn or monofilaments. Stretched ceilings may be perforated or not

3.2
product family
total range of products within specific variability limits (defined by the manufacturer or a technical specification) of the product parameters and, if appropriate, of the final use parameters for which the specified safety characteristics do not change (do not deteriorate)

This means that the test results obtained for one product in the family remain valid for all the products in the family

3.3
edge profile
element fixed at the periphery of the ceiling to keep the ceiling stretched

3.4
anchoring device
element connecting the stretched ceiling to the edge profile

4 Requirements relating to sheets and coated fabrics or fabrics made up of coated yarn or monofilaments

4.1 Essential requirements

4.1.1 Reaction to fire

4.1.1.1 Preparation and conditioning of test pieces

The test pieces shall be conditioned prior to the test in accordance with EN 13238.

4.1.1.2 Ignitability test

The ignitability test shall be carried out in accordance with EN ISO 11925-2.

The flame shall be applied to the surface of the test piece fixed on the test piece holder by means of small pins incorporated in the surface of the U-shaped frame

4.1.1.3 SBI "Single Burning Item" test

Carry out the reaction to fire test in accordance with EN 13823.

The stretched ceilings shall be tested perpendicularly in the test piece holder trolley for the SBI comprising one small wing (550 ± 5) mm × (1 500 ± 5) mm and one large wing (1 000 ± 5) mm × (1 500 ± 5) mm.

a) In the case of single or multi-layered sheets, take 850 mm × 1 800 mm of the sheet to make the small wing and 1 300 mm × 1 800 mm to make the large wing. Stretch the sheet in the transverse direction across a calcium silicate panel with a tensile force of 30 daN/m determined in accordance with EN ISO 527-3.

   There shall be an air gap of 40 mm between the stretched ceiling and the substrate when assembling the ceiling. This air gap is obtained by means of a calcium silicate frame of desired thickness fixed to the perimeter of the substrate of the small and the large wing.

   The final configuration may be obtained by pinching the stretched ceiling at the back of the substrate by means of an aluminium track and a PVC ring. Adequate tension shall be applied to obtain a satisfactory degree of flatness and no creasing over the whole of the exposed surface (see Figure A.1 in Annex A).

b) In the case of coated fabrics or those made of coated yarn or monofilaments, take a 1 500 mm × 1 500 mm test piece. Fix the test piece to a metallic frame (see Figures A.2, A.3 and A.4 in Annex A). This frame comprises an assembly of stainless steel tubes of rectangular cross-section forming two perpendicular wings, one small and one large.

   Attach the test piece to the peripheral members of the frame by means of the steel pins. Prior to the test, the test piece shall be adequately stretched and flat so that no more that 30 % of the total exposed surface shrinks by more than 10 mm from the coplanar vertical plane at the back of the U-profile

   Then place the frame against the U-profile on the test piece holder trolley. To be representative of the final use, conduct the test with a ventilated space 80 mm wide at the back of the test piece in accordance with EN 13823.

   Attach two calcium silicate walls made up of one small wing of (580 ± 5) mm × (1 500 ± 5) mm and one large wing of (1 080 ± 5) mm × (1 500 ± 5) mm vertically 80 mm from the test piece. The sides furthest away from the angle and the spaces behind each wing shall be left open.

4.1.1.4 Requirements

If the manufacturer wishes to make a declaration of the reaction to fire performance (i.e. if the stretched ceiling is subject to regulations), the stretched ceilings shall be subjected to the test and be classified in accordance with the requirements of EN 13501-1 and the resulting class shall be declared.

If it is decided not to declare a reaction to fire performance, i.e. to place a product family on the market as a class F product, no test is required for this product family.

4.1.2 Release of other dangerous substances

4.1.2.1 Heavy metals and other elements

4.1.2.1.1 Requirements

The migration of heavy metals and other elements, expressed in mg/kg of stretched ceiling, shall not exceed the values given in Table 1 (after correction as specified in 4.1.2.1.2) when measured in accordance with test A in EN 12149.

If none of these substances is added during manufacture and if the raw materials are certified by the supplier as not containing these substances, the test is not necessary.

4.1.2.1.2 Interpretation of results

The analytical results obtained in the tests specified in EN 12149 shall be corrected by subtracting the analytical correction factors given in Table 2 to obtain a corrected analytical result.

The stretched ceilings are considered as satisfying the requirements of this document if the corrected analytical result is equal to or less than the limits indicated in Table 1.

NOTE 1 Given the reliability of the methods specified in this EN 12149, it is necessary to use the corrected analytical results to take into account the results of the interlaboratory tests (see Annex D of EN 71-3).

Example: analytical result for lead: 120 mg/kg.
Corresponding analytical correction in Table 2: 30 %.
Corrected analytical result = 120 - (120 × 30) / 100 = 120 - 36 = 84 mg/kg. This is considered to meet the requirements of the standard (lead: 90 mg/kg).

NOTE 2 The measuring methods used in EN 12149 are derived directly from EN 71-3 on the safety of toys. Annex D of EN 71-3, in particular D.4 "Statistical uncertainty of the test procedure and interpretation of results", justifies the introduction of a correction factor.

Table 1 — Maximum migration of heavy metals and other elements

Heavy metal or element	Symbol	Maximum migration in mg/kg of stretched ceiling
Antimony	Sb	60
Arsenic	As	25
Barium	Ba	500
Cadmium	Cd	25
Chromium	Cr	60
Lead	Pb	90
Mercury	Hg	20
Selenium	Se	165

Table 2 — Analytical correction factor

Element	Sb	As	Ba	Cd	Cr	Pb	Hg	Se
Analytical correction factor (in percentage)	60	60	30	30	30	30	50	60

4.1.2.2 Vinyl chloride monomer

The maximum content of vinyl chloride monomer shall be less than 10 mg/kg measured as described in test B of EN 12149.

If vinyl chloride or the products containing vinyl chloride are not added during manufacture and if the raw materials are certified by the supplier as containing less than 10 mg/kg of vinyl chloride, the test is not necessary.

4.1.3 Water vapour permeability

Stretched ceilings in the form of single or multi-layered sheets and full coated fabrics have a water vapour permeability of < 50 g/m^2/24 h (measured in accordance with the conditions of procedure B in ISO 2528) which prevents condensation forming in the plenum.

Stretched ceilings with perforations or cut-outs and full coated fabrics present no risk of condensation when the circulation of air in ensured either through the product or in the attachment system; Therefore, this requirements does not apply to them.

4.2 Requirements of single or multi-layered sheets

Stretched ceilings made up of single or multi-layered sheets described in this document shall meet the requirements specified in Table 3 when they are subjected to the tests indicated.

Table 3

Characteristics	Units	Requirements	Test method
Mass per unit area	%	Nominal value ± 10	Annex B
Thickness	%	Nominal value ± 10	EN ISO 2286-3 with a pressure of 2 kPa
Colour fastness to light	-	≥ 6	EN ISO 105 – B 02
Dimensional stability after exposure to humidity [a]	%	≤ 1 in each direction	Annex C
Resistance of the assembly	daN	≥ 2 x operating stress	Annex D
Heat shrinkage	%	≤ 4, 5 in each direction	Annex E
Breaking strength	N/mm^2	longitudinal ≥ 12 transverse ≥ 10	EN ISO 527 – 3 with a type 2 test piece
Elongation at break	%	longitudinal ≥ 140 transverse ≥ 150	
Susceptibility to the development of micro-organisms [b]		Declare the type and quantity of bactericide or fungicide applied	
Weldability		Q ≥ 0,5	Annex F

[a] The test may be carried out on the basis of the final use of the ceiling (example: chlorinated atmosphere).

[b] Only for stretched ceilings used in humid conditions.

4.3 Requirements of coated fabrics and fabrics made up of coated yarn or monofilaments

Stretched ceilings made of the coated fabrics of coated yarn or monofilaments described in this document shall meet the requirements specified in Table 4, when subjected to the tests indicated.

Table 4 — Requirements of coated fabrics and fabrics made up of coated yarn or monofilaments

Characteristics	Units	Requirements		Test method
		All fabrics except those containing at least 40 % monofilaments	Fabrics containing at least 40 % monofilaments	
Mass per unit area	%	Nominal value ± 10		EN ISO 2286-2
Colour fastness to light	-	> 6		EN ISO 105-B 02
Dimensional stability after exposure to humidity [a] [b]	%	< 1 in each direction		Annex C
Resistance of the assembly	daN/5 cm	> 20	> 8	EN ISO 1421
Dimensional stability after exposure to heat	%	< 1 in each direction	< 10 °C to 60 °C	EN 12280-1 (30 min)
Tensile strength	daN/5 cm	> 50	> 10	EN ISO 1421
Tear strength	daN	> 10	> 3	EN 1875-3
Susceptibility to the development of microorganisms [b]	-	Method A: 0 Method B: 0		EN ISO 846

[a] The test may be carried out on the basis of the final use of the ceiling (example: chlorinated atmosphere).

[b] Only for stretched ceilings used in humid conditions.

4.4 Requirements of attachment systems (edge profiles and anchoring devices)

4.4.1 Suitability for dismantling and re- assembly

Dismantling and re-assembly of the stretched ceiling constructed according to the state of the art shall not change the intrinsic characteristics.

4.4.2 Mechanical strength

The stretched ceiling and its attachment system shall have a strength equivalent to the strength of the assembly specified for the stretched ceiling in Tables 3 and 4.

5 Assessment of conformity

5.1 General

The conformity of the stretched ceiling to the requirements of this document or to the declared values (including classes) shall be demonstrated by:

— initial type tests,

— factory production control; carried out by the manufacturer, including product verification (see Annex G).

If the tests have been carried out by the supplier of single or multi-layer sheets, coated fabrics or fabrics made up of coated yarn or monofilaments, the ceiling manufacturer does not necessarily have to repeat the tests.

For the tests, the stretched ceilings may be grouped by family (see 3.2) if it may be regarded that the selected characteristic is common to all the stretched ceilings belonging to this family.

5.2 Type tests

5.2.1 Initial type tests

The initial type tests shall be carried out to demonstrate conformity to this document. The tests carried out beforehand in conformity to the requirements of this document (same product, same characteristic(s), test method, sampling, attestation of conformity system, etc.) may be taken into account. In addition, the initial type tests shall be carried out at the beginning of production of any new product type (unless it is a member of the same family) or at the beginning of a new production method (which might have been able to affect the properties concerned).

If there is a change in the product, raw material or the supplier of one of the components or the manufacturing process (with the reservations connected to the definition of a family) that would significantly modify one or more characteristics, the type tests shall be repeated for the appropriate characteristic(s).

5.2.2 Sampling, tests and conformity criteria

The number of stretched ceiling samples to be submitted to the test (or to assess) shall meet the requirements specified in the test standards (see Table 5).

Table 5 — Number of samples and conformity criteria for the initial type tests

Characteristic	Requirements	Test method	Number of samples	Conformity criteria
Reaction to fire	4.1.1	EN 13823 EN ISO 1716 EN ISO 1182 EN ISO 11925-2	1 sample 30 m long and a minimum of 1,30 m wide	See classification in EN 13501-1
Release of dangerous substances				
- heavy metals	4.1.2.1	EN 12149		4.1.2 Table 1
- vinyl chloride monomer	4.1.2.2	EN 12149		< 10 mg/kg
Water vapour permeability	4.1.3	ISO 2528		< 50 g/m^2/24 h
Other characteristics specified in Tables 3 and 4	Tables 3 and 4			Tables 3 and 4

The results of all the type tests shall be recorded and kept by the manufacturer for at least 5 years.

6 Marking and data sheet

6.1 Marking of the product

The stretched ceilings covered by this document and/or their packaging shall carry a clear and indelible mark placed by the manufacturer on the stretched ceiling or on the packaging with the following information:

a) the number and date of this standard, i.e. EN 14716:2004;

b) the identification of the manufacturer or the supplier;

c) the product name, colour and lot number;

If the requirements of Annex ZA.3 give the same information as this clause, it is considered that the requirements of this clause are met.

6.2 Data sheet

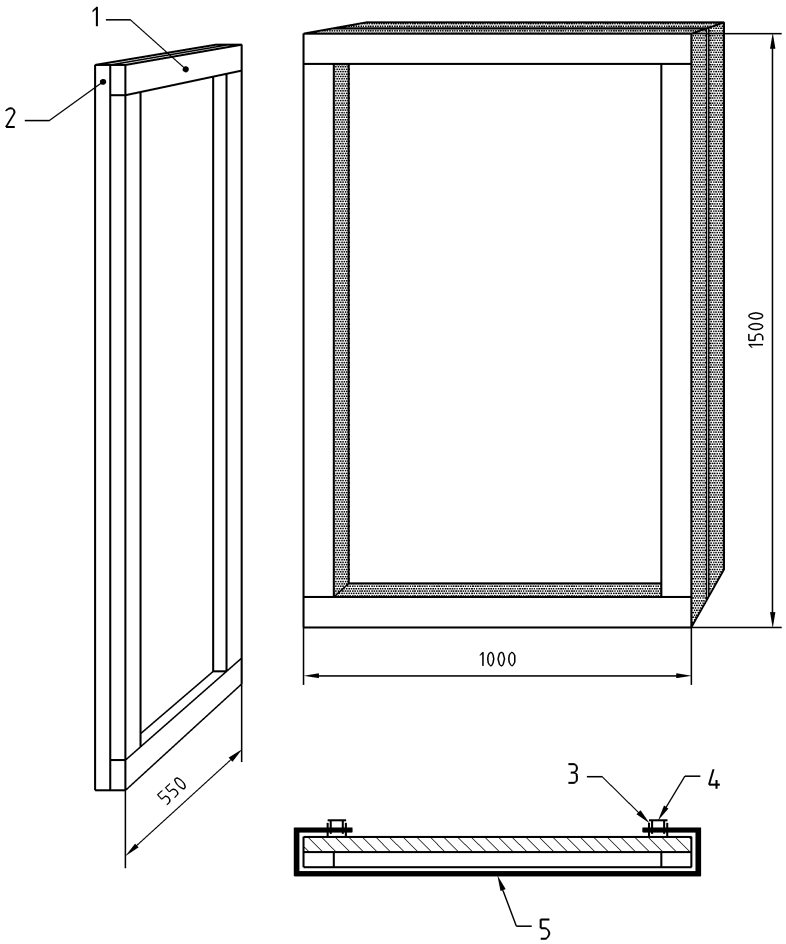
All the technical characteristics of the stretched ceiling conforming to this document shall be given in a data sheet.

Annex A
(normative)

SBI test

Single or multi-layered sheets shall be mounted in a calcium silicate frame for the SBI test as shown in Figure A.1

Dimensions in millimetres



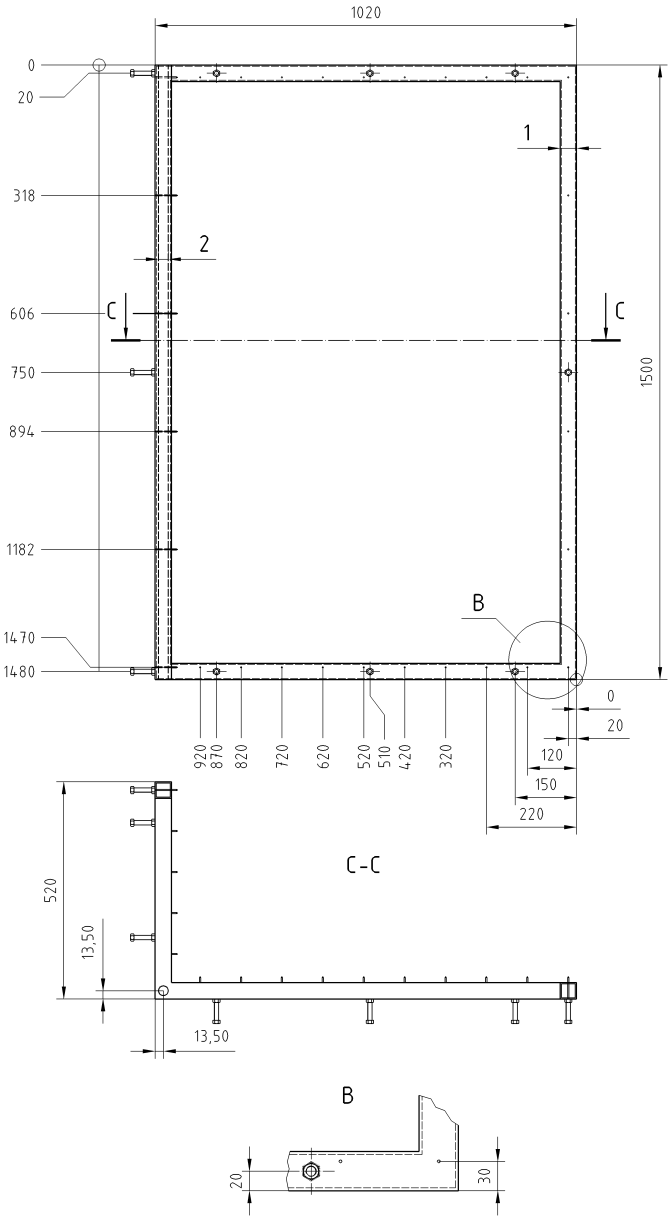
Key

1 Calcium silicate frame
2 Silicate panel
3 Aluminium track
4 PVC bead
5 Stretched ceiling

Figure A.1 — Calcium silicate frame

Coated fabrics or fabrics made up of coated yarn or monofilaments shall be mounted in a frame for the SBI test as shown in Figures A.2 to A.4

Dimensions in millimetres



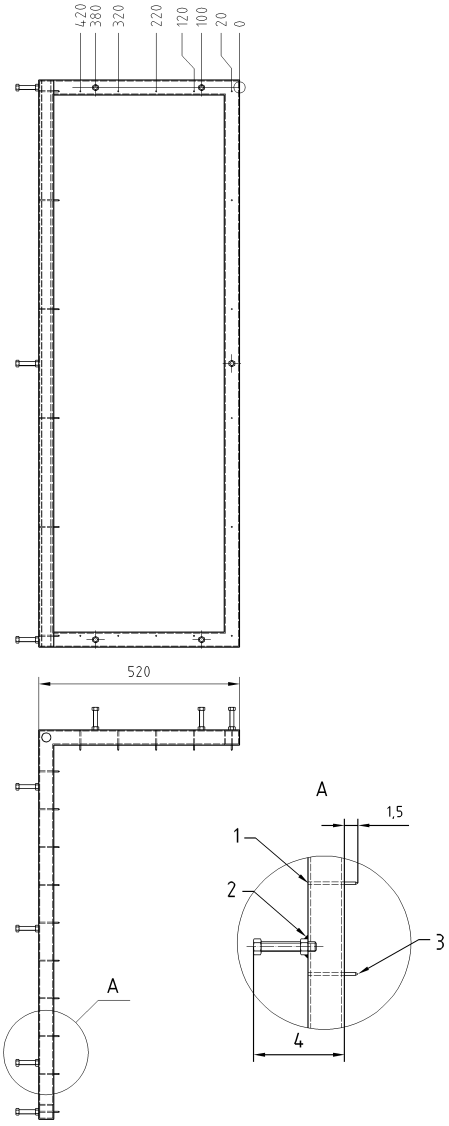
Key

1 Stainless tube 316L 30 x 40 th. 3

2 Stainless tube ∅ 25 th. 1

Figure A.2 — Example of metallic frame for holding test pieces – View 1

Dimensions in millimetres



Key

1 Weld
2 Stainless nut M10 welded to tube
3 Stainless pins ι 3 (for fixing the sample by perforation)
4 Foot adjustable from 55 to 100 (to regulate the width of the air gap)

Figure A.3 — Example of metallic frame for holding test pieces – View 2

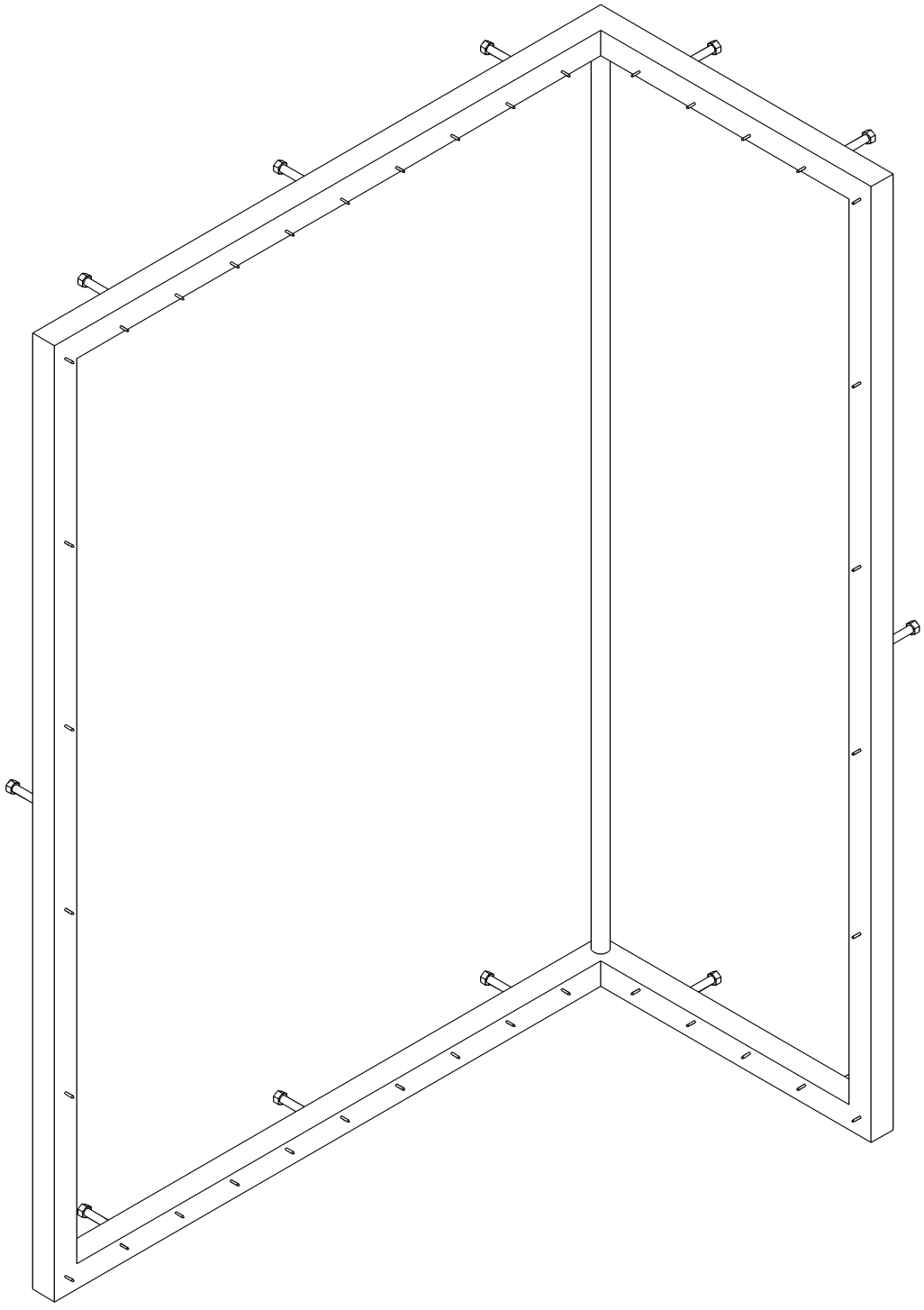


Figure A.4 — Example of metallic frame for holding test pieces – View 3

Annex B
(normative)

Determination of the mass per unit area and thickness of the sheets

B.1 Determination of the mass per unit area

B.1.1 Apparatus

Balance accurate to 0,005 g.

B.1.2 Test pieces

The test pieces shall be circular or rectangular with an area of 100 $cm^2 \pm 0{,}5$ cm^2.

Take at least three test pieces so that:

d) one of them is centred on the longitudinal axis of the sheet, preferably 1 m from the end of the roll;

e) the other test pieces are cut symmetrically relative to this axis on the same transverse line, the end test pieces being situated close to the edges of the sheet but at least 50 cm from them, if possible;

f) if the sheet is not wide enough to have the three test pieces aligned on the same transverse line, these other two test pieces may be moved in the longitudinal direction, but in such a way as to be located on the two symmetrical longitudinal axes relative to the median axis of the sheet.

B.1.3 Conditioning

Condition the test pieces at a temperature of 23 °C ± 2 °C for a minimum period of 3 h.

B.1.4 Procedure

Determine the mass of each test piece by means of balance B.1.1.

B.1.5 Calculation and expression of results

Calculate the mass per unit area, M, expressed in grams per square metre, for each test piece as follows:

$$M = \frac{m \times 10\,000}{s}$$

where

m is the mass of a test piece, expressed in grams ;

s is the area of the same test piece, expressed in square centimetres.

Express the result as the mean of the values obtained for each test piece.

B.2 Determination of the thickness

B.2.1 Apparatus

Use a micrometer graduated in 0,001 mm for sheets of thickness less than100 μm or a micrometer graduated in 0,01 mm for sheets of thickness greater than 100 μm. The bottom measuring face is fixed, the top measuring face is movable along the centre line of the measuring faces. The measuring faces shall be 10 mm in diameter.

B.2.2 Conditioning

Condition the test pieces at a temperature of 23 °C ± 2 °C for a minimum period of 3 h.

B.2.3 Procedure

Use the test pieces taken to measure the mass per unit area (see B.1) and take one measurement per test piece as follows:

Place the test piece on the fixed measuring face. Move the movable measuring face to within 1 mm of the test piece stopping it manually, then let if fall freely. Take the reading when the micrometer needle has come to a complete standstill.

NOTE The presence of dust attracted to the sheet by static electricity may cause errors. The dust may be removed from the sample by passing it between two sponge strips moistened with a low-concentration anti-electrostatic agent in ethanol immediately before the measurement.

B.2.4 Calculation and expression of results

Note the thicknesses measured, in micrometres, for each of the test pieces.

Calculate the arithmetic mean of the individual results.

B.3 Test report

The test report shall include the following information:

a) a reference to this document;

b) the date of the test;

c) the identification of the product under test;

d) the result of the test in accordance with B.1.5;

e) the result of the test in accordance with B.2.4;

f) any deviation relative to this document that may have influenced the results.

Annex C
(normative)

Determination of dimensional stability after exposure to moisture

C.1 Scope

The aim of the method described in this annex is to verify the suitability for use of the stretched ceiling in humid atmospheres, possibly charged with chlorine, such as those met in swimming baths for example.

C.2 Principle

A test piece of the stretched ceiling is subjected to the continuous action of water vapour possibly charged with chlorine.

C.3 Apparatus and reagents

C.3.1 Enclosure (see Figure C.1)

The enclosure is a rectangular parallelepiped of 1 m $\times$ 0,5 m $\times$ 1 m.

The bottom of the enclosure comprises a stainless steel tray 0,2 m high in which a resistor is immersed that is controlled by a regulator to maintain a temperature of 30 °C $\pm$ 2 °C.

The top is removable to be able to load the test pieces.

A fan is installed in the middle of one of the large vertical walls to ensure circulation of the vapours.

The walls are fitted with hooks or holding devices to which the test pieces may be attached. The test pieces may be fitted flat or at an angle of 5° or 45°.

C.3.2 Test solution

Fill the bottom tray with a known volume of water and add (for the chlorinated solution test) the required quantity of commercially available chlorine tablets to obtain a concentration equal to 10 times the concentration normally used in public places.

For the chlorinated solution test, it is necessary to verify that the concentration of the prepared test solution is exactly 10 times the concentration normally used in public places. For that, take a sample of the chlorinated solution, dilute it in a ratio of 1 to 10 and assess its pH. The pH shall be close to that of the chlorinated water used in public places. Then, if necessary, adjust the concentration of the test solution.

In order to allow good dissolution, the solution shall be prepared at least 8 hours before introducing the test pieces.

C.4 Preparation of the test pieces

C.4.1 General

The test shall be carried out on three test pieces noting the direction of the material (warp or weft for the coated fabrics).

C.4.2 Stretched ceiling

Prepare 3 strips of stretched ceiling of dimensions 450 mm $\times$ 50 mm. Mark a length L on each test piece.

C.4.3 Related materials

These are essentially thin elastic fixing cords of lengths between 250 mm and 450 mm. Mark a length L on each test piece.

C.5 Procedure

Measure the length L of each test piece.

Place the test pieces in the enclosure for at least 1 week.

Throughout the period of exposure, keep the temperature and the chlorine concentration (for the chlorinated solution test) constant by means of regular sampling and checking with the pH indicators.

It is important that the vapours condense on the exposed materials and there is a slight trickle. This is generally obtained by inclining the test piece slightly.

At the end of the exposure period, dry the test pieces with absorbent paper then measure the new length L' of each test piece.

C.6 Expression of results

Calculate the dimensional changes for each test piece as follows:

$$\frac{L' - L}{L} \times 100$$

where

L is the initial length of the test piece, in millimetres;

L' is the length after exposure to moisture, in millimetres.

Then calculate the arithmetic mean and express the result as a percentage.

Express the result as a percentage specifying the direction of the material (warp or weft for the coated fabrics).

C.7 Test report

The test report shall contain the following information:

a) a reference to this document;

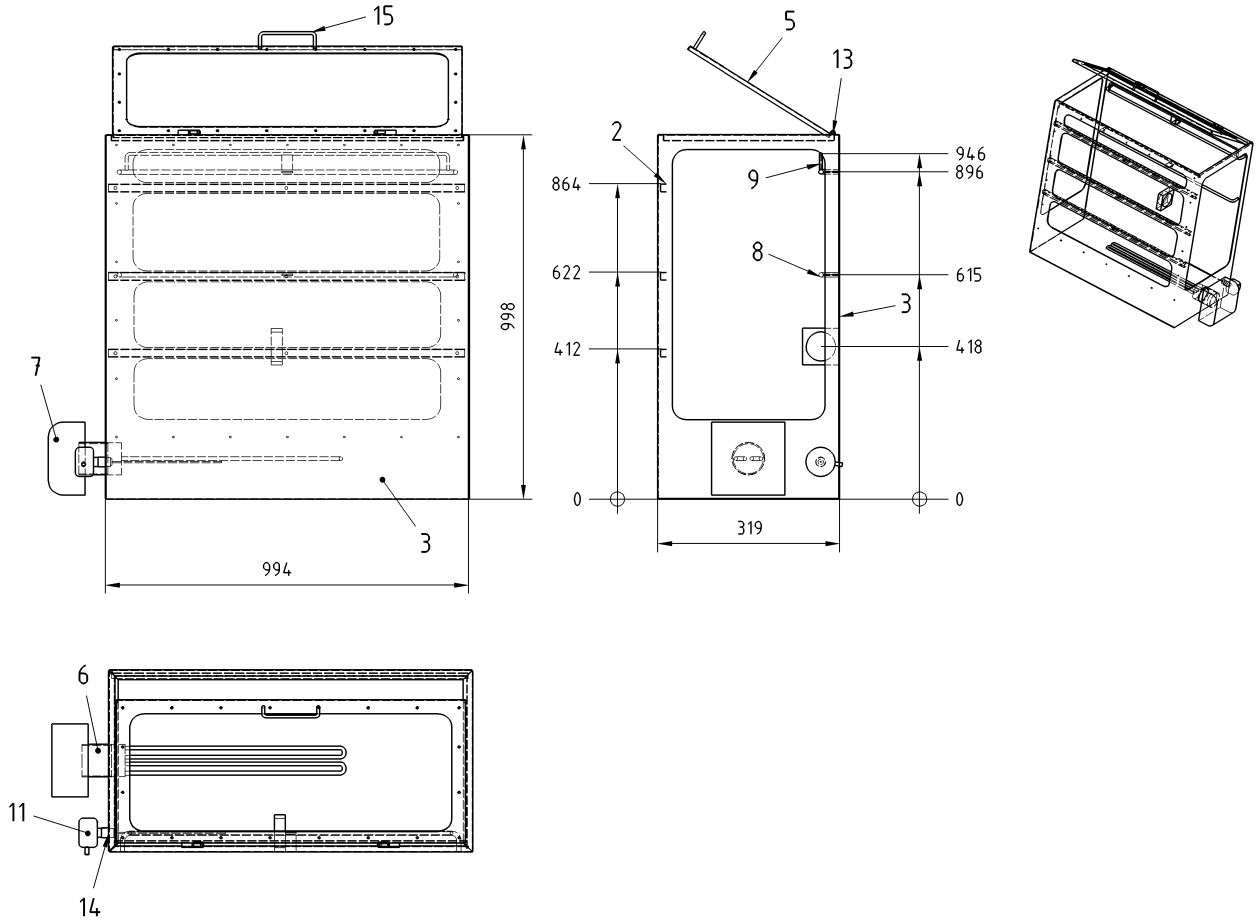
b) complete identification of the product under test;

c) the period of exposure;

d) whether the bath has been chlorinated or not and its concentration

e) the test result according to E.6 ;

f) any deviation relative to this document that may have influenced the results.



Key

1 Main plate
2 Perforated U profile
3 Base plate
4 Front window
5 Top door
6 Resistor support
7 Resistor
8 Single support
9 Support
10 Fan
11Temperature sensor
12 Male hinge
13 Female hinge
14 Sensor support
15 Top door handle

Figure C.1 – Schematic representation of the test apparatus

Annex D
Determination of the operating stress

D.1 Determination of the tensile strain at break

D.1.1 Preparation of the test pieces

Prepare a test piece as shown in Figure D.1.

Fold the wings of the test piece as shown in Figure D.2 along the axes AA and BB so that these wings are superposed (Figure D.3). Fold the ends of the test piece at an angle of 45 ° to obtain a triangle (Figure D.4). Place these ends forming a triangle in the jaws of a tensile testing machine. The base of the jaws shall be at the base of the triangles thus demarcating the traction area.

Then prepare a second test piece in the same manner but using a sheet comprising an assembled structure (see Figure D.5).

Dimensions in millimetres

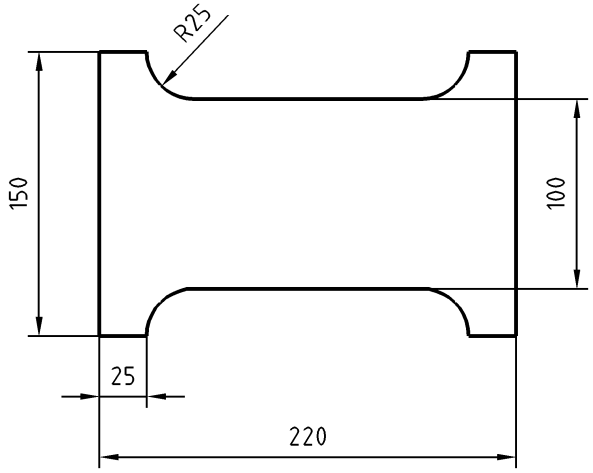


Figure D.1 — Form and dimensions of the test piece for the test to determine tensile strain at break

Dimensions in millimetres

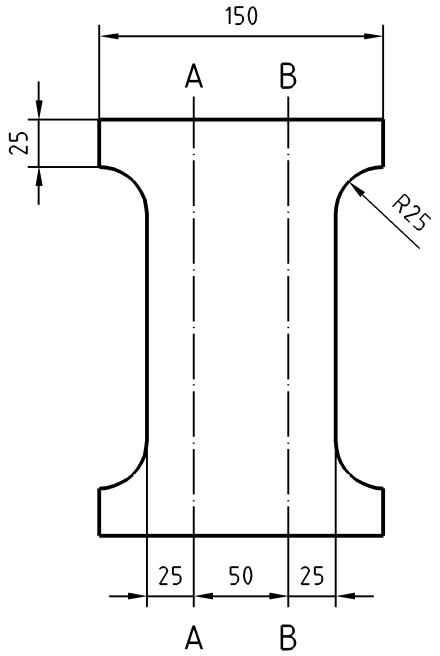


Figure D.2 — Folding areas

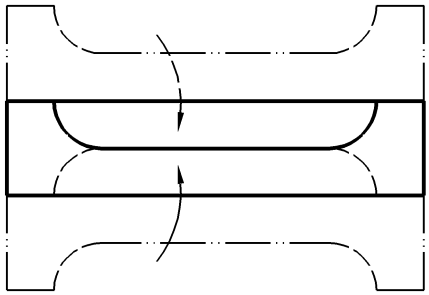
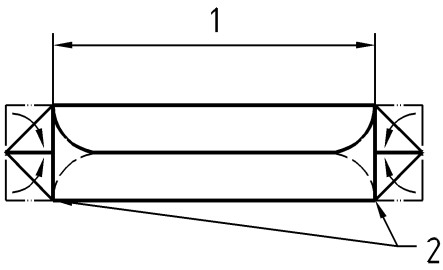


Figure D.3 — Example of folding the test piece



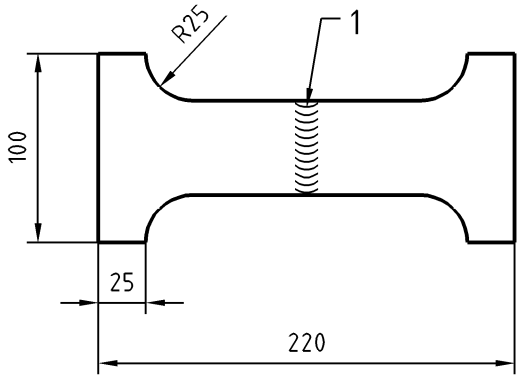
Key

1 Traction zone

2 Limit of the jaws

Figure D.4 — Folded test piece and positioning of the jaws

Dimensions in millimetres



Key

1 Weld

Figure D.5 — Test piece with assembled structure

D.1.2 Procedure

Determine the strain to break in accordance with EN ISO 527-1 on the test piece described in D.1.1 and on the test piece containing an assembly in its medium.

Calculate the rate of elongation resulting in the length and the width of the sample as indicated in D.2.

D.2 Calculation of the rate of elongation resulting in the length and the width of a sample of single or multi-layered sheet (see Figure D.6)

D.2.1 Definition

If

L_o is the initial length of the sample;

l_o is the initial width of the sample.

If

L is the length of the sample after elongation;

l is the width of the sample after elongation;

l' is the reduced width of l_0 after elongation in the length direction relative to Poisson's ratio.

If

R_L % is the percentage reduction in length;

$$R_L\ \% = \frac{L - L_o}{L} \times 100$$

R_l % is the percentage reduction in width;

$$R_l\ \% = \frac{l - l_o}{l} \times 100$$

If

A_L % is the percentage elongation of the initial length;

$$A_L\ \% = \frac{L - L_o}{L_o} \times 100$$

A_l % is the percentage elongation of the initial width and

$$A_l\ \% = \frac{l - l_o}{l_o} \times 100$$

If

v is Poisson's ratio (material characteristic).

If

Rv_L % is the percentage reduction in length relative to Poisson's ratio;

$$Rv_L\ \% = \frac{L_o - L'}{L_o} \times 100$$

Rv_l % is the percentage reduction in width relative to Poisson's ratio;

$$Rv_l\ \% = \frac{l_o - l'}{l_o} \times 100$$

If

A_{LR} % is the resulting percentage elongation in length;

$$A_{LR}\ \% = \frac{L - L'}{L'}$$

A_{lR} % is the resulting percentage elongation in width;

$$A_{lR}\ \% = \frac{l - l'}{l'}$$

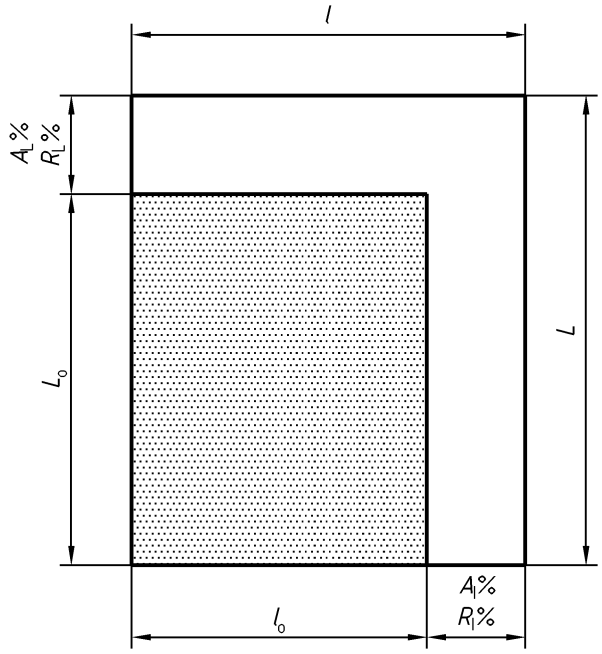


Figure D.6 — Percentage reduction and percentage elongation

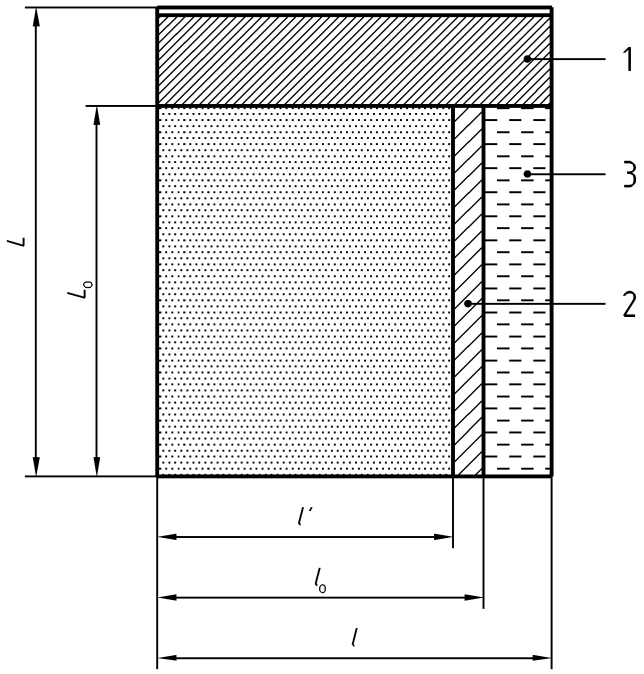
D.2.2 Schematic presentation of the calculation

Given 3 zones: A, B et C (see Figure D.7)

Zone A: zone of elongation in the length direction, A_L %

Zone B: zone of reduction in width l_o relative to Poisson's ratio of Rv_l % (this reduced width is l') (see D.2.4).

Zone C: zone of elongation in the width direction, A_l %



Key

1 Zone A
2 Zone B
3 Zone C

Figure D.7 — Zones of elongation and reduction

D.2.3 Calculation of the reduction of l_o (Rv_l %) during the elongation of L_o

General equation for Poisson's ratio

$$v = \frac{\Delta l}{\Delta L}$$

$$\Delta l = l_o - l'$$

$$\Delta L = L - L_o$$

$$v = \frac{l_o - l'}{L - L_o}$$

$$v\left(L - L_o \right) = l_o - l'$$

$$l' = l_o - v\left(L - L_o \right)$$

$$Rv_l\ \% = \frac{l_o - l'}{l_o} \times 100$$

$$Rv_l\ \% = \frac{l_o - \left[l_o - v\left(L - L_o \right) \right]}{l_o} \times 100$$

Multiply the numerator and the denominator of the equation by L_o to obtain A_L %.

$$Rv_l\ \% = \frac{l_o - l_o + v\left(L - L_o\right)}{l_o} \times \frac{L_o}{L_o} \times 100$$

$$Rv_l\ \% = \frac{L - L_o}{L_o} \times \frac{L_o}{l_o} \times v \times 100$$

$$A_L\ \% = \frac{L - L_o}{L_o} \times 100$$

Equation for percentage reduction in width l_o according to Poisson's ratio (v)

$$Rv_l\ \% = A_L\ \% \times \frac{L_o}{l_o} \times v$$

D.2.4 Calculation of the reduction of L_o (Rv_L%) during the elongation of l_o

General equation for Poisson's ratio

$$v = \frac{\Delta L}{\Delta l}$$

where:

$$\Delta l = l - l'$$

$$\Delta L = L_o - L'$$

$$v = \frac{L_o - L'}{l - l'}$$

$$v\left(l - l' \right) = L_o - L'$$

$$L' = L_o - v\left(l - l' \right)$$

$$Rv_L\ \% = \frac{L_o - L'}{L_o} \times 100$$

$$Rv_L\ \% = \frac{L_o - \left[L_o - v\left(l - l' \right) \right]}{L_o} \times 100$$

Multiply the numerator and the denominator of the equation by *l'* to obtain A_l %

$$Rv_L\ \% = \frac{L_o - L_o + v\left(l - l' \right)}{L_o} \times \frac{l'}{l'} \times 100$$

$$Rv_L\ \% = \frac{l - l'}{l'} \times \frac{l'}{L_o} \times v \times 100$$

$$A_l\ \% = \frac{l - l'}{l'}$$

Equation for the percentage reduction in the length L according to Poisson's ratio (v)

$$Rv_L\ \% = A_{lR}\ \% \times \frac{l'}{L_o} \times v$$

D.2.5 Calculation of the percentage elongation resulting in the length and the width of the sheet

If *l'* et *L'* are the reduced dimensions of l and L, giving the percentage elongation in the length A_L % and the percentage elongation of the width A_l % :

$$A_{LR}\ \% = \frac{L - L'}{L'}$$

$$A_{lR}\ \% = \frac{l - l'}{l'}$$

D.3 Numerical application

D.3.1 Hypothesis

l = 920 cm

L = 1 520 cm

PVC fabric: matt white

Dimensional reduction: 7 % in the 2 directions.

D.3.2 Calculation of l_o and L_o

$$L_o = L - \left(L \times R_L \% \right)$$

$$l_o = l - \left(l - R_l \% \right)$$

where:

R_L% is the percentage reduction in length L : R_L % = 0,07

R_l% is the percentage reduction in width l : R_l % = 0,07

L_o = 1 520 – (1 520 x 0,07)

L_o = 1 413,6 cm

l_o = 920 – (920 x 0,07)

l_o = 855,6 cm

D.3.3 Calculation of A_l% and A_L%

If A_l % and A_L % are the percentage elongations of l_o and L_o defined by:

$$A_L \% = \frac{\left(L - L_o \right)}{L_o} \times 100$$

$$A_l \% = \frac{\left(l - l_o \right)}{l_o} \times 100$$

$$A_L \% = \frac{\left(1520 - 1413{,}6 \right)}{1413{,}6} \times 100$$

A_L % = 0,0752 i.e. 7,52 %

$$A_l \% = \frac{920 - 855{,}6}{855{,}6} \times 100$$

A_l % = 0,0752 i.e. 7,52 %

By definition if R_L % = R_l % then A_L % = A_l %

D.3.4 Calculation of the percentage reduction Rv_l % of l_o according to Poisson's ratio

$$Rv_l\ \% = A_L\ \%\ \frac{L_o}{l_o} \times v$$

where:

v is Poisson's ratio, for flexible PVCs v = 0,5;

A_L % is the percentage elongation of L.

Giving Rv_l % equal to:

$$Rv_l\ \% = \frac{0{,}0752 \times 1413{,}6}{855{,}6 \times 0{,}5}$$

Rv_l % = 0,062121

i.e. 6,2121 % reduction of l_o.

D.3.5 Calculation of the width *l'* reduced by Poisson's ratio

By definition,

$$Rv_l\ \% = \frac{l_o - l'}{l_o} \times 100$$

$l' = l_o - (l_o \text{ x } Rv_l\ \%)$;

$l' = l_o - (l_o \text{ x } Rv_l\ \%)$;

l' = 855,6 – (855,6 x 0,062121);

l' = 802,44 cm.

D.3.6 Calculation of the resulting percentage elongation in width: A_{lR} %

$$A_{lR}\ \% = \frac{l - l'}{l'}$$

$$A_{lR}\ \% = \frac{920 - 802{,}44}{802{,}44}$$

A_{lR} % = 0,1465

i.e. 14,65 % of total elongation of *l'* to obtain *l*.

D.3.7 Calculation of the percentage reduction Rv_l% of L_o according to Poisson's ratio

$$Rv_L\ \% = A_l\ \%\ \frac{l'}{L_o} \times v$$

where:

v is Poisson's ratio for flexible PVCs v = 0,5;

A_l % is the percentage total elongation of l' to l.

giving Rv_L% equal to:

$$Rv_L\ \% = \frac{A_l\ \% \times l'}{L_o \times v}$$

$$Rv_L\ \% = \frac{0{,}1465 \times 802{,}44}{1\,413{,}6 \times 0{,}5}$$

Rv_L % = 0,0415

i.e. 4,15 % of reduction of L_o

D.3.8 Calculation of the reduced width *l'* by Poisson's ratio

By definition,

$$Rv_L\ \% = \frac{L_o - L'}{L_o} \times 100$$

$$L' = L_o - \left(L_o \times Rv_L\ \% \right)$$

L' = 1 413,6 – (1 413,6 x 0,0415)

L' = 1 354,935 cm

D.3.9 Calculation of the resulting percentage elongation in the length and the width of the sample

A_{LR} % = A_L % + Rv_L %

A_{lR} % = A_l % + Rv_l %

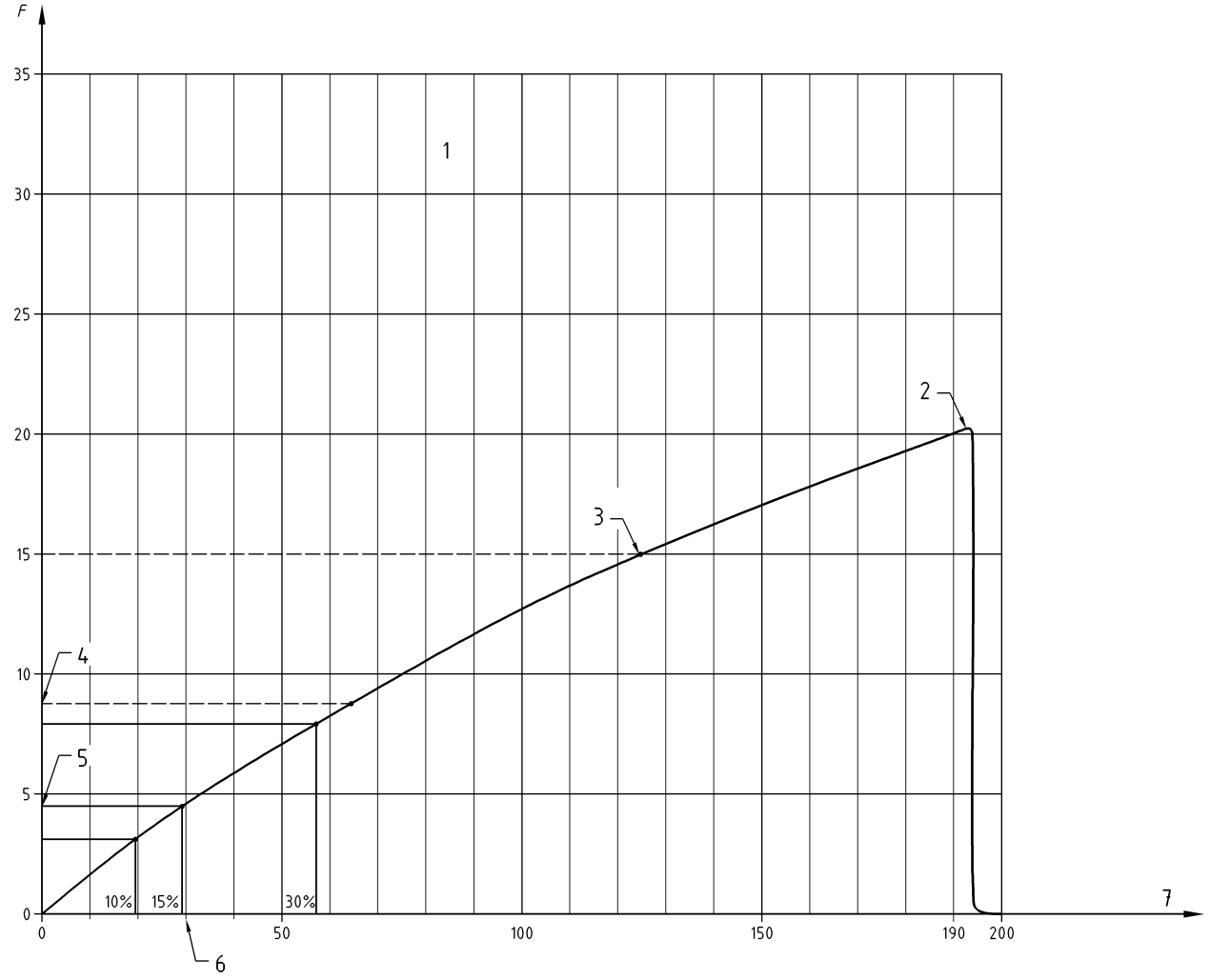
In the numerical example chosen, the percentage elongation in length is equal to 12,18 % and the percentage elongation in width is14,65 %.

Use the highest resulting elongation value, i.e. 14,65 %.

D.4 Determination of the operating stress

Transfer the elongation value obtained in D.3.8 to the stress/strain curve at break obtained in D.1 for the test piece with an assembly and derive from that the corresponding operating stress (see example in Figure D.8).

The stretched ceiling is considered to meet the specification fixed in Table 3 if the test piece with assembly breaks at a force greater than 2 × the operating stress.



Key

1 10% elongation = 3,2 daN,15% elongation = 4,6 daN, 30% elongation = 8,1 daN
2 Break of full test piece
3 Break of test piece with transverse weld
4 9,2 = 2 x 4,6 daN (operating stress)
5 Operating stress
6 Resulting elongation ($x = y$)
7 Elongation (mm)

Figure D.8 — Example of stress/strain curve

Annex E
(normative)

Determination of dimensional changes after exposure to heat (kaolin bed method)

E.1 Principle

This Annex describes a method for the determination of the initial dimensions of the test pieces. The initial dimensions of the test pieces are measured in the longitudinal and transverse directions, then oven-dried on a kaolin bed intended to facilitate their relative movements and raised to a fixed and regulated temperature. After removal from the oven and cooling down, measurement of the test pieces at the marked points and calculation of the resulting dimensional change.

E.2 Apparatus

E.2.1 Naturally ventilated oven in which the draught shall be such that the renewal of air does not disturb the test pieces and the temperature adjustable to the specified value is uniform to within ± 2 °C in the tray and test piece area.

E.2.2 Metal tray, containing a bed of kaolin approximately 20 mm thick of dimensions such that the test pieces can be deposited flat without deformation and that it can be introduced into the oven. A thin aluminium sheet with folded edges is adequate.

E.2.3 Thermometer, for measuring the temperature of the bed of kaolin; the reservoir of this thermometer shall be such that it can be completely immersed in the bed of kaolin.

E.2.4 Cylindrical punch of diameter less than or equal to100 mm ± 0,1 mm.

E.2.5 Measuring apparatus, capable of measuring the dimensions of the test pieces to the nearest 0,5 mm.

E.3 Test pieces

E.3.1 Shape and dimensions

The test pieces comprise discs cut using the punch (E.2.4) and on which is marked the longitudinal direction of the sheet (machine direction).

Conventionally, the initial dimensions of the test piece are regarded as being equivalent to those of the punch.

E.3.2 Taking of test pieces

Take at least three test pieces from one sheet sample before conditioning for at least 2 h in the laboratory atmosphere.

Cut out one of the test pieces from the middle of the sheet width and the others symmetrically relative to the first so that the outer edge of the furthest test pieces is approximately 50 mm from the edge of the sheet.

E.4 Procedure

E.4.1 Test temperature

The temperature at which the test shall be carried out is variable according to the nature of the basic material of the sheet. In the absence of any specifications, the manufacturer shall indicate the test temperature.

By way of a guide, a test temperature of 70 °C ± 2 °C is generally used.

E.4.2 Test

Introduce the tray into the oven and adjust the latter so that the bed of kaolin is raised to the test temperature ± 2 °C at all points. Ensure that the temperature of the bed of kaolin is only affected within the fixed limits when the door is opened.

Coat the test pieces in kaolin and lay them flat on the bed of kaolin. Leave them for 5 min.

Remove the test pieces from the oven and let them cool down long enough to attain the temperature of the laboratory atmosphere.

Measure the dimensions of the test pieces in the marked longitudinal direction (E.3.1) and in the transverse direction, to the nearest 0,5 mm.

E.5 Expression of results

For each test piece, calculate, in percent, the dimensional changes using the following formulae:

Changes in the longitudinal direction = L – 100

Changes in the transverse direction = T – 100

where

L is the longitudinal dimension of the test piece after oven drying, in millimetres;

T is the transverse dimension of the test piece after oven drying, in millimetres;

100 is the initial dimension of the test piece, in millimetres, corresponding to the diameter of the punch.

A negative value means shrinkage, a positive value elongation of the sheet.

Example

	Initial dimensions	**Dimensions after oven drying**
Longitudinal direction	100 mm	90 mm
Transverse direction	100 mm	102 mm

Dimensional changes: longitudinal direction – 10 %

transverse direction + 2 %

For each direction, form the mean of the results obtained. Express the result as the percentage dimensional change in the longitudinal and transverse direction, rounded to the nearest 0,5 %, with its sign.

E.6 Test report

The test report shall contain the following information:

a) a reference to this document;

b) the date of the test;

c) the identification of the product under test;

d) the indication of the point of the sheet from which the test pieces have been taken;

e) the result of the test in accordance with E.5;

f) any deviation relative to this document that may have influenced the results.

Annex F
(normative)

Method of assessing the weldability of sheets assembled by the high frequency welding process

F.1 Scope

This Annex describes a practical method reproducing on a defined apparatus the high frequency industrial welding process for assessing the weldability of an assembly of sheets and assessing the quality of the welds.

The method is applicable to all thermoplastics products that have been transformed into sheets and the assembly of which is acknowledged to be suitable to be welded by means of a large temperature rise in the mass of the material and due to its dielectric properties

It applies to sheets produced from materials in which the with dielectric losses (see F.2), caused by a specific electrical field, are characterized by their loss factor generally greater than 0,01 (at the conventional frequency of 1 MHz).

NOTE All the constituents of the material(s), including the plasticizers, fillers, stabilizers, etc. play a role and have an influence on the weldability.

F.2 Definitions

F.2.1 General

For the purposes of this Annex, the following definitions apply:

F.2.2
weldability by thermodielectric effect
any thermoplastic material is weldable which, in the form of sheets, is likely to soften to partial fusion of the two parts of the assembly in contact

The suitability for HF welding or weldability is characterized by the thermoplasticity of the product (sheet) resulting during its self-heating due to the action of a specific electric field in which the energy is dissipated by the dielectric and calorific effect in the mass of the product

F.2.3
high frequency welding procedure
procedure by which the electric field applied by means of electrodes to the assembly to be welded develops in the mass of the product a thermal effect due to the dielectric effects caused by the size of the dielectric losses of the material

The electric field is created by an electric energy generator supplying the electrodes with an a.c. current of high frequency and power suitable for the elements to be welded

F.2.4
evaluation of weldability
comparison of a weld using the HF welding procedure in two elements of a product with one produced on an assembly regarded as a reference weld

The comparison is made after welding under optimum conditions obtained with the best parameters and HF welding adjustments; the comparison criteria are defined in F.3

F.2.5
weld quality
confirmation of the strength of a welded test piece by subjecting welded test pieces to mechanical stress tests and by comparing the results to the performances of non-welded reference test pieces. The comparison criteria are defined in F.6.

F.3 Principles used for assessing HF weldability

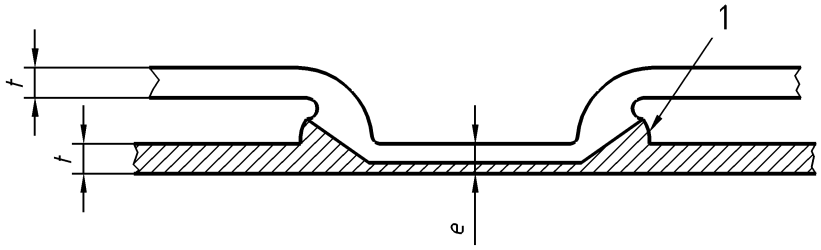
F.3.1 Methodology

A strip consisting of two sheets of thermoplastic material(s) is welded by regulating the operating conditions relating to the electrodes and generator according to the criteria indicated in F.3.2.

The strip of the two welded and assembled elements is examined after each test until a weld of homogenous and regular appearance is obtained of a final thickness, called ideal, equal to 0,50 to 0,65 times the sum of the thicknesses of the two sheets.

NOTE The weldability assessed by the level of thermoplasticity obtained during HF welding is an inverse function of the thickness of the welded strip (see Figure F.5).

Figure F.1 illustrates the appearance and geometry (cross-section view) of a welded strip before good weldability (case of two identical materials).



Key

1 Bead

e = 0,5 to 0,65 times the sum of the thicknesses

Figure F.1 – Appearance of a weld made on a strip (cross-section view)

F.3.2 HF welding criteria

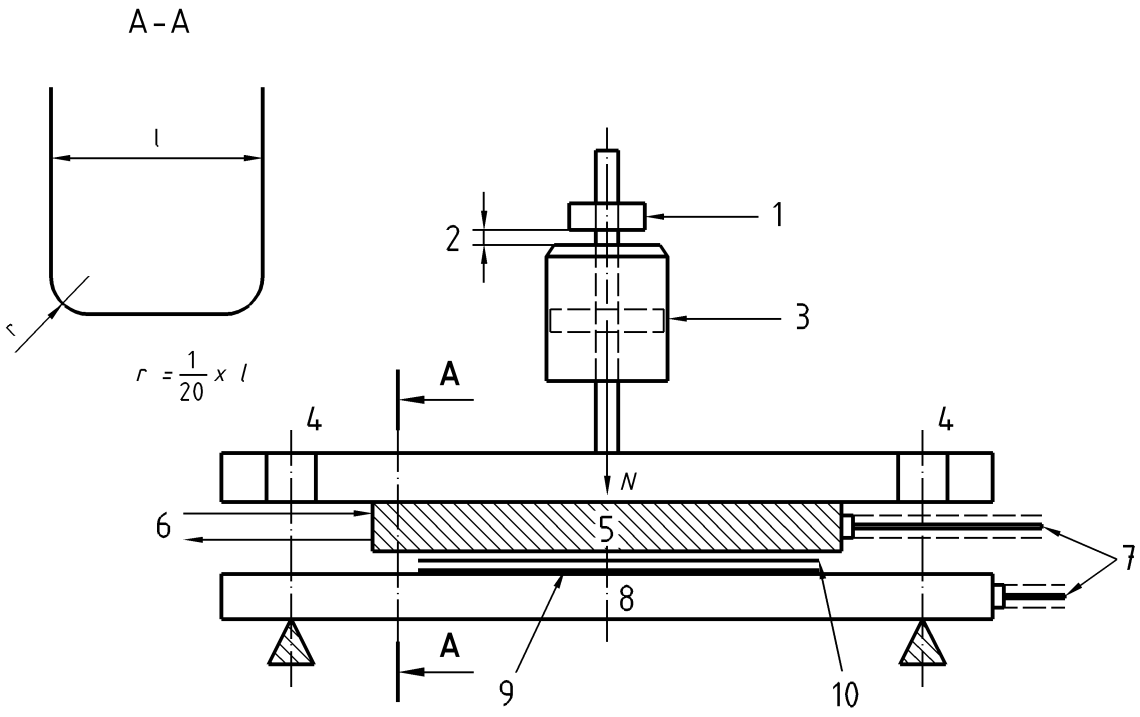
Two factors sre essential in seeking good weldability parameters, i.e.:

— welding tools (geometry, relative position relative);

— characteristics of the electric power supplied by the HF generator.

F.3.2.1 Welding tools

The tools (or electrodes) shall have the shapes and dimensions given in Figure F.2. The pressure exerted on the test piece strip is variable and directly proportional to the application force on the two elements to be welded. It is controlled as a function of the thinning obtained during welding.



Key

1 Stop control
2 Stop (limit switch)
3 Cylinder
4 Guide
5 Electrode
6 Thermal fluid
7 To HF generator
8 Backing electrode
9 Top sheet to be welded
10 Bottom sheet to be welded

Figure F.2 – Welding tools; shape, dimensions and positions of electrodes

NOTE 1 Other shapes of electrodes may be necessary to obtain other results for other applications (round, cutting, notched, etc.). The shape selected is to be mentioned in the test report.

NOTE 2 The electrodes are made of highly conducting metal, they may be maintained at a constant temperature by means of a fluid or heating device (see note 4) in order to control the heat exchanges when in contact with the material to be welded.

NOTE 3 The bottom electrode generally comprises a plate. No insulating layer should generally be inserted between the material to be welded and this plate.

NOTE 4 It may be useful to heat the electrode to facilitate the welding of rigid or semi-rigid materials.

F.3.2.2 Electrical characteristics

The energy dissipated in the strip to be welded in contact with the electrodes depends:

— on the material or materials (dielectric loss factor tang δ);

— on the total thickness of the assembly to be welded;

— on the power supplied to the electrodes and the working frequency of the HF generator.

The HF generator shall supply energy in the form of an adjustable voltage the frequency of which is fixed: the one most often used is 27,12 MHz; other frequencies are permitted (13,56 MHz et 40,68 MHz).

NOTE 1 As a guide, for PVC-P, the average power to obtain a 1 cm² weld is of the order of 50 W. This power is obtained with the best match. This involves adapting the HF generator output controls to obtain the maximum current supplied in the circuit comprising the electrodes and the material to be welded.

NOTE 2 Influence of thickness on weldability: for thin or very thick sheets, the power to be used is relatively greater.

After obtaining the best match, the duration of the actual welding (action of the electric field strength) shall be determined as a function of:

— the total thickness to be welded;

— the maximum power possible without flash in the capacitor formed by the electrodes or the material to be welded.

Depending on the applications, this welding period may range from a few 10ths of a second to 20 seconds.

F.4 Welding strips

F.4.1 Shape and dimensions of the strips

All the weldability test strips shall be taken from the same sheet(s) and in the same direction (longitudinal or transverse). These strips are made up of two rectangular sizes of suitable width. The strip used for assessing the comparative weldability shall be made up of two sections of approximately 300 mm $\times$ 200 mm (see Figure F.3). Note the thicknesses (spot and mean of the two sections) of this optimum strip.

The two superposed sections are arranged, depending on the case:

— either face to face;

— or back to back;

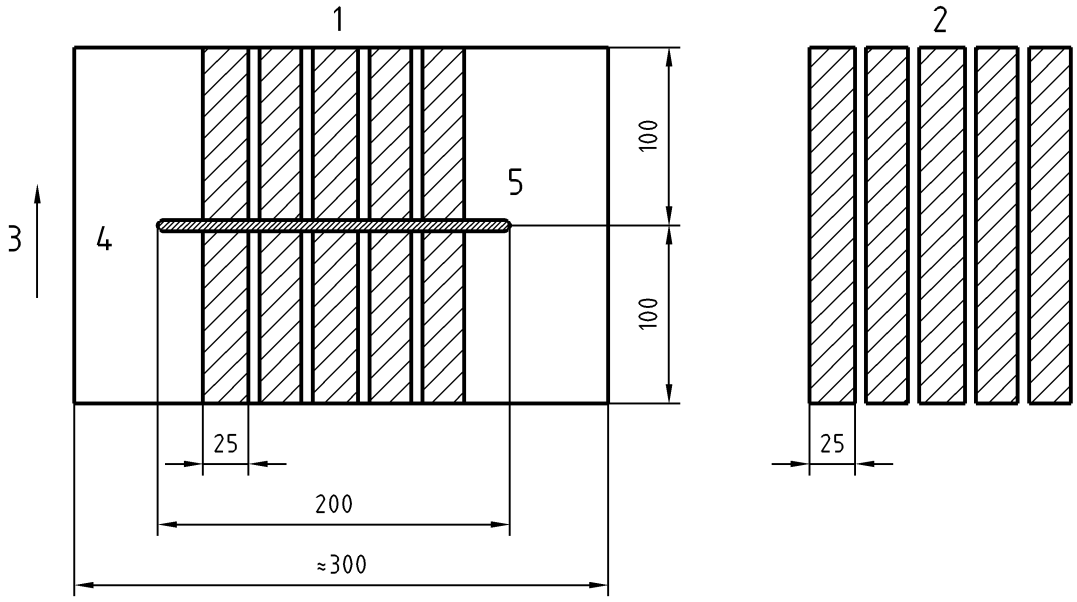
— of face to back.

The arrangement shall be mentioned in the test report.

F.4.2 Taking of test pieces

After assessing the weldability (see F.5.2), take five test pieces from the strip used in order to assess the weld quality; these test pieces shall be cut perpendicular to the weld line (test direction), from the two welded rectangular sections (see Figure F.3).

Five further (reference) test pieces shall be cut, also in the same direction, from the same sheets making up the two sections of the assessed strip.



Key

1 Welded strip
2 Reference strips
3 Test direction
4 Test piece strip
5 Weld

Figure F.3 – Example of welded strip from which to take test pieces to compare with reference test pieces (non-welded sheet)

F.5 Procedure

F.5.1 Preliminary adjustments

F.5.1.1 Weld

Taking account of the material (hardness, thermoplasticity, softening temperature, etc.) and the thickness of the two sections to be welded, install in the welding machine the upper electrode of suitable width and length slightly greater than that of the area from which the five test pieces will then be taken.

i.e. :

— length equal to approximately 200 mm;

— width equal to approximately 10 times the thickness of the sheet to be welded (or approximately five times the total thickness of the two sheets to be welded).

The edges of the electrodes shall be rounded with a radius of approximately $1/20^{th}$ of the width of the electrode (see Figure F.2).

NOTE In the case of embossed sheets, the thickness considered is the thickness determined by the weight method.

Check that the top electrode moves vertically to the backing electrode and that the contact surface is completely parallel to it.

Apply to the electrode a force capable of varying fro 30 N to 100 N per square centimetre of electrode surface.

For safety reasons and in case the electrode overruns the material, a safety lock shall be provided at least by means of an adjustable stop (to prevent flash).

F.5.1.2 Search for welding parameters

Carry out a certain number of preliminary tests on identical strips with minimum power and maximum duration until the best match is found (see note in F.3.2.2). Then, adapt the power as a function of the surface to be welded and reduce the duration of the welding until the maximum current observed is stabilized

NOTE The optimum welding duration is one that permits a rapid cycle that comprises:

— preheating time (pressed electrodes);

— actual welding time;

— time kept under pressure after welding.

F.5.2 Assessment of weldability

With the welding parameters fixed, weld the strips to be assessed under the same conditions. Examine and measure the final thicknesses of the welds obtained on these strips. Compare with the appearance and thickness of the welded reference strip.

Use the strip that meets the welding criteria given in F.3.1.

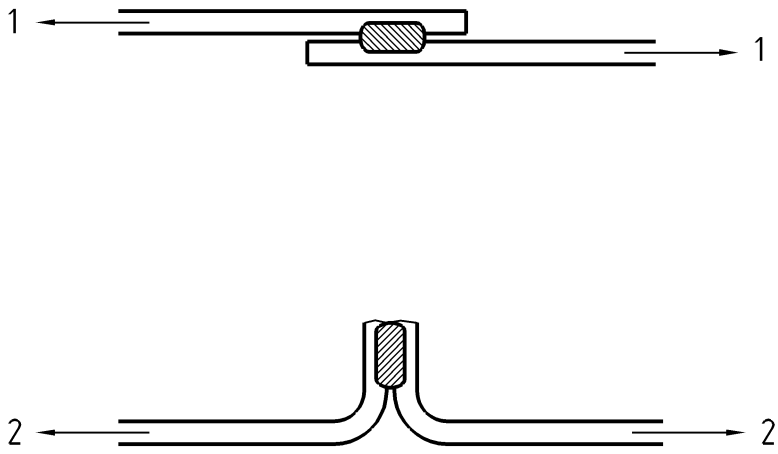
NOTE The method assumes that the strips to be assessed are of similar composition to the reference strip, and are made of identical (polymer) constituents.

By way of example, Figure F.5 shows an application of this method for assessing the weldability of PVC-P sheets as a function of the rate of the plasticizer added to the polymer.

F.5.3 Weld quality

Cut and take from the strip the five test pieces defined in F.4.2 and also cut the reference test pieces from the unwelded sheet as shown in Figure F.3.

On each test piece, determine either the shear or the peeling breaking strength depending on the application using a tensile test conforming to the general method described in EN ISO 527-1 and the specific conditions relating to sheets indicated in EN ISO 527-3 (see Figure F.4).



Key

1 Shearing (rigid sheet)
2 Peeling (flexible sheet)

Figure F.4 – Methods of assessing weld quality (shear strength or peel strength)

The comparison of welded/reference test pieces shall be carried out with sheets of identical thickness.

NOTE Examples of weld quality in the form of weld cohesion curves are given in Figures F.6 and F.7.

F.6 Expression of results

F.6.1 Assessment of weldability

Compare the average thickness measured to that of the reference strip. Indicate the variation in percentage. For each strip suitable for welding used, indicate:

— the average thicknesses of the two sheets before assembly;

— the average thickness of the weld made using the method described in Clause 5;

— the power supplied by the generator when matched and for the welded surface;

— the welding cycle, comprising:

  — the preheating contact time;

  — the actual welding time;

  — the holding time.

F.6.2 Weld quality

Calcuate the arithmetic mean of the breaking forces of the five welded test pieces, and relate it to the centimetre width of the welded strip, i.e. R_1.

Calcuate the arithmetic mean of the breaking forces of the five similar reference test pieces, and relate it tp the centimetre width of the tested strip, i.e. R_2.

Express the weld quality assessed by the ratio Q:

$$Q = \frac{R_1}{R_2}$$

F.7 Test report

The test report shall refer to this document and give:

a) the date of the test;

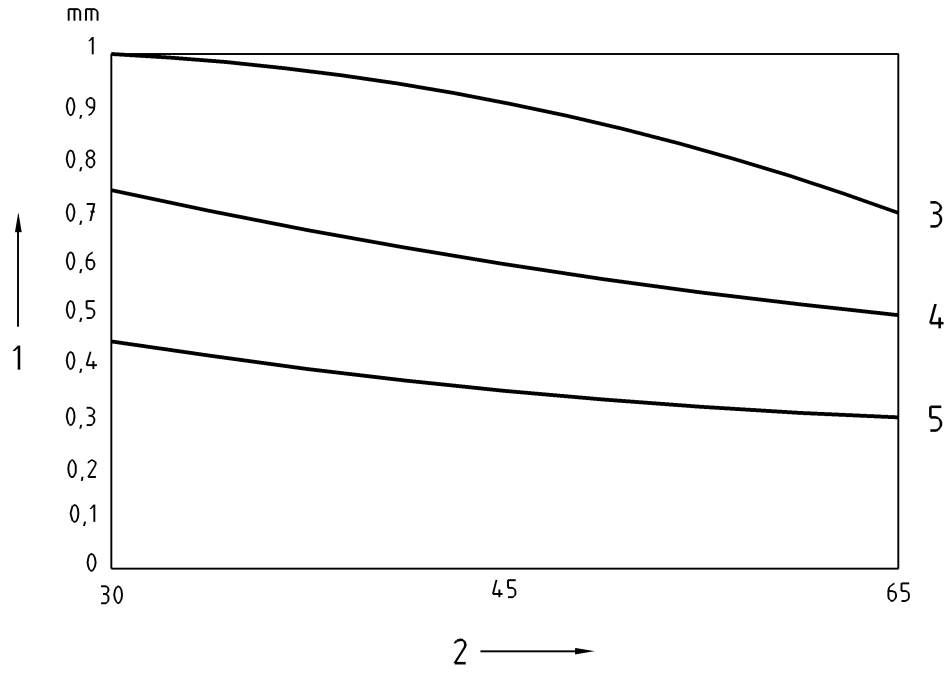
b) the complete identification of the sample subjected to the tests, and the method of assembling the strip(s) in order to produce the weld (also specify the assembled surfaces, location, back or both);

c) the weld appearance (homogenous, regular, with or without beads, with or without thinnings or spot enlargements, etc.) ;

d) the weldability criteria indicated in F.6.1 ;

e) the weld quality assessment results indicated in F.6.2 ;

f) any indication or observation regarded as important noted during the tests.



Key

1 e = weld thickness
2 Plasticizing rate
3 0,70 mm sheet
4 0,50 mm sheet
5 0,30 mm sheet

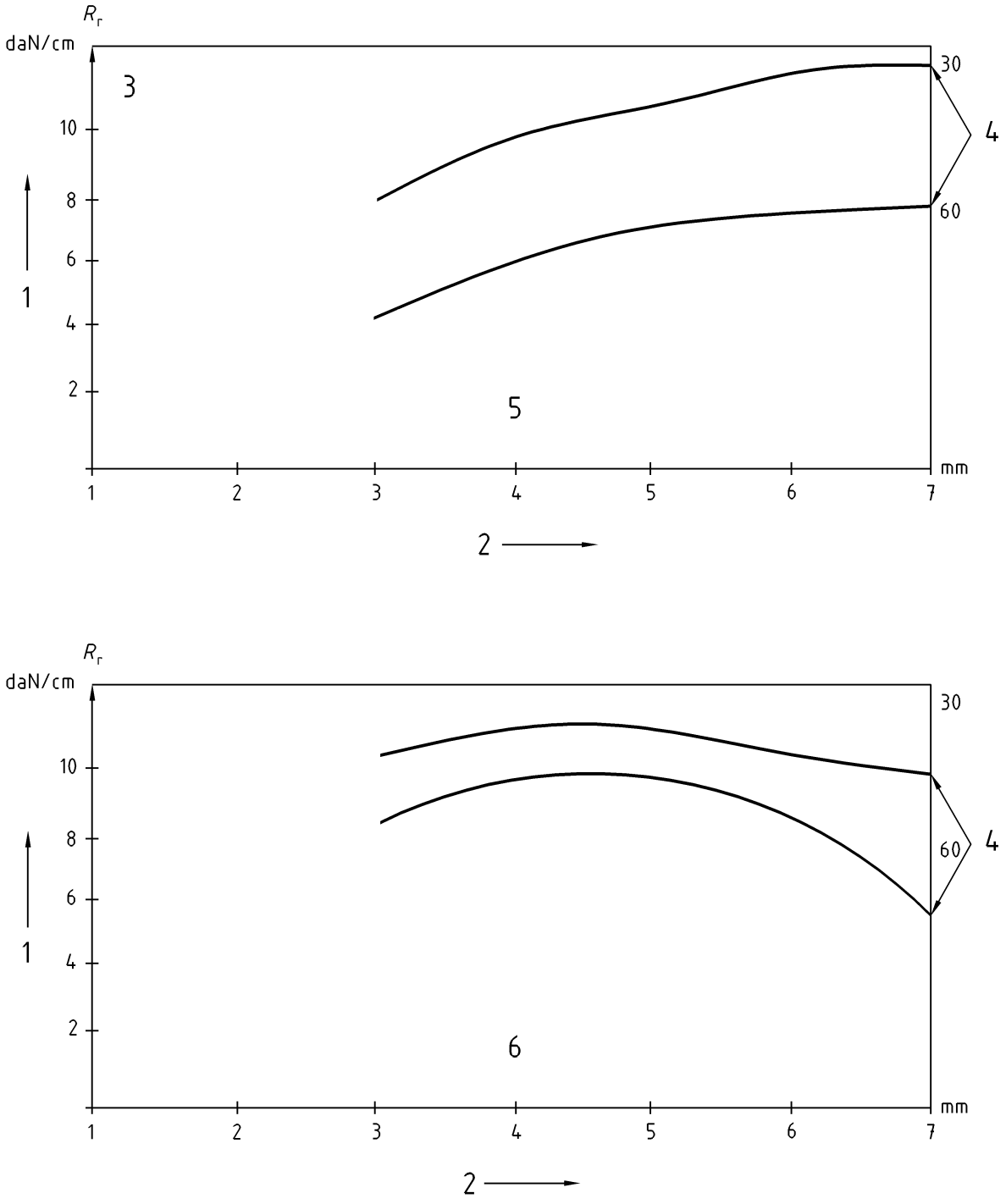
Figure F.5 – Variation in weld thickness as a function of the plasticizing rate

NOTE 1 The general shape of the curves illustrates the weldability/thickness relationship of the weld of the two sheets.

$$weldability = f\left(\frac{1}{e}\right)$$

where

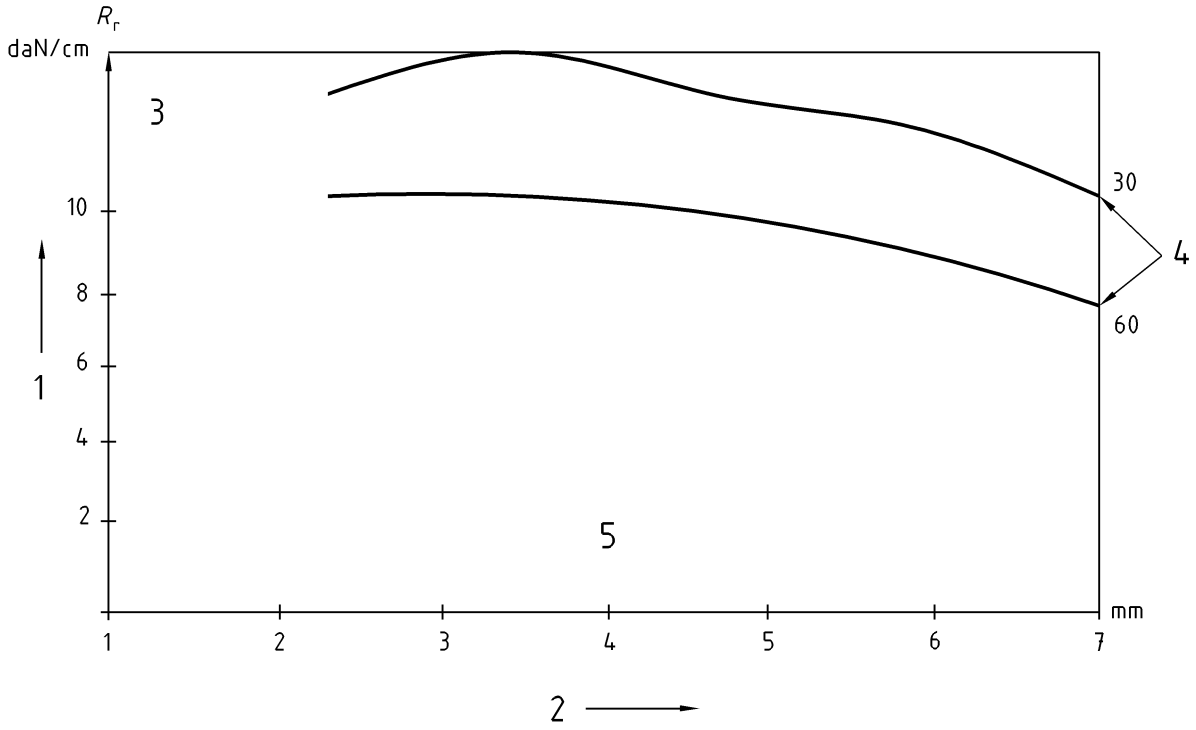
e is the thickness of the weld made with two sheets.



Key

1 Weld cohesion
2 Electrode width
3 Test piece width
4 Plasticizing rate
5 Shear tests
6 Peel tests

Figure F.6 – Variation as a function of the top welding electrode width (PVC-P sheets of nominal thickness = 0,5 mm)



Key

1 Weld cohesion
2 Weld thickness
3 Test piece width
4 Plasticizing rate
5 Peel tests

Figure F.7 – Variation as a function of the weld thickness

NOTE 2 The curves illustrate the optimum weldability obtained at approximately 60 % of the thickness of the two sheets.

Annex G
Factory production control

G.1 General

Factory production control (FPC) is the permanent internal control of production carried out by the manufacturer. FPC shall be based on:

— control of the raw materials;

— control of the procedures;

— the calibration plan;

— testing of the finished products;

— traceability.

All the elements, requirements and provisions adopted by the manufacturer shall be documented systematically in the form of written policies and procedures. This documentation of the production control system shall ensure a common understanding of the quality assurance and enable the required characteristics of the product to be obtained and the efficient functioning of the production control system to be verified.

A manufacturer applying the relevant part of the EN ISO 9000 series covering the products in question is regarded as meeting the requirements of the FPC.

G.2 Control of the raw materials

The manufacturer shall ensure that the raw materials and constituent elements conform to the specified requirements. When the required verifications have been made, the control exercised by the supplier and the documented proofs of conformity shall be taken into account.

G.3 Control of the procedure

In order to manufacture products in conformity to this document, the manufacturer shall verify the procedure used and carry out an inspection and tests as described in the documentation of the production control system.

G.4 Calibration plan

The test equipment shall be calibrated as a function of standardized equipment or materials that can be linked to relevant reference standards in conformity to a calibration plan. The appropriate calibrations shall be carried out on testing and measuring equipment used for the production control. The minimum calibration intervals shall be specified in the manufacturer's instruction manual.

G.5 Testing of the finished products

G.5.1 Direct testing

The manufacturer shall regularly subject the finished products to tests. The tests shall be carried out in accordance with the standardized test method specified in this document or, in the case of indirect testing, as specified in G.5.2.

The verifications and tests shall be carried out on finished products at a frequency that shall be indicated in the documentation of the production control system and be suitable for the product and its conditions of manufacture.

If test results are used to assess conformity to the requirements of this document, all these test results (direct and indirect) shall be within the limits fixed by the manufacturer for each test..

G.5.2 Indirect evaluation

The tests shall normally be carried out according to the test method indicated in this product document. However, indirect evaluation is authorized. Indirect authorization is defined as verification of a specified property X by means of another property Y, if the relationship between these two properties for the product in question is known and may be proven.

For each indirect test procedure applied at a production site, the sampling plan and conformity criteria for the indirect property shall be specified, taking into account the relevant relationship between the corresponding properties.

G.6 Inspection and testing

Conformity and non-conformity of the product on the basis of the inspections and tests carried out shall be clearly indicated.

All the results of the inspection, calibration and testing shall be recorded with:

— a description of the product;

— the date of manufacture;

— the test method;

— the test result;

— the signature of the inspector.

If the products do not conform to the requirements of this document, the necessary corrective actions shall be taken. The non-conforming products or lots shall be isolated and correctly identified. Once the defect has been corrected, the test or verification in question shall be repeated.

The manufacturer's record shall be kept for five years.

G.7 Traceability

It is the responsibility of the manufacturer or his agent to keep full records of the individual products or product lots, comprising manufacturing details and characteristics, and to keep the records of the people to whom these products or lots have been sold initially.

Annex ZA
(informative)

Clauses of this European Standard addressing provisions of the EU Construction Products Directive

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under the mandate M 121 "Internal and external finishes of walls and ceilings" given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European Standard shown in this annex meet the requirements of the mandate given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of the stretched ceilings covered by this annex for the intended uses; reference shall be made to the information accompanying the CE marking

WARNING : Other requirements and other EU Directives not affecting the fitness for the intended uses may be applicable to the stretched ceiling falling within the scope of this European Standard.

NOTE 1 In addition to any specific clauses relating to dangerous substances possibly contained in this standard, there may be other requirements applicable to the products falling within its scope (e. g: transposed European legislation, national regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with when and where they apply.

NOTE 2 An informative database of European and national provisions on dangerous substances is available at the Construction web site on EUROPA (accessed through http://europa.eu.int).

This annex establishes the conditions for the CE marking of stretched ceilings intended for the uses indicated in Table ZA.1 and the relevant clauses applicable.

The scope of this annex is defined by Table ZA.1

.

Table ZA.1 — Relevant clauses for stretched ceilings and the intended use

Product: Stretched ceilings **Intended use**: internal finishes of ceilings			
Essential characteristics	**Requirement clauses in this European Standard**	**Levels and/or classes**	**Notes: Expression of results**
Reaction to fire	4.1.1	A1 to F	class
Release of other dangerous substances	4.1.2 (4.1.2.1 and 4.1.2.2)	-	Heavy metals: Table 1 Vinyl chloride monomer: ≤ 10 mg/kg
Water vapour permeability	4.1.3	-	For stretched ceilings made of sheets < 50 g/m^2/24 h
Susceptibility to the development of micro-organisms	4.2 or 4.3	-	See Table 3 or 4
Durability	4.2 or 4.3	-	Dimensional stability when exposed to humidity, strength of the assembly, heat shrinkage, breaking strength, elongation at break, tear strength (according to the type of material

The requirement relating to a certain characteristic is not applicable in those Member States where there are no regulatory requirements for that characteristic for the intended use of the product. In this case, manufacturers placing their products on the markets of these Member States are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option "No performance determined" (NPD) in the information accompanying the CE marking (see ZA.3) may be used. This option may not be used where this characteristic is subject to a threshold level.

ZA.2 Procedure for attestation of conformity of stretched ceilings

ZA.2.1 Systems of attestation of conformity

The systems of attestation of conformity of stretched ceilings indicated in Table ZA.1, conforming to the Decision of the Commission 1998/437 as given in Annexe III of mandate M 121 "Internal and external finishes of walls and ceilings", are shown in Table ZA.2 for the intended uses and relevant levels or classes:

Table ZA.2 — Systems of attestation of conformity

Product	Intended uses	Levels or classes	Attestation of conformity systems
Coatings	Internal finishes of ceilings subject to regulations on reaction to fire	A1*,A2*,B*, C*	1
		A1**, A2**, B**, C**, D and E	3
		F	4
Ceiling coatings	Internal finishes of ceilings for the other characteristics		4
* Products/Materials for which a clearly identifiable stage of the production process leads to an improvement in the classification with regard to reaction to fire. ** Products/Materials not covered by the note (*)			
System 1: See Construction Products Directive 89/106/EEC, Annex III.2(i), without testing by sampling of pieces **System 3**: See Construction Products Directive 89/106/EEC, Annex III.2(ii), Second possibility. **System 4**: See Construction Products Directive 89/106/EEC, Annex III.2(ii), Third possibility.			

The attestation of conformity of the stretched ceilings in Table ZA.1 shall be based on the evaluation of conformity procedures indicated in Tables ZA.3a, ZA.3b and ZA.3c, resulting from the application of the clauses of this or other European Standards indicated therein.

Table ZA.3a — Assignment of evaluation of conformity tasks for stretched ceilings under system 1

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to all the characteristics of Table ZA.1	5.1
	Initial type testing by the manufacturer	Release of dangerous substances, water vapour permeability, susceptibility to the development of microorganisms and durability	5.2
Tasks for the product certification body	Initial type testing	Reaction to fire, Classes A1*, A2*, B*, C*	5.2
	Initial inspection of factory and factory production control	Parameters related to all the characteristics of Table ZA.1, in particular: reaction to fire, Classes A1*, A2*, B*, C*	**5.1**
	Continuous surveillance, assessment and approval of factory production control	Parameters related to all the characteristics of Table ZA.1, in particular: reaction to fire, Classes A1*, A2*, B*, C*	5.1
(*) See footnotes to Table Z.A.2.			

Table ZA.3b — Assignment of evaluation of conformity tasks for stretched ceilings under system 3

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to all the characteristics of Table ZA.1	5.1
	Initial type testing	Release of dangerous substances, water vapour permeability, susceptibility to the development of microorganisms and durability	5.2
Tasks for the notified body	Initial type testing	Reaction to fire, Classes A1**, A2**, B**, C**, D and E	5.2
(*) See footnotes to Table Z.A.2.			

Table ZA.3c — Assignment of evaluation of conformity tasks for stretched ceilings under system 4

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to all the characteristics of Table ZA.1	5.1
	Initial type testing by the manufacturer	Release of dangerous substances, water vapour permeability, susceptibility to the development of microorganisms and durability	5.2

ZA.2.2 EC certificate and declaration of conformity

If conformity to the conditions of this annex has to be met, the manufacturer or his agent established in the EEA shall prepare and keep a declaration of conformity authorizing the manufacturer to affix the CE marking. This declaration shall include:

— name and address of the manufacturer or his authorized agent established in the EEA, and place of production;

— description of the product (type, identification, use,…) and copy of the information accompanying the CE marking;

— provisions to which the product conforms (e.g. Annex ZA of this EN);

— particular conditions applicable to the use of the product (e. g. provisions for use under certain conditions, etc.);

— name and address (or identification number) of the notified laboratory(ies) (only for products under system 3);

— name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or of his authorized representative.

If certification is required (system 1), the certification body shall establish a certificate of conformity (EC certificate of conformity) authorizing the manufacturer to affix the CE marking. This certificate shall include:

— name, address and identification number of the certification body;

— name and address of the manufacturer or his agent established in the EEA and place of production;

— description of the product (type, identification, use,…)

— provisions to which the product conforms (e.g. Annex ZA of this EN);

— particular conditions applicable to the use of the product (e. g. provisions for use under certain conditions, etc.);

— certificate number;

— conditions of the certificate, as appropriate;

— name of, and position held by, the person empowered to sign the certificate.

The abovementioned declaration and certificate shall be presented in the official language or languages of the Member State in which the product is to be used.

ZA.3 CE marking and labelling

The manufacturer or his authorized representative within the EEA is responsible for affixing the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the stretched ceiling on the packaging or commercial documents.

The CE marking symbol shall be accompanied by the following information:

on the product:

— the EC certificate number for the product (if appropriate);

— the identifying number of the certification body (only for products under system 1);

on the packaging:

— the identifying number of the certification body (only for products under system 1);

— the name and identifying mark and declared address of the manufacturer;

— the last two digits of the year in which the marking is affixed;

— the number of the certificate of conformity for the product (if appropriate);

— reference to this European Standard (EN 14716);

— description of the product: generic name, material, dimensions,… and intended use;

on the commercial documents:

— the information given on the packaging;

— the information on the essential characteristics listed in Table ZA.1 and presented in the form of: the class (and sub-classes for the smoke and drips, if applicable) for the reaction to fire, "satisfactory test" for the release of dangerous substances, "satisfactory test" for the water vapour permeability (except for ceilings with perforations and cut-outs and full fabrics as the requirement is not applicable) and the values in Tables 3 and 4 with regard to susceptibility to the development of microorganisms and durability;

  — "no performance declared" (NPD) for the relevant characteristics

The "no performance declared" option shall not be used where the characteristic is subject to a threshold level. Otherwise, the NPD option (or class F for the reaction to fire) may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State of destination.

Figure ZA.1 gives an example of the information to be given on the product, label, packaging and/or commercial documents.

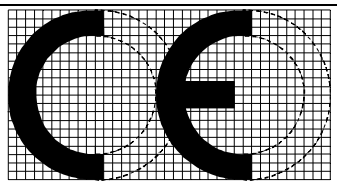
 01234	CE marking of conformity, consisting of the CE symbol specified in Directive 93/68/EEC Identification number of the certification body (if appropriate)
Any Co Ltd, PO Box 21, B-1050 04 01234-CPD-00234	Name or identification mark and declared address of the manufacturer Last two digits of the year in which the marking was affixed Number of the certificate (if appropriate)
EN 14716 Stretched ceiling **Reaction to fire** – Class D-s1, d0 **Release of dangerous substances** – Satisfactory test **Susceptibility to the development of microorganisms** – NPD **Durability** – Satisfactory test	Number of the European Standard Description of the product and information on regulated characteristics

Figure ZA.1 — Example of information accompanying the CE marking

In addition to any specific information relating to the dangerous substances mentioned above, the product should be accompanied when required and in the appropriate form by a mention of any other regulation on dangerous substances to which the product is alleged to conform and any information required by this regulation.

NOTE It is not necessary to cite the European regulations if no national derogation exists.

Bibliography

[1] EN 71-3:1994, *Safety of toys - Part 3: Migration of certain elements*.