BS EN 15681-1:2016

BSI Standards Publication

Glass in building — Basic alumino silicate glass products

Part 1: Definitions and general physical and mechanical properties

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National foreword

This British Standard is the UK implementation of EN 15681-1:2016.

The UK participation in its preparation was entrusted to Technical Committee B/520/1, Basic and transformed glass products.

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

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Glass in building - Basic alumino silicate glass products - Part 1: Definitions and general physical and mechanical properties

Verre dans la construction - Produits de base : verre aluminosilicate - Partie 1 : Définitions et propriétés physiques et mécaniques générales

Glas im Bauwesen - Basiserzeugnisse aus Alumo-Silicatglas - Teil 1: Definitionen und allgemeine physikalische und mechanische Eigenschaften

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European foreword

This document (EN 15681-1:2016) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by July 2016, and conflicting national standards shall be withdrawn at the latest by July 2016.

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This European Standard consists of the following parts:

— EN 15681-1 Glass in Building — Basic alumino silicate glass products — Part 1: Definitions and general physical and mechanical properties;

— EN 15681-2 Glass in Building — Basic alumino silicate glass products — Part 2: Evaluation of conformity / Product standard[1].

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[1] Standard under development.

1 Scope

This Part of this European Standard specifies and classifies basic alumino silicate glass products, indicates their chemical composition, their main physical and mechanical characteristics, their dimensional and their minimum quality requirements (in respect of optical and visual faults).

This European Standard applies to basic alumino silicate glasses supplied in stock sizes, supplied sizes or in cut sizes for final end use.

This European Standard does not apply to final cut sizes having a dimension less than 100 mm or a surface area less than 0,05 m^2.

2 Normative references

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

EN 410, *Glass in building - Determination of luminous and solar characteristics of glazing*

ISO 9385, *Glass and glass-ceramics — Knoop hardness test*

3 Terms and definitions

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

3.1
alumino silicate glass
silicate glass containing between 5,8 % to 16,2 % aluminium and with a chemical composition according to 4.1 of this standard

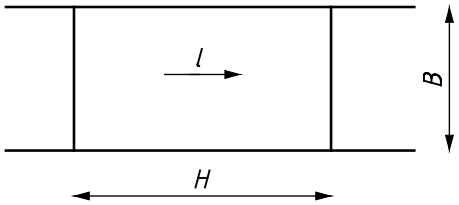
3.2
alumino silicate float glass
flat, transparent, clear or tinted alumino silicate glass having parallel and polished faces obtained by continuous casting and floatation on a metal bath

Note 1 to entry: In French called 'glace' and in German 'Floatglas'.

3.3
alumino silicate drawn sheet glass
flat, transparent or translucent, clear or tinted basic alumino silicate glass obtained by continuous drawing of a regular thickness and with the two surfaces fire polished

3.4
alumino silicate rolled glass
flat, transparent or translucent, clear or tinted basic alumino silicate glass obtained by rolling

3.5
length, H and width, B
defined with reference to the direction of draw of the glass ribbon as shown in Figure 1



Key

I direction of draw

H length

B width

Figure 1 — Relationship between length, width and direction of draw

3.6
stock sizes
glass delivered in manufacturers standard stock sizes

3.7
supplied size
pane of glass that has been supplied either as raw material for further processing and/or cutting down to a size for installation

Note 1 to entry: This is a size that is outside the stock size.

3.8
final cut size
pane of glass that has been cut down to the dimensions being required either for installation or processing into a final product

Note 1 to entry: Examples of processed final products are insulating glass units and thermally toughened safety glass of those dimensions.

3.9
optical fault
fault which leads to distortions in the appearance of objects observed through the glass

3.10
visual fault
fault which alters the visual quality of the glass

Note 1 to entry: Visual faults include spot faults and linear / extended faults.

3.11
spot fault
spherical or quasi spherical fault which is produced by differing mechanisms, e.g. gaseous inclusion, solid inclusion, mark or deposit of small size

3.12
linear / extended faults
fault which can be on or in the glass, in the form of deposits, reams, marks or scratches that occupy an extended length or area

3.13
edge defect
defect which can occur on the edge of a cut size piece in the form of entrant and emergent fault and/or bevel

3.14
concentration
sum of the lengths of gaseous inclusions greater than 1,0 mm in any circle of 400 mm diameter

4 Chemical composition

4.1 General

The basic glass products covered by this European Standard are all manufactured from alumino silicate glass.

The magnitude of the proportions by mass of the constituents of alumino silicate glass covered by this standard is given in Table 1, see also Annex A

Table 1 — Magnitude of the proportions by mass of the constituents of alumino silicate glass

Constituents	Proportion by mass of element
Silicon (Si)	25,3 % to 35,1 %
Aluminium (Al)	5,8 % to 16,2 %
Σ Si + Al	32,1 % to 51,3 %
Lithium (Li)	0 % to 3,7 %
Sodium (Na)	0 % to 10,5 %
Calcium (Ca)	0 % to 2,1 %
Magnesium (Mg)	0 % to 5 %
Zinc (Zn)	0 % to 2,4 %
Potassium (K)	0 % to 7 %
Zirconium (Zr)	0 % to 3,0 %
Strontium (Sr)	0 % to 2,5 %
Barium (Ba)	0 % to 3,6 %
Other components[a]	0 % to 5 %
[a] Properties other than photometric characteristics shall not be significantly altered by these other components	

4.2 Tint

Body tinted glass is obtained by the addition of suitable materials.

5 Physical and mechanical characteristics

5.1 General characteristics

Conventional numerical values for the physical and mechanical characteristics of basic alumino silicate glass products excluding 'Characteristic bending strength' ($f_{g;k}$) are given in Table 2. These values, for

normal annealed glass without any further toughening, are not precise requirements with which the glass shall strictly comply, but are the generally accepted figures for use in calculations where a high degree of accuracy is not required.

Table 2 — General characteristic values of basic alumino silicate glass

Characteristic	Symbol	Value and unit
Density (at 18 °C)	ρ	2300 to 2600 kg/m^3
Hardness (Knoop)	$HK_{0,1/20}$	400 to 700 [a]
Young's modulus (modulus of elasticity)	E	70 to 90 x GPa
Poisson's ratio	μ	0,2 to 0,25
Specific heat capacity	C_p	0,7 to 0,9 × 10^3 J/(kg*K)
Nominal value of average coefficient of linear expansion between 20 °C and 300 °C	α	3,5 to 9,8 × 10^{-6}/K
Resistance against temperature differential and sudden temperature change		60 K [b]
Thermal conductivity	λ	0,8 to 1,7 W/(m*K)
Mean refractive index to visible radiation (at 589,3 nm)	n	1,5 to 1,55
Emissivity (corrected)	ε	0,837

[a] Knoop Hardness in accordance with ISO 9385

[b] Generally accepted value that is influenced by edge quality and glass type

5.2 Characteristic bending strength

The characteristic bending strength value applies to quasi-static loading over a short time, e.g. wind loading, and relate to a 5 % probability of breakage at the lower limit of the 95 % confidence interval.

The value of the characteristic bending strength, $f_{g;k}$, for alumino silicate float glass is 45 MPa, for drawn sheet and rolled glass 25 MPa.

NOTE Methods of determination of the bending strength of glass are given in EN 1288–1, EN 1288–2, EN 1288–3, EN 1288–4 and EN 1288–5 (see [1], [2], [3], [4], [5]). Design of glass panes is covered by prEN 16612 (see [6]).

5.3 Designation of clear alumino silicate glass

5.3.1 General

An alumino silicate glass product is designated as clear alumino silicate glass when it is not tinted and when the light transmittance of the glass material, unmodified by the possible presence of a coating or surface roughness complies with 5.3.2 and 5.3.3.

In order to measure the light transmittance characteristics of glass, to determine whether it can be designated as a clear glass, it is necessary, in some cases, to carry out a pre-treatment:

— coatings on smooth surfaces have to be eliminated, without modifying the thickness of the glass substrate;

— rough surfaces, with or without coatings, have to be eliminated by smoothing and polishing. The thickness of the glass will be modified by this process.

The light transmittance of the glass substrate shall be measured with its surfaces in a polished condition.

NOTE The light transmittance values given in 5.3.2 and 5.3.3 are not suitable for design. They are values used only for the designation of clear glass and exclude the effects of coatings and of surface roughness. The values of light transmittance used for design can be obtained from the glass manufacturer. They are determined in accordance with EN 410.

5.3.2 Clear transparent alumino silicate glass

A transparent glass product shall be designated as clear glass when it is not tinted and when its light transmittance:

— after any necessary pre-treatment,

— measured according to EN 410 and

— rounded to the nearest 0,01

is greater than or equal to the value given in Table 3 for the nominal thickness of the glass product.

NOTE The limiting value given in Table 3 is appropriate provided that the measured thickness of the glass product is within the allowable tolerances for the nominal thickness of that glass product.

Table 3 — Minimum light transmittance values for designating a transparent glass product as clear

Nominal thickness (mm)	Minimum value
2 - 5	0,87
6, 8	0,84
10, 12	0,80
15	0,77
19	0,73
25	0,68

5.3.3 Clear translucent alumino silicate glass

A translucent glass product is designated as clear glass when it is not tinted and when its light transmittance:

— after any necessary pre-treatment;

— measured according to EN 410; and

— rounded to the nearest 0,01;

is greater than or equal to the value obtained by linear interpolation from Table 4, for the measured thickness of the specimen.

NOTE The limiting value will vary with the exact thickness of the specimen after its pre-treatment.

Table 4 — Minimum light transmittance values for designating a translucent glass product as clear

Nominal thickness (mm)	Minimum value
2 - 5	0,81
6, 8	0,78
10, 12	0,74
15	0,71
19	0,67
25	0,62

5.4 Stability of physical and chemical characteristics

For basic alumino silicate glass products, the physical and chemical characteristics can be considered as remaining constant over time.

a) Since glass is insensitive to photochemical effects, the spectral properties (transmissions of light and solar energy) of the basic glass products are not modified significantly by direct or indirect solar radiation.

b) The surface of glass used in building is virtually insensitive to attack from the environment.

NOTE While the surface of the glass when installed in a building is virtually insensitive to attack from water, it is advised to take care to protect the glass surface prior to installation. Inappropriate storage can result in water/humidity being drawn up between glass sheets. This concentrated environment can cause attack of the surface (see [7]).

6 Dimensional requirements

6.1 Manufacturing dimensions

6.1.1 Stock sizes

Glass delivered in the following size range:

Nominal length H: 2000 mm to 6000 mm

Nominal width B: 1000 mm to 3210 mm

6.1.2 Supplied and final cut sizes

Glass delivered in any dimension less than those covered by the stock sizes.

The minimum cut size shall have dimensions H and B not less than 100 mm and a minimum surface area of not less than 0,05 m^2.

6.2 Thickness and thickness tolerances

The actual thickness shall be the average of four measurements, taken to the nearest 0,01 mm, one taken at the centre of each side. Measurement shall be made by means of an instrument of the calliper micrometre type.

The actual thickness, rounded to the nearest 0,1 mm shall not vary from the nominal thickness by more than the tolerances shown in Table 5.

Table 5 — Nominal thicknesses and thickness tolerances

Nominal thickness D (mm)	Thickness tolerances for glass type	
	Float	Drawn sheet, rolled
2	±0,2	±0,5
3	±0,2	±0,5
4	±0,2	±0,5
5	±0,2	±0,5
6	±0,2	±0,5
8	±0,3	±0,8
10	±0,3	±1,0
12	±0,3	±1,5
15	±0,5	±1,5
19	±1,0	±2,0
25	±1,0	±2,5

6.3 Length, width and squareness

The tolerances, t, on nominal dimensions length, H and width, B are given in Table 6.

Table 6 — Tolerances, t, on the nominal dimensions length and width

Nominal thickness, d (mm)	Tolerance *t* (mm)			
	Stock	Supplied and final cut sizes		
		(H, B) ≤ 1500	1500 < (H,B) ≤ 3000	(H, B) > 3000
2 - 6	±10	±2	±5	±8
8 - 12	±10	±3	±5	±8
15, 19, 25	±10	±4	±5	±8

The limits of squareness are described by the difference between diagonals. Limits are given in Table 7.

Table 7 — Limits for the difference between diagonals

Nominal thickness, d (mm)	Limit for the difference between diagonals (mm)			
	Stock	Supplied and final cut sizes		
		(H, B) ≤ 1500	1500 < (H, B) ≤ 3000	(H, B) > 3000
2 - 6	10	3	4	5
8 - 12	10	4	5	6
15, 19, 25	10	5	6	8

7 Quality requirements

7.1 General

Alumino silicate glass is classified into three categories, A, B and C, according to optical faults and visual faults (see 7.3).

NOTE It is advised to consult the manufacturer(s) if higher levels of quality are required.

7.2 Methods of observation and measurement

7.2.1 Optical faults

7.2.1.1 Method of observation of optical faults on float glass

A screen bearing an assembly of black and white stripes (zebra) is observed through the glass to be examined.

The usual size of screen is between 1500 mm x 1150 mm and 2500 mm x 2000 mm. It consists of a translucent white background with parallel black stripes, 25 mm wide and 25 mm apart, inclined at 45°.

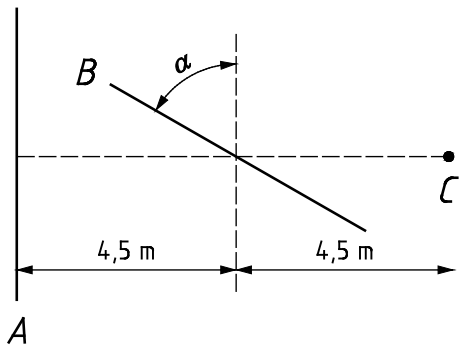
The screen is uniformly lit from behind with white daylight fluorescent tubes. The illuminance of the screen measured 1 m from it shall be between 400 lx and 1 200 lx. The measurement shall be taken at a point on a line normal to the centre of the screen. The walls of the test room should be painted with a dark non-reflective paint having a diffuse reflection ≤ 0,10.

The glass to be examined shall be held vertically in a support frame. The centre of the glass shall be at a distance of 4,5 m from the screen and on a line normal to the centre of the screen. The glass shall be capable of being rotated around a vertical axis. The glass shall be held with the direction of draw of the glass vertical.

Appropriate critical viewing angles, α, formed by the glass and the screen should be indicated (see Figure 2). The observer stands still at a distance of 9 m from the centre of the screen on a line passing through the axis of rotation.

7.2.1.2 Method of measurement of optical faults on float glass

The glass being examined is rotated from an angle $\alpha = 90°$ until there is no longer any distortions of the lines on the screen. The angle, α (see Figure 2), at which this occurred is noted.



Key

A screen

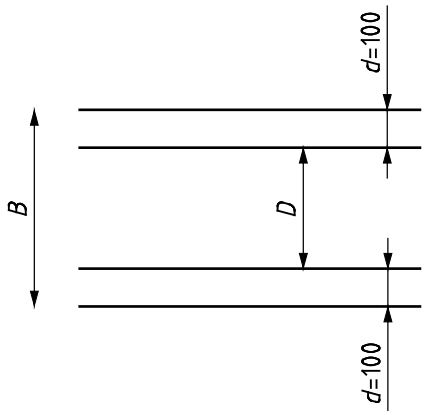
B glass sample

C observer

Figure 2 — Plan view showing set up of zebra test

The glass sample taken, with a length, *H*, between 300 mm and 500 mm and a width, *B*, of 3 210 mm, is split into four. This gives samples of width approximately 800 mm The distortion is measured in the areas D and d as shown in Figure 3.

Dimensions in mm



Key

B width of glass sample

D area of measurement of distortion

d area of measurement of distortion

Figure 3 — Zones for the measurement of optical distortion

7.2.1.3 Method of observation of optical faults on drawn sheet and rolled glass

A reticulated screen is observed through the pane of glass to be examined.

The screen should have approximately the same dimensions as the pane of glass to be examined. It should consist of a matt black background (reflection coefficient between 0,2 and 0,4) having a network of lines 10 mm thick of a colour contrasting clearly with the background. The network of lines should have the appearance of a wall of bricks whose size is 200 mm x 70 mm, each line offset by 100 mm from the lines above and below.

The lighting of the screen should correspond to diffuse natural or artificial daylight.

Place the pane of glass to be examined vertically 3 m from the screen. Arrange the point of observation 1 m from the glass keeping the direction of observation perpendicular to the screen. Arrange the pane of glass to form an angle of 45° with the plane of the screen.

7.2.1.4 Method of measurement of optical faults on drawn sheet and rolled glass

View the screen through the glass and note any disturbing distortions.

7.2.2 Visual faults (spot faults, linear/extended faults), all types of basic alumino silicate glass

7.2.2.1 Method of observation of visual faults (spot faults, linear/extended faults)

The glass pane to be examined is illuminated in conditions approximating to diffuse daylight and is observed in front of a matt black screen (reflection between 0,2 and 0,4).

The pane of glass to be examined shall be placed vertically in front of the screen and parallel to it. The point of observation shall be 2 m from the glass, keeping the direction of observation normal to the glass surface.

7.2.2.2 Method of measurement of spot faults

Measure the largest dimension (diameter or length) of these faults with a micrometre with graduations in tenths of a millimetre.

Note the number and dimensions of the spot faults and relate to the three categories of faults as shown in Table 9.

7.2.2.3 Method of measurement of linear/extended faults

View the pane of glass, note the number and dimensions of visually disturbing faults and relate to the allowable numbers of the categories of faults as shown in Table 9.

7.3 Acceptance levels

7.3.1 Optical faults

7.3.1.1 Float glass

When viewed under the conditions of observation as described in 7.2.1.1 the angle α, at which there is no disturbing distortion shall be not less than the appropriate critical viewing angle given in Table 8.

Table 8 — Critical viewing angle

Nominal glass thickness [mm]	Angle α in zone D [degrees]	Angle α in zone d [degrees]
2	45	40
≥ 3	50	45

7.3.1.2 Drawn sheet and rolled glass

When viewed under the conditions of observation described in 7.2.1.3, no disturbing distortions are allowed for category A. The manufacturer should be consulted on the optical criteria for category B and C.

7.3.2 Visual faults (spot faults, linear/extended faults), all types of basic alumino silicate glass

When viewed under the conditions of observation described in 7.2.2.1, the allowable numbers of the faults per category are shown in Table 9.

Table 9 — Summary of acceptance levels

Category	category A	category B	category C
Visual Faults [a] [b]	**Acceptance criteria**		
Gaseous inclusions ≤ 1 mm	acceptable	acceptable	acceptable
Gaseous inclusions > 1 mm acceptable if:			
- maximum length	≤ 5 mm	≤ 10 mm	≤ 20 mm
- sum of lengths per m^2	≤ 15 mm	≤ 50 mm	≤ 100 mm
- maximum number per m^2	5 for length 1 mm to 5 mm	10 for length 1 mm to 5 mm and 3 for length > 5 mm	50 for length 1 mm to 5 mm and 5 for length > 5 mm
Concentration (c)	≤ 14 mm	≤ 25 mm	≤ 60 mm
Other spot faults			
0,5 mm to 2 mm	3 per m^2	3 per m^2	3 per m^2
> 2 mm to 3 mm	2 per m^2	2 per m^2	2 per m^2

[a] Remark concerning all spot faults: In the case of a single fault per m^2 the maximum dimension may be increased by 25 %.

[b] Linear/extended faults: The allowable number of faults is an average of 0,05 faults in 20 m^2 of glass relating to at least 20 tonnes.

7.4 Edge defects for final cut sizes

7.4.1 Entrant and emergent faults

These faults are shown in Figures 4 and 5. The dimensions h_1, h_2 and p and the glass thickness e are measured.

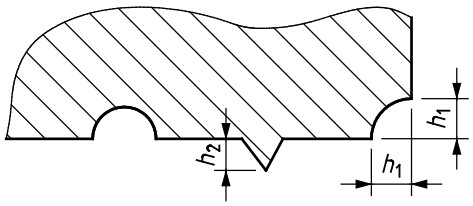


Figure 4 — Entrant and emergent faults – surface view

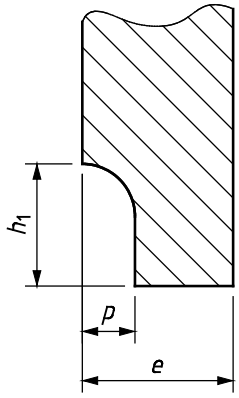


Figure 5 — Entrant faults – edge view

7.4.2 Bevel

This fault is shown in Figure 6. The dimension d and the glass thickness e are measured.

Figure 6 — Bevel – edge view

7.4.3 Limitations on edge defects

The limitations on entrant and emergent faults and bevel are given in Table 10.

Table 10 — Limitations on edge defects

Edge defect	Limitations
Entrant fault	$h_1 < (e - 1)$ mm $p < (e/4)$ mm
Emergent fault	h_2 shall not exceed the positive tolerance t as given in Table 5 and the pane shall remain within the rectangle resulting from nominal dimensions, i.e. h and b, with positive tolerance.
Bevel	The ratio (d/e) shall be less than 0,25

NOTE The limitations only apply when there is no risk of breakage resulting from thermal stress. In applications where thermal stress breakage may apply, it is advised to follow the manufacturers' recommendations on edge quality.

8 Designation

Basic alumino silicate glass in compliance with this standard shall be designated respectively by:

— type;

— tint (manufacturers reference) or clear;

— category A, B, or C;

— nominal thickness in mm;

— nominal width, B in mm and nominal length, H, in mm;

— reference to this Part of this European Standard.

EXAMPLE:

Designation of an alumino silicate float glass, intended for use in buildings, clear, category A, thickness 5 mm, nominal width 1,2 m, nominal length 2,0 m:

Alumino silicate float glass, clear, category A, 5 mm, 1200 mm x 2000 mm, EN 15681–1

Annex A
(informative)

Complementary information related to REACH

Alumino silicate glass is an amorphous inorganic substance obtained from different inorganic raw materials which react at high temperature to form a new random network, where different elements are linked together, typically by oxygen bridges, arranged in such a way that no free oxides are present.

Under the REACH Regulation (Registration, Evaluation, Authorization and Restriction of Chemicals Regulation (EC) No 1907/2006) glass is considered as a UVCB substance (substance of unknown or variable composition, complex reaction products or biological materials).

NOTE 1 Alumino silicate glass may benefit from exemption from the obligation to register in accordance with article 2(7)(b) of REACH (Commission Regulation (EC) No 987/2008).

NOTE 2 Glass products covered by this standard are “articles” in accordance with article 3(3) of REACH (Regulation (EC) No 1907/2006).

Alumino silicate glass can better be identified by the chemical formula:

$$Li_rCa_mK_oMg_tZr_qSr_xBa_y\ldots Al_pSi_nO_s$$

Where: $s = r/2 + m + o/2 + t + 3\,p/2 + 2\,q + x + y + \ldots + 2\,n$

Bibliography

[1] EN 1288-1, *Glass in building - Determination of the bending strength of glass - Part 1: Fundamentals of testing glass*

[2] EN 1288-2, *Glass in building - Determination of bending strength of glass - Part 2: Coaxial double ring test on flat specimens with large test surface areas*

[3] EN 1288-3, *Glass in building - Determination of the bending strength of glass - Part 3: Test with specimen supported at two points (four point bending)*

[4] EN 1288-4, *Glass in building - Determination of the bending strength of glass - Part 4: Testing of channel shaped glass*

[5] EN 1288-5, *Glass in building - Determination of the bending strength of glass - Part 5: Coaxial double ring test on flat specimens with small test surface areas*

[6] prEN 16612, *Glass in building - Determination of the load resistance of glass panes by calculation and testing*

[7] Evaluation of the relevant parameters allowing to prevent the weathering of float glass during storage, Franco Geotti-Bianchini, Martina Preo, Rivista della Stazione Sperimentale del Vetro n. 3-1999, pages 127 – 146

[8] EN 15681-2, *Glass in Building — Basic alumino silicate glass products — Part 2: Evaluation of conformity / Product standard*[2]

[2] Standard under development.

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