BRITISH STANDARD

BS EN
14963:2006

Roof coverings — Continuous rooflights of plastics with or without upstands — Classification, requirements and test methods

The European Standard EN 14963:2006 has the status of a British Standard

ICS 91.060.20

BSI
British Standards

National foreword

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A list of organizations represented on B/542/8 can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Roof coverings - Continuous rooflights of plastics with or without upstands - Classification, requirements and test methods

Éléments de couverture - Lanterneaux continus en matière plastique avec et sans costière - Classification, spécifications et méthodes d'essais

Dachdeckungen - Dachlichtbänder aus Kunststoff mit oder ohne Aufsetzkränzen - Klassifizierung, Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 4 September 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document (EN 14963:2006) has been prepared by Technical Committee CEN/TC 128 “Roof covering products for discontinuous laying and products for wall cladding”, the secretariat of which is held by IBN/BIN.

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of an identical text or by endorsement, at the latest by April 2007, and conflicting national standards shall be withdrawn at the latest by July 2008.

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

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

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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies requirements for continuous rooflights made of plastic materials (e.g. GF-UP, PC, PMMA, PVC) with or without bearing profiles to be used with upstands made of e.g. GF-UP, PVC, steel, aluminium, wood or concrete, for laying in roofs, which serve the purpose of lighting by means of daylight and, possibly, of ventilating interior spaces by means of opening devices.

This European Standard applies to continuous rooflights without upstand and to continuous rooflights, where a single manufacturer provides all components of the rooflight with upstand, which are bought in a single purchase. Products covered by this European Standard may be supplied as continuous rooflights with and without upstand and rooflights intended to be used with an upstand, for which the upstand is specified, but not supplied.

It applies to continuous rooflights when mounted with an inclination δ in the longitudinal direction not more than 10° to the horizontal and not more than 10° in the transversal direction (see Figure 1):

a) with bearing profiles:

- symmetrical, angled, curved (see Figure 2) or flat (see Figure 3);
- constructed with bearing profiles parallel to the span and with a rectangular ground plan;

b) without bearing profiles:

- symmetrical, angled or curved with an α angle not more than 45° (measured to the horizontal at the line of fixing, see Figure 4);
- constructed with a span (width) lower than or equal 2,5 m and with a rectangular ground plan.

This European Standard applies to continuous rooflights, including barrel vault rooflights, with a rectangular ground plan of plastic glazing laying in roofs having, in addition a minimum distance of b/3 (b = effective span of rooflights, corresponding to the light opening). The upstands may be self-supporting or non self-supporting.

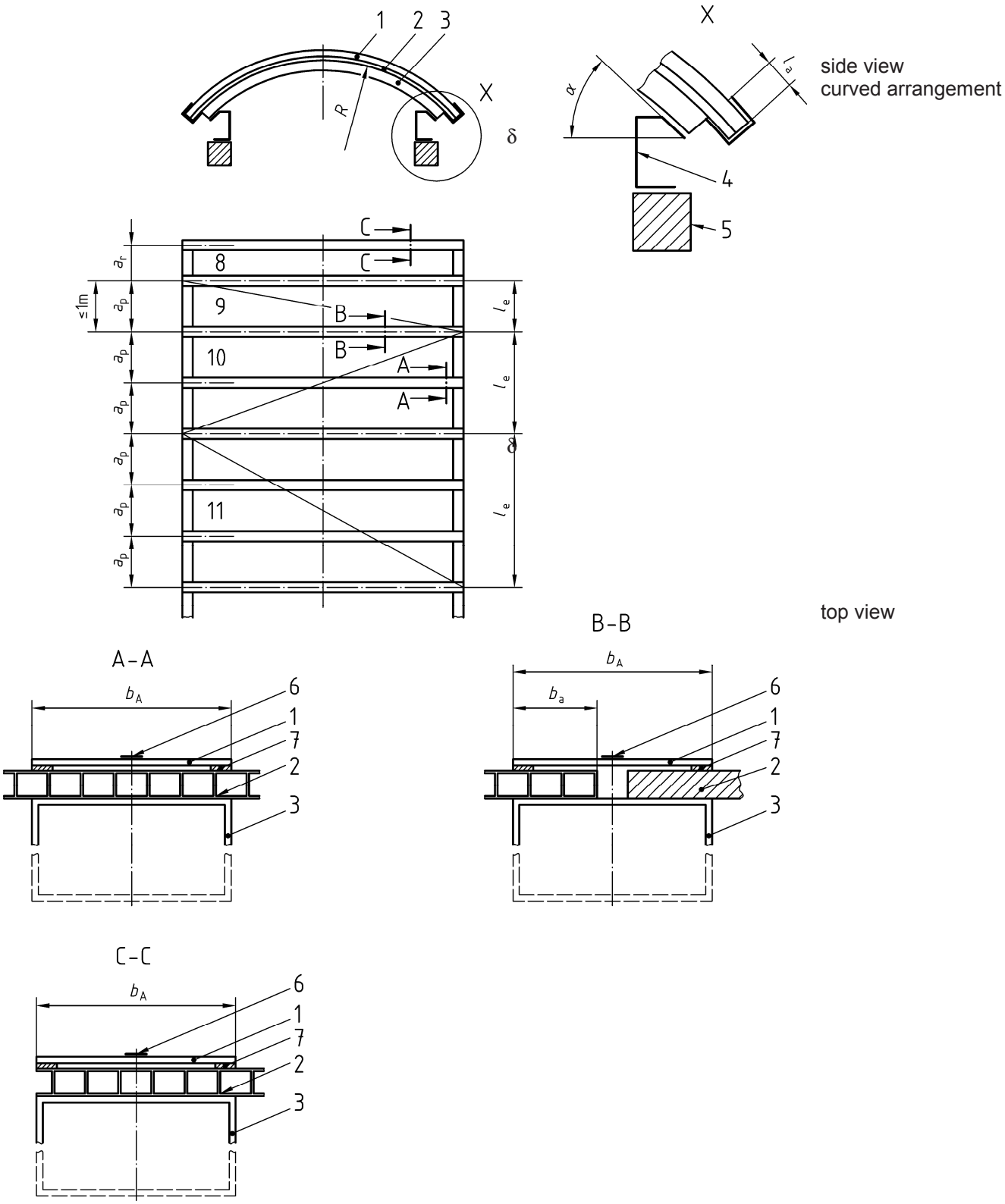
The design of the upstand is not part of this European Standard. Upstands can be prefabricated or site fabricated. Prefabricated upstands are to be considered as part of the continuous rooflight. Site fabricated upstands are not covered by this European Standard.

This European Standard does not include calculation with regard to works, design requirements and installation techniques.

The possible additional functions of smoke and heat ventilation in case of fire, and/or roof access are outside the scope of this European Standard.

NOTE 1 Continuous rooflights outside of the scope of this European Standard will be covered by European Technical Approvals based on EOTA ETA-Guideline 010 "Self supporting translucent roof kits". Individual rooflights are covered by EN 1873.

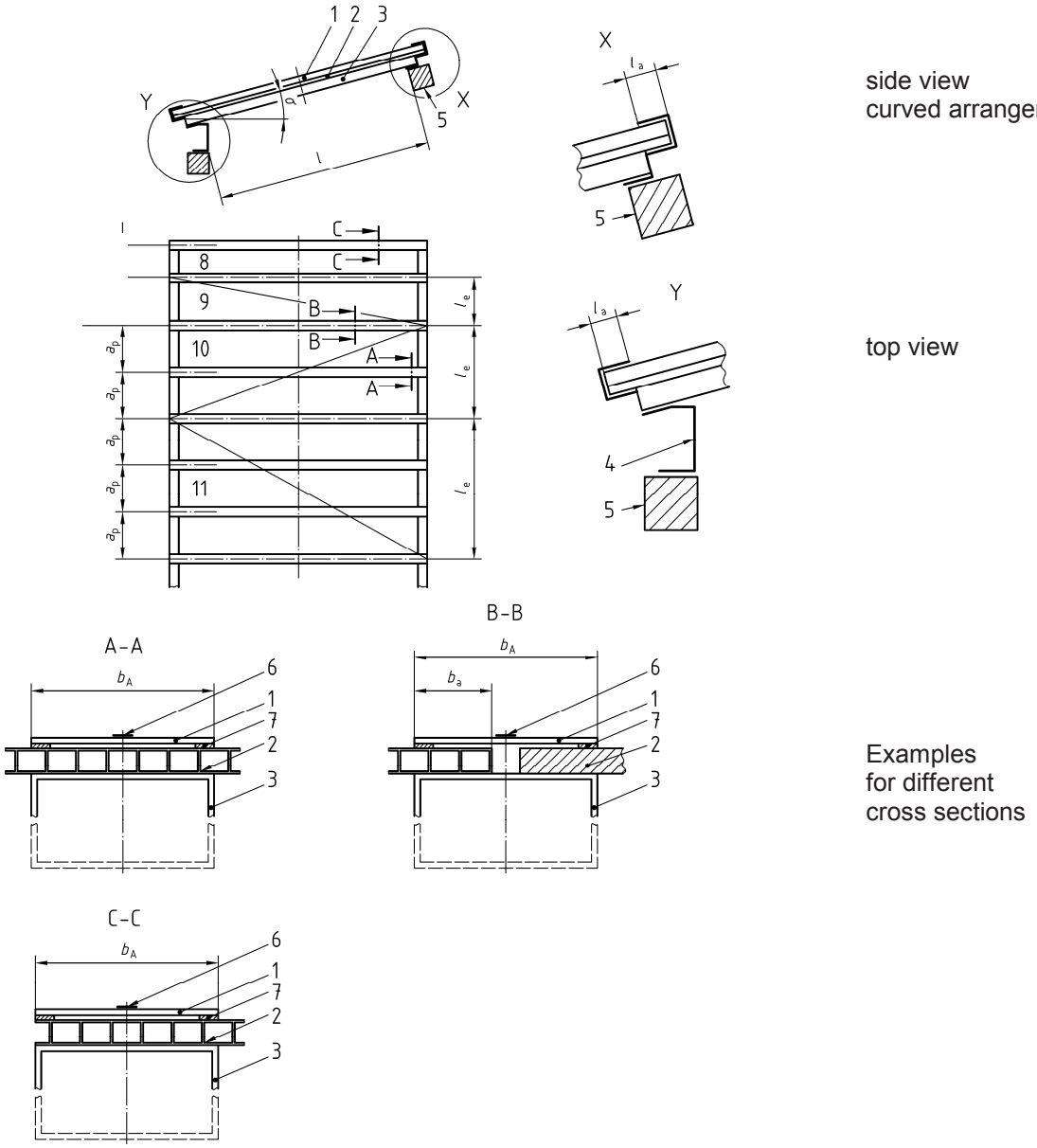
NOTE 2 Guidelines for safety, application, use and maintenance of continuous rooflights are presented in Annex A.



Key

1 joint
b_e built-in width
l span
δ inclination to the horizontal

Figure 1 — Range of inclination of continuous rooflights without bearing profiles



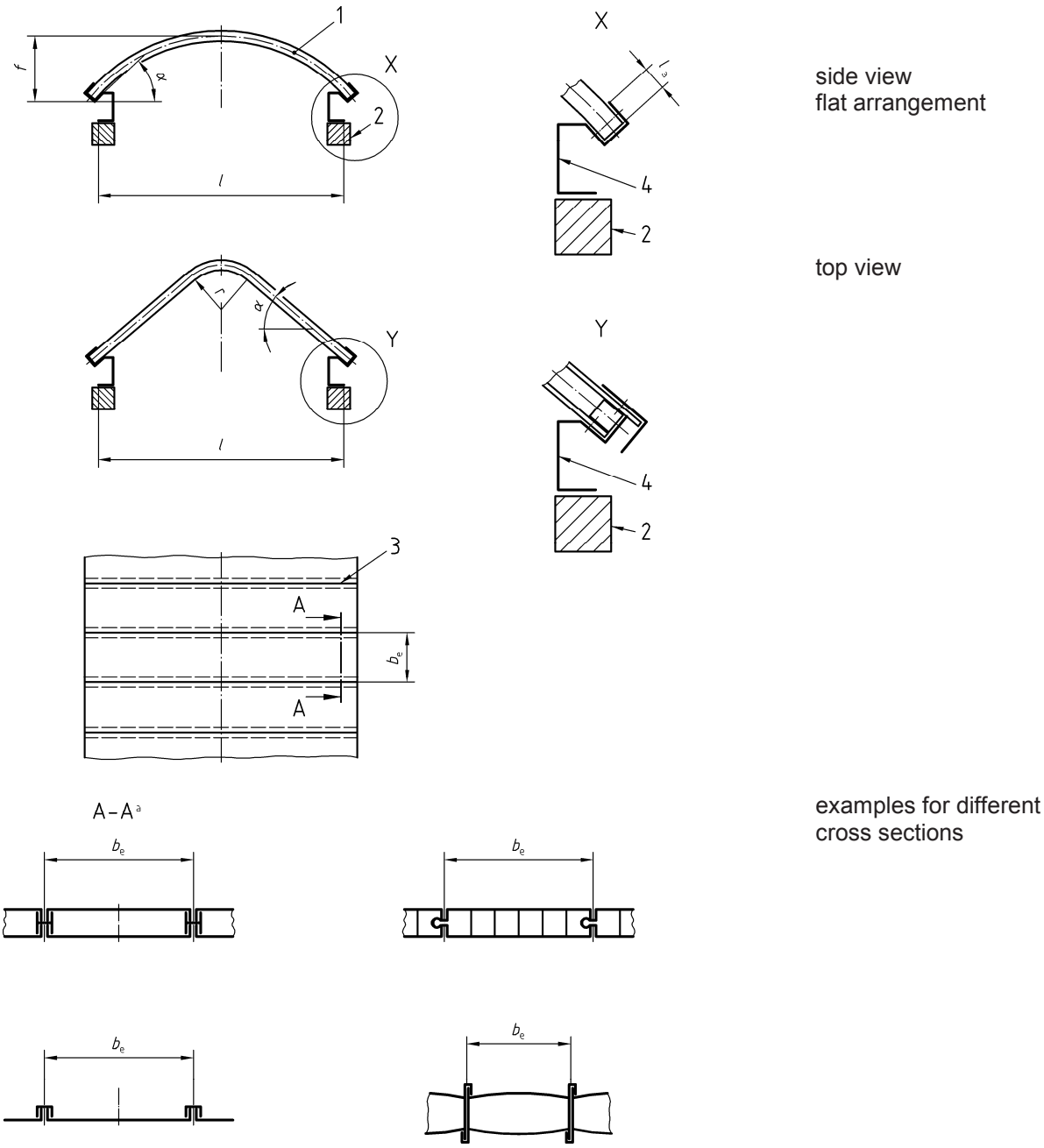
Key

1 covering profile
2 solid or multi-wall sheet
3 bearing profile
4 upstand
5 support
6 screw
7 sealing profile
8 marginal sheet
9 single span sheet
10 double span sheet
11 triple span sheet

a inclination measured to the horizontal at the line of fixing
a_p spacing of the bearing profiles
a_r spacing of the bearing profiles for marginal sheets
b_A width of the bearing profiles
b_a supported width of the sheet
l_a supported length of the sheet
l_e sheet width
R radius

NOTE If drilled profiles should be avoided, e.g. in PMMA-sheets, the covering profiles in curved systems can be alternatively fixed at their end (similar to a tie member).

Figure 2 — Example for curved continuous rooflights with bearing profiles, for single, double and triple span systems

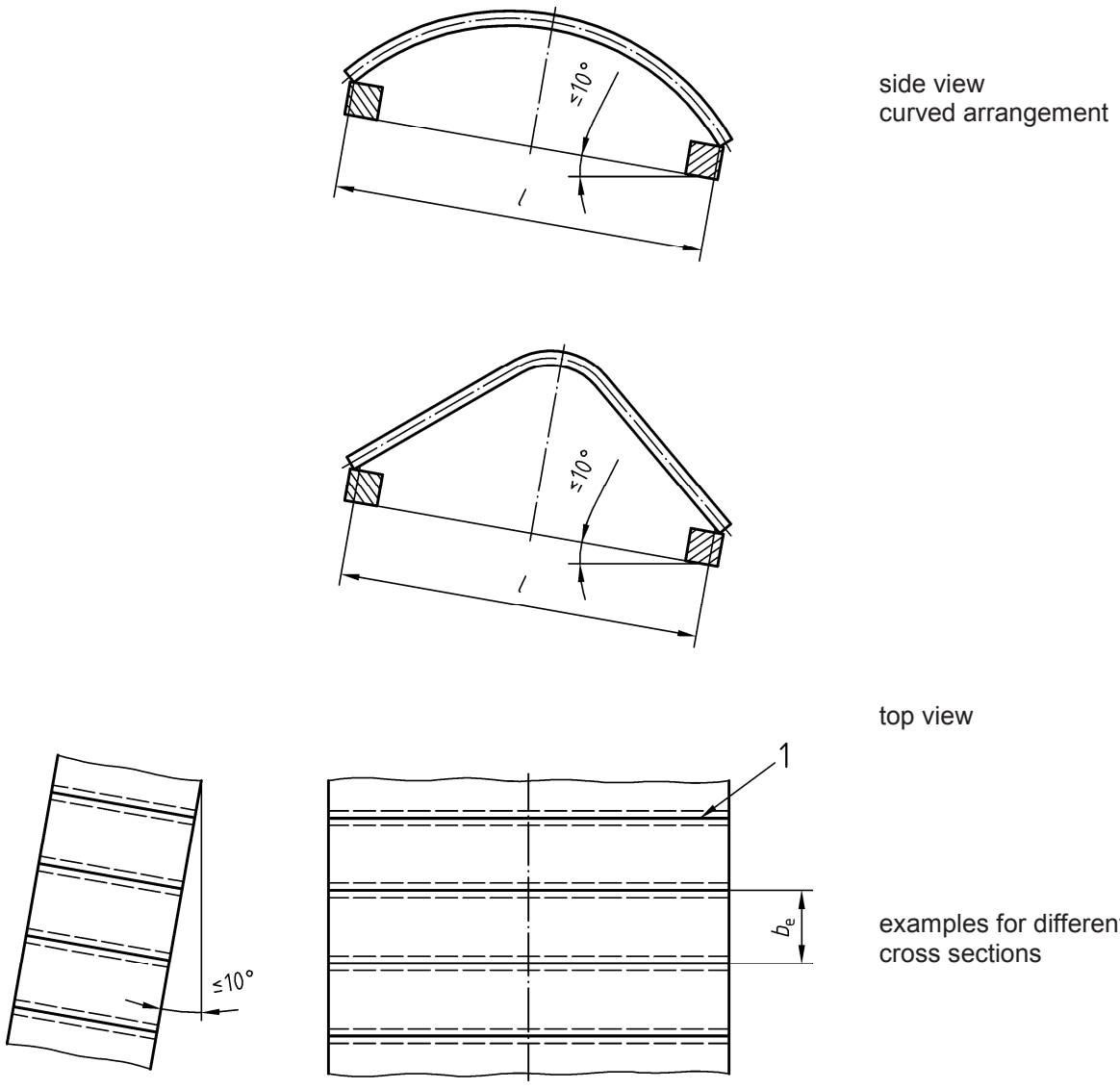


Key

1 covering profile
2 solid or multi-wall sheet
3 bearing profile
4 upstand
5 support
6 screw
7 sealing profile
8 marginal sheet
9 single span sheet
10 double span sheet
11 triple span sheet

a_p spacing of the bearing profiles
a_r spacing of the bearing profiles for marginal sheet
b_A width of the bearing profiles
b_a supported width of the sheet
l_a supported length of the sheet
l_e sheet width
σ inclination to the horizontal

Figure 3 — Example for flat continuous rooflights with bearing profiles, for single, double and triple span systems



Key

1 single or multi-layer sheets with joints parallel to the span
2 support
3 joint
4 upstand

a inclination measured to the horizontal at the line of fixing
b_e built-in width
f height
l span
l_a supported length of the sheet
r radius of fillet

Figure 4 — Examples for curved continuous rooflights without bearing profiles

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

EN 596, *Timber structures — Test methods — Soft body impact test of timber framed walls*

EN 673, *Glass in building — Determination of thermal transmittance (U value) — Calculation method*

EN 674, *Glass in building — Determination of thermal transmittance (U value) — Guarded hot plate method*

EN 675, *Glass in building — Determination of thermal transmittance (U value) — Heat flow meter method*

EN 1013-1, *Light transmitting profiled plastic sheeting for single skin roofing — Part 1: General requirements and test methods*

EN 1013-3, *Light transmitting profiled plastic sheeting for single skin roofing — Part 3: Specific requirements and test methods for sheets of polyvinyl chloride (PVC)*

EN 1013-5, *Light transmitting profiled plastic sheeting for single skin roofing — Part 5: Specific requirements, test methods and performance of polymethylmethacrylate (PMMA) sheets*

EN 1026, *Windows and doors — Air permeability — Test method*

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

EN 13501-2, *Fire classification of construction products and building elements — Part 2: Classification using data from fire resistance tests, excluding ventilation services*

EN 13501-5, *Fire classification of construction products and building elements — Part 5: Classification using data from external fire exposure to roof tests*

EN ISO 140-3, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 3: Laboratory measurements of airborne sound insulation of building elements*

EN ISO 178, *Plastics — Determination of flexural properties (ISO 178:2001)*

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

EN ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:1993 including Corr 1:1994)*

EN ISO 717-1, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation (ISO 717-1:1996)*

EN ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance (ISO 4892-1:1999)*

EN ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps (ISO 4892-2:2006)*

EN ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance - Calculation method (ISO 6946:1996)*

EN ISO 10077-2, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance – Part 2: Numerical method for frames (ISO 10077-2:2003)*

EN ISO 10211-1, *Thermal bridges in building construction — Heat flows and surface temperatures — Part 1: General calculation methods (ISO 10211-1:1995)*

EN ISO 10211-2, *Thermal bridges in building construction — Calculation of heat flows and surface temperatures — Part 2: Linear thermal bridges (ISO 10211-2:2001)*

EN ISO 10456, *Building materials and products — Procedures for determining declared and design thermal values (ISO 10456:1999)*

EN ISO 12017:1996, *Plastics — Poly(methyl methacrylate) double- and triple-skin sheets — Test methods (ISO 12017:1995)*

EN ISO 12567-2, *Thermal performance of windows and doors — Determination of thermal transmittance by hot box method — Part 2: Roof windows and other projecting windows (ISO 12567-2:2005)*

EN ISO 13468-1, *Plastics — Determination of total luminous transmittance of transparent materials — Part 1: Single-beam instrument (ISO 13468-1:1996)*

EN ISO 13468-2, *Plastics — Determination of the total luminous transmittance of transparent materials — Part 2: Double-beam instrument (ISO 13468-2:1999)*

EN ISO 14125, *Fibre-reinforced plastic composites — Determination of flexural properties (ISO 14125:1998)*

EN ISO 14683, *Thermal bridges in building construction — Linear thermal transmittance — Simplified methods and default values (ISO 14683:1999)*

ISO 10526, *CIE standard illuminants for colorimetry*

ISO 10527, *CIE standard colorimetric observers*

3 Terms and definitions

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

3.1
continuous plastic rooflight element
glazing element, coloured or not, which is manufactured to be self-supporting or non-self-supporting. It consists of one or several, translucent or transparent, flat or profiled skins made of solid or structured sheets, cold curved or not. It may require junction profiles for water tightness

3.2
self-supporting glazing element
element in accordance with 3.1 which does not require any bearing profile. It transmits the applied loads to the upstand

3.3
non-self-supporting glazing element
element in accordance with 3.1 which requires two or more bearing profiles

3.4
bearing profile
element which consists of single or several profiles on which the glazing elements are fitted and which transmits the applied loads to the upstand

3.5
gable end
end of a continuous rooflight, which can be vertical, curved or pitched

3.6
upstand
element which is single or multi-walled or composite with vertical and/or pitched walls; with or without thermal insulation, providing an area for the fastening of plastic rooflights and/or bearing profiles and for connection to

the substructure, the roof covering or the roof sealing. The upstand transmits into the substructure the loads acting upon the continuous rooflight elements. Upstands may include ventilation devices

3.7
material description
chemical composition of the product, geometry, mass per unit area and supplier's/manufacturer's name

3.8
ventilation panel
unit integrated into a continuous rooflight which enables its opening for ventilation purposes

3.9
accessories
connections, opening and locking devices and seals for the assembly of the elements according to 3.1 to 3.6 and 3.8

3.10
batch
quantity of material made in a single operation, or in the case of continuous production for a defined quantity, which need to be demonstrated by the producer to have a uniform composition

4 Symbols and abbreviations

C_c	Change in light transmittance expressed in %
ΔYI	Change in the yellowness index
g	Total solar energy transmittance (solar factor)
H_c	Energy applied during the ageing procedure
L_s	Light transmittance of a test piece
L_{sn}	Light transmittance of the nth test piece
τ_A	Light transmittance for the CIE-standard illuminant A expressed in %
τ_V	Light transmittance for the CIE-standard illuminant D_{65} expressed in %
τ_e	Solar direct transmittance expressed in %
M_s	Mean of R_1 and R_3
M_v	Light transmittance of the sample
R	Thermal resistance in m²·K/W
R_1 and R_3	Reading of galvanometer without any test piece
R_2	Reading of galvanometer with the test piece
R_w	Airborne sound index in dB
U	Heat transmittance W/(m²·K)
YI	Value of the yellowness index of an aged test piece

YI_0	Value of the yellowness index of an un-aged test piece
ΔE	Variation of E-modulus expressed in %
$\Delta\sigma$	Variation of strength expressed in %
X_{CIE}, Y_{CIE}, Z_{CIE}	Colourimetric coordinates

5 Requirements

5.1 Radiation transmittance

5.1.1 Degrees of total luminous transmittance (τ_V) and total solar energy transmittance (τ_e)

The degrees of light transmittance τ_V and direct radiant transmittance τ_e for solar radiation of each glazing element as defined in 3.1 in new continuous plastic rooflights shall be stated by the manufacturer when measured with a photometer according to 6.1.1 either on a flat specimen and/or a finished product. In factory production control the recorded τ_V value of total luminous transmittance shall be within $\pm$ 5 % of the stated value.

5.1.2 Solar factor (g)

The total solar energy transmittance g (solar factor) according to 6.1.2 of new continuous rooflights shall be stated by the manufacturer (see Annex C).

5.2 Durability

5.2.1 General

Durability of the product is evaluated by measuring the variation of total luminous transmittance, yellowness index and mechanical properties after an ageing procedure of the rooflight material with the same energy level for the three following characteristics either on flat sheets and/or finished product. The ageing procedure shall be conducted in accordance with 6.2.

NOTE For the most common materials (GF-UP, PC, PMMA and PVC) types have been indicated in EN 1013-1, -2, -3, -4 and -5.

5.2.2 Variation of light transmittance τ_V and yellowness index YI(ΔYI)

Continuous rooflights shall be classified into one of the nine types given in Table 1.

Table 1 — Material classification according to the change of light transmittance τ_V and yellowness index *YI*(*ΔYI*)

Type	H_C GJ/m^2	Change of τ_V %	ΔYI %
ΔA	18	≤ 5	≤ 10
ΔB	18	≤ 5	≤ 20
ΔC	18	≤ 10	≤ 10
ΔD	18	≤ 10	≤ 20
ΔE	10	≤ 10	≤ 10
ΔF	10	≤ 10	≤ 20
ΔG	10	≤ 15	≤ 20
ΔH	6	≤ 15	≤ 20
ΔI	4	≤ 15	≤ 20

The figures indicated for the change of light transmittance τ_V refer to variation in percentage of the initial value.

5.2.3 Variation of mechanical properties

The tensile strength and Young's Modulus are properties of a material which can vary with age.

Where required, the variation of the properties shall be determined by a bending test (or a tensile test) as defined in 6.2.4.

The percentage reduction in Young's Modulus, E, and tensile strength, σ, between new samples and samples aged to energy exposures (H_c) as described in Table 1, shall then be expressed in accordance with Tables 2 and 3.

If the geometry of a multi-walled sheet does not allow the mechanical test on each wall, the test shall be carried out on a solid sheet of the same formulation and of a thickness not greater than the combined horizontal wall thicknesses.

Table 2 — Material classification according to the change of E-Modulus after an ageing procedure at the same energy level H_c selected from Table 1

Type	ΔE %
Cu 0	≥ 0
Cu 1	0 > ΔE ≥ -10
Cu 2	-10 > ΔE ≥ -20
Cu 3	-20 > ΔE ≥ -30

Table 3 — Material classification according to the change of σ after an ageing procedure at the same energy level H_c selected from Table 1

Type	$\Delta\sigma$ %
Ku 0	≥ 0
Ku 1	0 > $\Delta\sigma$ ≥ -10
Ku 2	-10 > $\Delta\sigma$ ≥ -20
Ku 3	-20 > $\Delta\sigma$ ≥ -30

5.3 Water tightness

5.3.1 Continuous rooflights with upstand

Water tightness shall be assessed when subject to regulatory requirements and may be assessed otherwise. The continuous plastic rooflight in the closed condition shall be tested in accordance with 6.3. No water shall drop from the internal surface. The design of the continuous rooflight shall ensure that water drains away.

5.3.2 Rooflight sheets (may be used for continuous rooflights without upstand)

Water tightness shall be assessed when subject to regulatory requirements and may be assessed otherwise. The products covered by this European Standard are water impermeable provided that they are free of defects such as holes. The absence of such defects shall be checked by visual inspection of the finished product.

5.4 Mechanical performances

5.4.1 General

The mechanical performances shall be tested in accordance with 6.4.1.

Alternatively for continuous rooflights with bearing profiles which can be calculated according to e.g. EN 1994-1-1, calculation may be used instead of testing, provided that the junction of bearing profile - glazing element is tested. As a result of the testing method, the acting forces are normal to the glazing element surface instead of horizontal.

The stiffness of any upstand, in all directions, shall be equal to or larger than the stiffness of the upstand subjected to verification by testing or by calculation. If upstands differ from the one tested or calculated together with the continuous rooflight itself, their performance shall be calculated using the forces exerted by the rooflight in horizontal and vertical directions; the deformation has to be lower than or equal to that tested or calculated.

5.4.2 Resistance to upward loads

Resistance to upward loads shall be assessed when subject to regulatory requirements and may be assessed otherwise. According to their resistance to upward loads, continuous plastic rooflights are classified into one of the four types as given in Table 4.

Table 4 — Classes of upward loads

Type	Load N/m^2
UL 1000	1 000
UL 1500	1 500
UL 3000	3 000
UL A [a]	A[a]
[a] The value of A can be selected to meet specific requirements.	

The designations UL 1000, UL 1500, UL 3000 and UL A represent the test upward load in N/m^2 applied, when the continuous rooflight is tested in accordance with 6.4.1. When tested in accordance with 6.4.1, the rooflight shall be capable of resisting the test load.

A successful test is achieved if neither damage nor permanent deformation occurs which would affect the performance in use (e.g. water tightness, opening).

5.4.3 Resistance to downward loads

Resistance to downward loads shall be assessed when subject to regulatory requirements and may be assessed otherwise. According to their resistance to downward loads, continuous plastic rooflights are classified into one of the five types as given in Table 5.

Table 5 — Classes of downward loads

Class	Load N/m^2	Asymmetric load [a] N/m^2
DL 750	750	375
DL 1125	1 125	565
DL 1750	1 750	875
DL 2500	2 500	1 250
DL A [b]	A	A/2

[a] If it is possible to calculate the rooflight with bearing profile, testing is not necessary.

[b] The value of A can be selected to meet specific requirements.

The designations DL 750, DL 1175, DL 1750, DL 2500 and DL A represent the test downward load in N/m² applied, when the continuous rooflight is tested in accordance with 6.4.1. When tested in accordance with 6.4.1, the rooflight shall be capable of resisting the test load.

A successful test is achieved if neither damage nor permanent deformation occurs which would affect the performance in use (e.g. water tightness, opening).

5.4.4 Impact load

5.4.4.1 Small, hard body

Resistance to impact load shall be assessed when subject to regulatory requirements and may be assessed otherwise. The product shall be tested in accordance with 6.4.2.1. Continuous plastic rooflights shall be resistant to the impact of a small hard body. The products shall always be tested with the manufacturer's corresponding or specified upstand.

NOTE The identification of the tested assembly (the rooflight and the upstand) is part of the information accompanying the declared performance.

If no visible damage occurs, the test specimen may be used for the soft body test according to 6.4.2.2.

5.4.4.2 Large, soft body

Resistance to impact load shall be assessed when subject to regulatory requirements and may be assessed otherwise. The product shall be tested in accordance with 6.4.2.2. Continuous plastic rooflights shall be classified according to Table 6. The products shall always be tested with the manufacturer's corresponding or specified upstand.

NOTE The identification of the tested assembly (the rooflight and the upstand) is part of the information accompanying the declared performance.

Table 6 — Types of large soft body impact loads

Type	Impact energy vertical impact J	Impact energy horizontal impact J
SB 1200	1 200	900
SB 800	800	600
SB 600	600	450
SB 300	300	225
SB A[a]	A	0,75 x A
SB 0	no requirement	no requirement
[a] The value of A can be selected to meet specific requirements.		

The designations SB 1200, SB 800, SB 600, SB 300 and SB A represent the test impact energy in Joules applied, when the continuous rooflight is tested in accordance with 6.4.2.2.

A successful test is achieved if neither the bag nor the gauge can pass through the specimen.

5.5 Reaction to fire

Reaction to fire shall be assessed when subject to regulatory requirements and may be assessed otherwise. The product shall be tested using the test method(s) as referred to and classified in accordance with EN 13501-1.

Where required by a particular test method, and in addition to any specific requirements in that test method, the product shall be mounted and fixed for testing in a manner representative of its intended end use. Where substantial parts of the rooflight (e.g. the rooflight and its upstand) are made of different materials, and it is not practicable to test them together, each substantial part shall be tested separately and its reaction to fire performance declared separately.

5.6 Resistance to fire

Resistance to fire shall be assessed when subject to regulatory requirements and may be assessed otherwise. The product shall be tested using the test method(s) as referred to and classified in accordance with EN 13501-2.

Where required by a particular test method, and in addition to any specific requirements in that test method, the product shall be mounted and fixed for testing in a manner representative of its intended end use.

5.7 External fire performance

External fire performance shall be assessed when subject to regulatory requirements and may be assessed otherwise. The product shall be tested using the test method(s) as referred to and classified in accordance with EN 13501-5. The products to be tested shall be installed, in addition to the general provisions given in the relevant test method, in a manner representative of their intended end use.

5.8 Air permeability

5.8.1 Continuous rooflights with upstand

Air permeability shall be assessed when subject to regulatory requirements and may be assessed otherwise. The test method shall be as given in EN 1026.

5.8.2 Rooflight sheets (may be used for continuous rooflights without upstand)

The products covered by this European Standard are air impermeable provided that they are free of defects such as holes. Where required, the absence of such defects shall be checked by visual inspection of the finished product.

5.9 Thermal resistance

5.9.1 General

Thermal resistance shall be evaluated and declared when subject to regulatory requirements, and may be evaluated and declared when not subject to such requirements.

5.9.2 Continuous rooflights

The calculated or measured value of the thermal transmittance, U value, in W/(m²·K) shall be determined. The thermal resistance of continuous rooflights depends on many glazing elements and bearing profile combinations.

Calculations shall be performed on the basis of the thermal properties of component products (see 5.9.3) in accordance with EN ISO 6946. The effect of any areas of thermal bridging shall be included as a massed area resultant for the total product based on its thermal resistance, R-value, determined in accordance with EN ISO 10211-1, EN ISO 10211-2 and/or EN ISO 14683. Alternatively, measurements in accordance with EN ISO 12567-2 or ETAG 010, as appropriate for a given product, shall be performed.

For calculation purposes for the complete rooflight construction consisting of glazing elements, edge profiles and bearing profiles, the thermal transmittance shall be determined in accordance to EN ISO 10077-2.

5.9.3 Continuous rooflight components

5.9.3.1 Glazing element

The thermal transmittance, U value, in W/(m²·K) of the glazing element shall be in accordance with the values as specified in Table 7. In case Table 7 does not apply or if the manufacturer claims better performance, the thermal transmittance shall be determined in accordance with EN ISO 10456, based on test results in accordance with EN 674 or EN 675, or calculated in accordance with EN 673 (for flat sheets). The values relate to the surface area of the glazing element made of one or more skins of solid sheet material, without edge effects.

5.9.3.2 Upstand, edge profiles and accessories

For calculation purposes for the rooflight with upstand (see 5.9.1), the thermal transmittance of upstands, edge profiles and accessories shall be determined in accordance with EN ISO 10077-2.

Table 7 — Thermal resistance

Type of rooflight	Heat transmittance (*U*-value) W/(m^2·K)
solid single skin	5,6
solid double skin	3,0
solid triple skin	2,2
double walled sheets thickness 10 mm	3,1
double walled sheet thickness 16 mm	2,4

5.10 Airborne sound insulation

This characteristic shall be evaluated and declared when subject to regulatory requirements, and may be evaluated and declared when not subject to such requirements.

If testing is required, the test method given in EN ISO 140-3 shall apply. Evaluation of the test results shall be performed in accordance with EN ISO 717-1.

6 Testing

6.1 Radiation transmittance

6.1.1 Light transmittance

The radiation transmittance of the continuous rooflight material is determined as light transmittance τ_V and direct radiant transmittance τ_e for solar radiation using a photometer according to EN ISO 13468-1 or EN ISO 13468-2. The light transmittance of structured sheets is determined as light transmittance τ_A according to EN ISO 12017:1996, Annex A.

If the reference test method specified above is not used for factory production control testing, the alternative method given in Annex B shall be followed.

6.1.2 Solar factor (g)

The total solar energy transmittance g (solar factor) shall be determined according to EN 410 (see Annex C).

6.2 Durability

6.2.1 Conditions for accelerated ageing

The testing shall be carried out in accordance with EN ISO 4892-1. The spectral distribution of the filtered Xenon-arc-radiation shall be in accordance with EN ISO 4892-2.

The following test conditions shall be observed:

— black-panel-temperature (45 ± 3) °C;

— black-standard-temperature (65 ± 3) °C.

— air-temperature in the test chamber: + 30 °C to + 35 °C;

— relative humidity in the dry period: (65 ± 5) %;

— spray cycle: 120 min = 18 min rain + 102 min dry.

Either the black panel temperature or the black standard temperature may be used according to the details of the apparatus.

The dimensions of the test samples shall be sufficient to be subsequently tested for light transmittance (see 6.2.2), yellowness index (see 6.2.3) and mechanical properties (see 6.2.4).

Test specimens for these tests shall be representative: of the sheets used in practice.

6.2.2 Variation of light transmittance

6.2.2.1 Apparatus

Determine the light transmittance using a photometer as described in 6.1 before and after the ageing procedure.

6.2.2.2 Test pieces

Use ten test pieces chosen at random so as to be representative.

6.2.2.3 Procedure

Calibrate and operate the photometer and other instruments in accordance with instructions supplied by their manufacturer.

Obtain spectral transmittance data relative to air in the wave length range of 380 nm to 780 nm.

6.2.2.4 Expression of results

The change of light transmittance is expressed as the mean of the variation of light transmittance of each test piece. These figures are evaluated as a percentage of the initial value.

6.2.3 Variation in yellowness index

6.2.3.1 Apparatus

Determine the yellowness index using a photometer as described in 6.1 before and after the ageing procedure.

6.2.3.2 Test pieces

The same test pieces as already used for change in light transmittance shall be used.

6.2.3.3 Procedure

Calibrate and operate the photometer and other instruments in accordance with instructions supplied by their manufacturer.

Obtain spectral transmittance data relative to air in the wave length range of 380 nm to 780 nm.

6.2.3.4 Expression of results

Calculate the tristimulus values for CIE standard illluminant D 65 according to ISO 10526 and CIE standard observer 2° according to ISO/CIE 10527 by numerical integration from recorded spectral data or by automatic integration during photometer operation.

Calculate the magnitude and sign of the yellowness index from the following equation:

$$YI = \frac{100(1{,}2985X - 1{,}1335Z)}{Y} \quad (1)$$

Calculate the magnitude and direction of change in yellowness index from the following equation:

$$\Delta YI = YI - YI_0 \quad (2)$$

6.2.4 Variation of mechanical properties with ageing

Measure the bending strength and the corresponding E-modulus of the material of the sheets according to EN ISO 14125 or EN ISO 178 for new samples and samples aged to ΔE according to Table 2 and aged to H_C according to Table 1.

If a bending test cannot be performed measure the tensile strength and the corresponding E-modulus according to EN ISO 527-1 and EN ISO 527-2.

Ten test pieces are used for evaluation, five new samples and five aged samples.

Bending or tensile and light transmitting tests shall be carried out on the same sample ensuring the aged surface is in tension.

6.3 Water tightness

6.3.1 Principle

This test simulates the effect of rainwater or melting snow which can run across the external surface of the continuous rooflight.

6.3.2 Procedure

A representative section of the complete continuous rooflight as installed on the roof in accordance with manufacturer's specifications, shall be sprayed with water in the following manner:

— water is sprayed over the whole test area, the nozzles being in horizontal position;

— minimum flow volume of 2 l/(m^2.min) on the test area;

— test duration of 60 min.

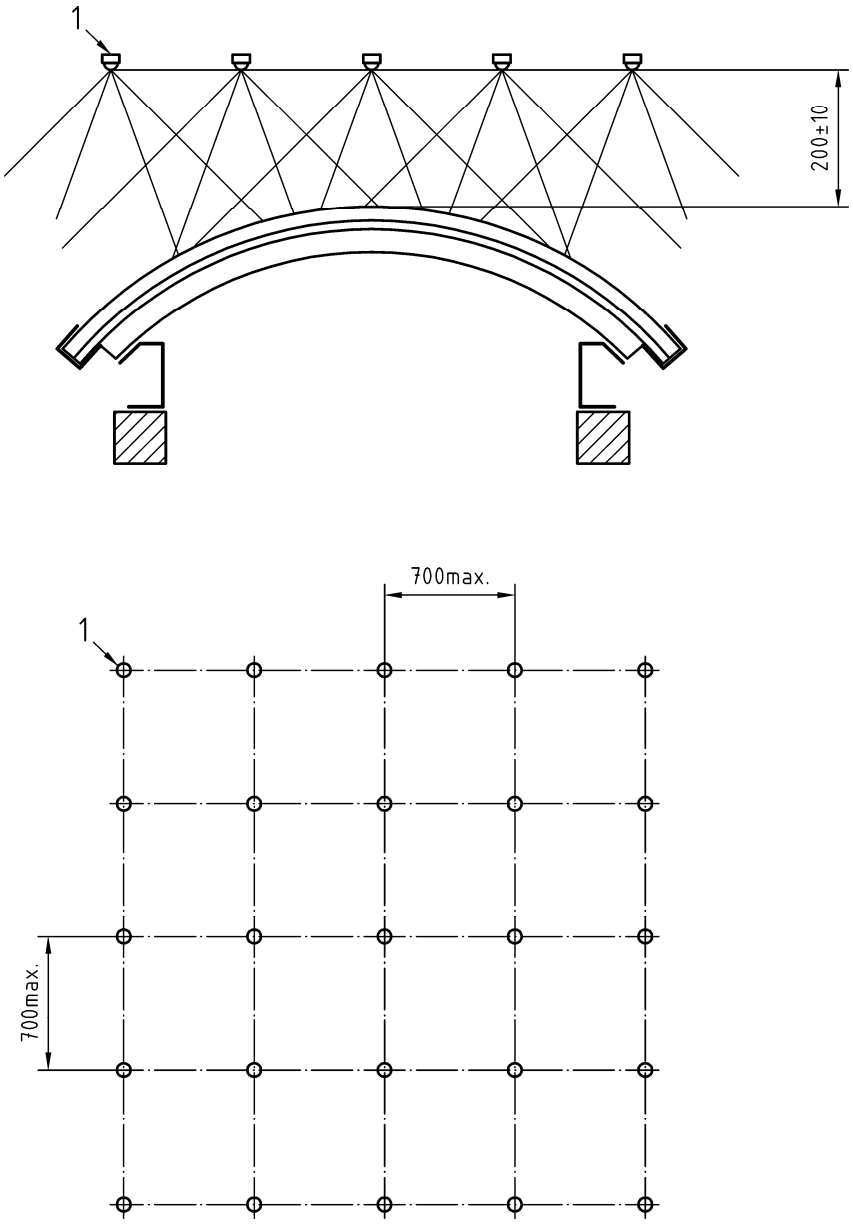
Ventilation panels shall, if present, be in the closed position during the test.

The test report shall indicate the range of inclinations at which the test was satisfactorily performed.

6.3.3 Apparatus

The apparatus used shall conform to Figure 5 which allows the water used to emanate from a rectangular grid system of nozzles. The nozzles together shall cover the whole of the plan area relative to the horizontal plane as shown in Figure 5. The vertical position of the nozzle grid shall be fixed at (200 ± 5) mm above the highest point of the continuous rooflight.

Dimensions in millimetres



Key
1 spray nozzle

Figure 5 — Grid system of nozzles for water tightness test

6.4 Mechanical performances

6.4.1 Resistance to upward and downward loads

6.4.1.1 General

This test procedure serves the purpose of judging the behaviour of plastic continuous rooflights under varying loads.

6.4.1.2 Equipment and procedure

The test shall be performed on a representative section of the complete continuous rooflight in accordance with the following procedure:

a) tests shall be performed on a new continuous rooflight at a temperature of (23 ± 4) °C;

b) continuous rooflight shall be secured on a rigid support/upstand in accordance with the manufacturer's instructions for regular use;

c) connection between the continuous rooflight, the bearing profiles and the support/upstand shall be made using the fixings normally used and in accordance with the manufacturer's instructions;

d) ventilation panels shall, if present, be in the closed position during the test;

e) free area to serve as the basis for the assessment of the test load is indicated in Figures 6 to 8;

f) for testing, air pressure (horizontal fixing) or weights to reproduce positive or negative loads can be used;

g) if air pressure is used, the test surface shall be covered with a foil on the excess pressure face, the edges of which shall be sealed so as to be airtight or the air leakage shall be measured;

h) equivalent loading methods (i.e. using weight instead of air pressure) can be used. The rate of loading shall be such that a mean rate of 100 Pa/min ± 20 % is generated; interruptions of increase of the loading are permitted for examination and recording;

i) test load shall be maintained for 6 minutes accurate to $^{+2}_{0}\%$ at the required value;

j) if air pressure is used, it shall be measured as a function of time and recorded on a diagram;

k) for asymmetric load test, weight (point loads e.g. sandbags or small individual weights) shall be used.

NOTE As a result of the vacuum or excess pressure test method, the forces will be normal to the surface of the continuous rooflight, whereas actual forces can be normal to the horizontal. The differences are considered negligible and are taken into account in the estimation of national safety factors, if any.

6.4.2 Impact load

6.4.2.1 Small hard body

6.4.2.1.1 General

This test procedure serves the purpose of judging the behaviour of a continuous rooflight when subject to the impact of a steel ball falling free from a height of 1,0 m above the impact point in a laboratory environment.

6.4.2.1.2 Equipment and procedure

a) Test specimens and equipment shall be at (23 ± 4) °C;

b) the continuous rooflight shall be secured on a rigid horizontal support in accordance with the manufacturer's instructions for regular use;

c) the connection between the continuous rooflight, the bearing profiles (or opening frame, if used) and the support/upstand shall be made using the fixings normally used and in accordance with the manufacturer's instructions;

d) the test shall be conducted in closed position of the ventilation panels, if any;

e) the steel ball shall have a mass of 250 g ± 1 %;

f) the impact strength shall be tested at three points, which are located in the glazing element of the continuous rooflight at the centre, in a corner or edge and in the most unfavourable position.

6.4.2.2 Large soft body

6.4.2.2.1 General

This test procedure serves the purpose of determining the behaviour by vertical and/or horizontal impact of a spheroconic bag of 50 kg falling without initial velocity from a given height/distance in a laboratory environment.

6.4.2.2.2 Determination of type testing, horizontal or vertical impact

For each type of continuous rooflight a horizontal or a vertical impact test shall be performed. The following shall be considered to determine whether a horizontal or a vertical impact test shall be performed (see Figures 9 to 11):

— if both points A and B are beneath the outer skin of the continuous rooflight, perform a horizontal impact test;

— if point A is beneath the outer skin of the continuous rooflight and point B is above it, perform a vertical impact test;

— if both points A and B are above the outer skin of the continuous rooflight, perform a vertical impact test;

— if point A is above the outer skin of the continuous rooflight and point B is beneath it, perform a horizontal impact test.

If the width of the continuous rooflight is smaller than or equal to 1,0 m, then:

— if point A is beneath the outer skin, perform a vertical impact test;

— if point A is above the outer skin, perform a horizontal impact test.

If different tests apply to the same continuous rooflight (see examples given in Figures 9 to 11), perform a vertical and a horizontal test on two test specimens.

6.4.2.2.3 Equipment and procedure

a) The test specimens and equipment shall be at (23 ± 4) °C;

b) the continuous rooflight shall be secured on a rigid assembly that does not allow a deformation over 1/500 of the smallest horizontal dimension of the upstand (i.e. span or length of the rooflight tested) during the test. The horizontal upstand/support shall be in accordance with the manufacturer's instructions for regular use. The fixing to the substructure or to the ground shall be built in such a way that no supporting air pressure below the continuous rooflight occurs;

c) the connection between the continuous rooflight, bearing profiles and the upstand/support shall be made using the fixings normally used and in accordance with the manufacturer's instructions;

d) the test shall be conducted with any ventilation panels in the closed position;

e) the bag defined in EN 596 shall be suspended at a height (distance between lowest point of bag and prospective impact point) given in Table 8;

f) the test specimen shall be as described in Figures 6 to 8;

g) the impact strength test shall be carried out at the most unfavourable point which is determined as being within the glazing element and within a distance of 1 m from the outer edge of the continuous rooflight (pre-testing may be necessary to determine the most unfavourable point). For horizontal impact tests, the impact strength shall be tested at a point, which is determined at a height of 0,86 m above the plane of the upper edges of the support/upstand according to example given in Figure 11;

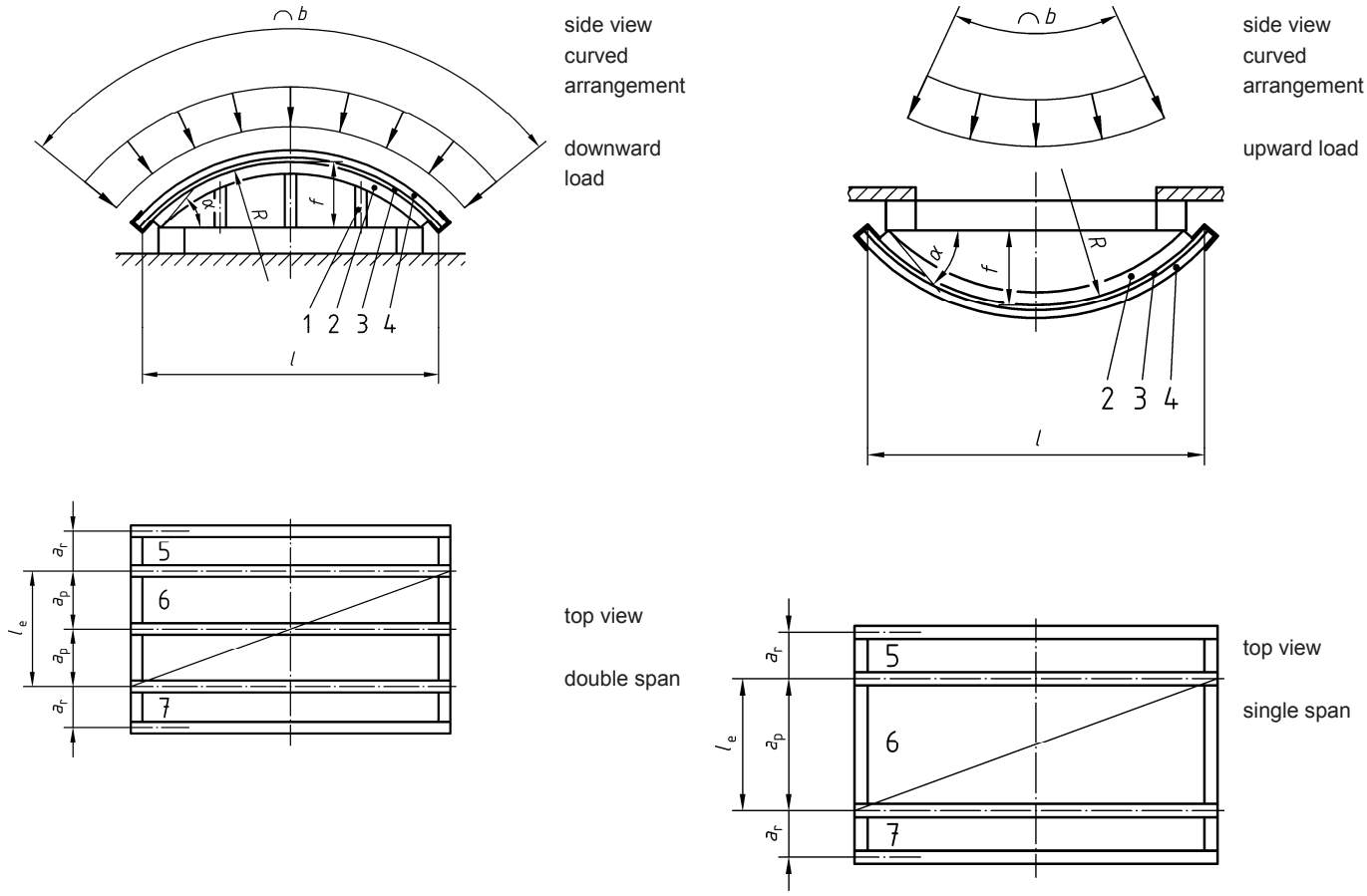
h) only one test per type testing shall be carried out;

i) without changing the position of the bag, check the test specimen one minute after the impact to determine whether a spherical gauge with a 300 mm diameter can pass through.

Table 8 — Relation between types and test heights for large soft body test

Type	Height for vertical impact test	Height for horizontal impact test
SB 1200	2,40 m ± 1 %	1,80 m ± 1 %
SB 800	1,60 m ± 1 %	1,20 m ± 1 %
SB 600	1,20 m ± 1 %	0,90 m ± 1 %
SB 300	0,6 m ± 1 %	0,45 m ± 1 %
SB A [a]	(A × 0,002 m) ± 1 %	(A × 0,0015 m) ± 1 %
SB 0	No requirement	No requirement

[a] The value of A can be selected to meet specific requirements.

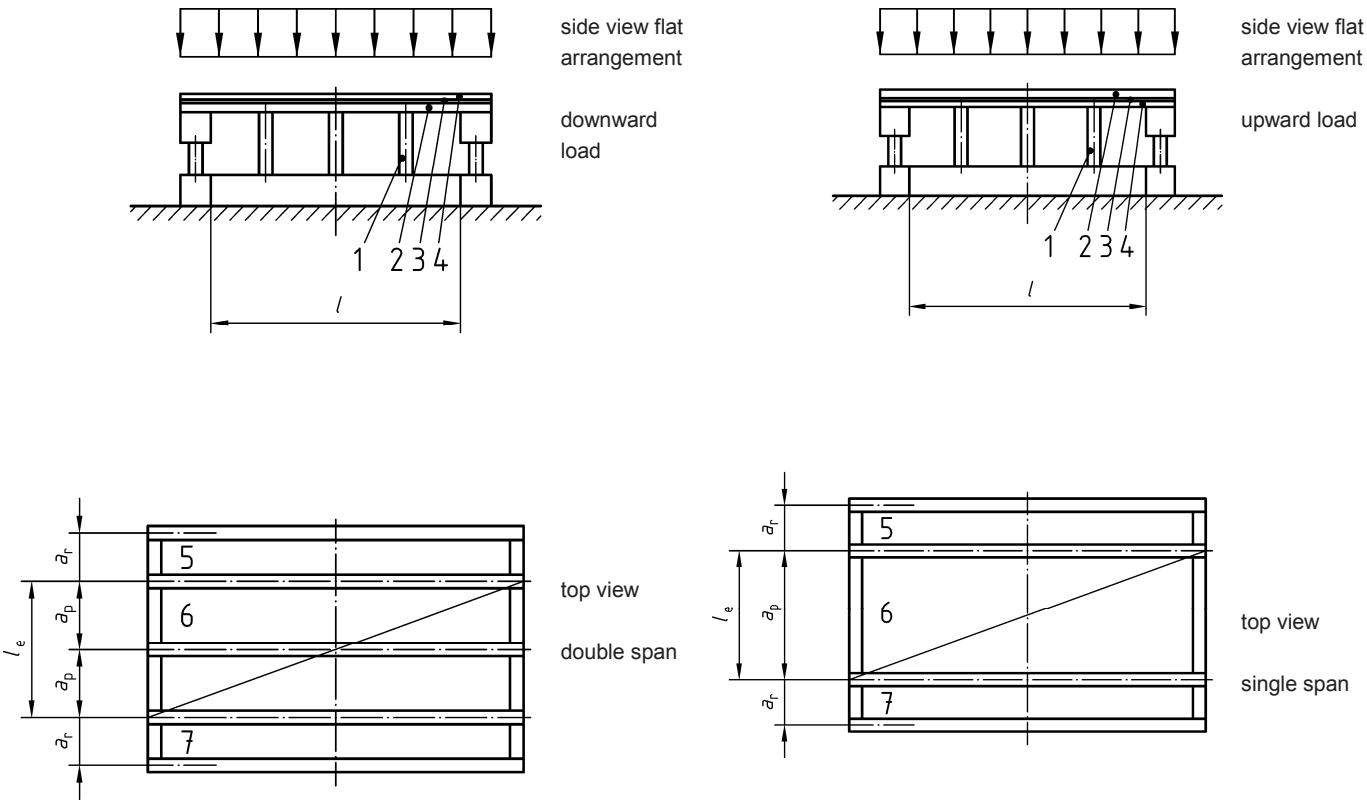


Key

1 auxiliary construction
2 bearing profile
3 testing sheet
4 covering profile
5 marginal sheet
6 testing sheet
7 marginal sheet

a inclination measured to the horizontal at the line of fixing
a_p spacing of the bearing profiles
a_r spacing of the bearing profiles for marginal sheets
b arc length
f height
l span
l_e sheet width
R radius

Figure 6 — Test setup (schematic) under downward and upward loads for curved continuous rooflights with bearing profiles

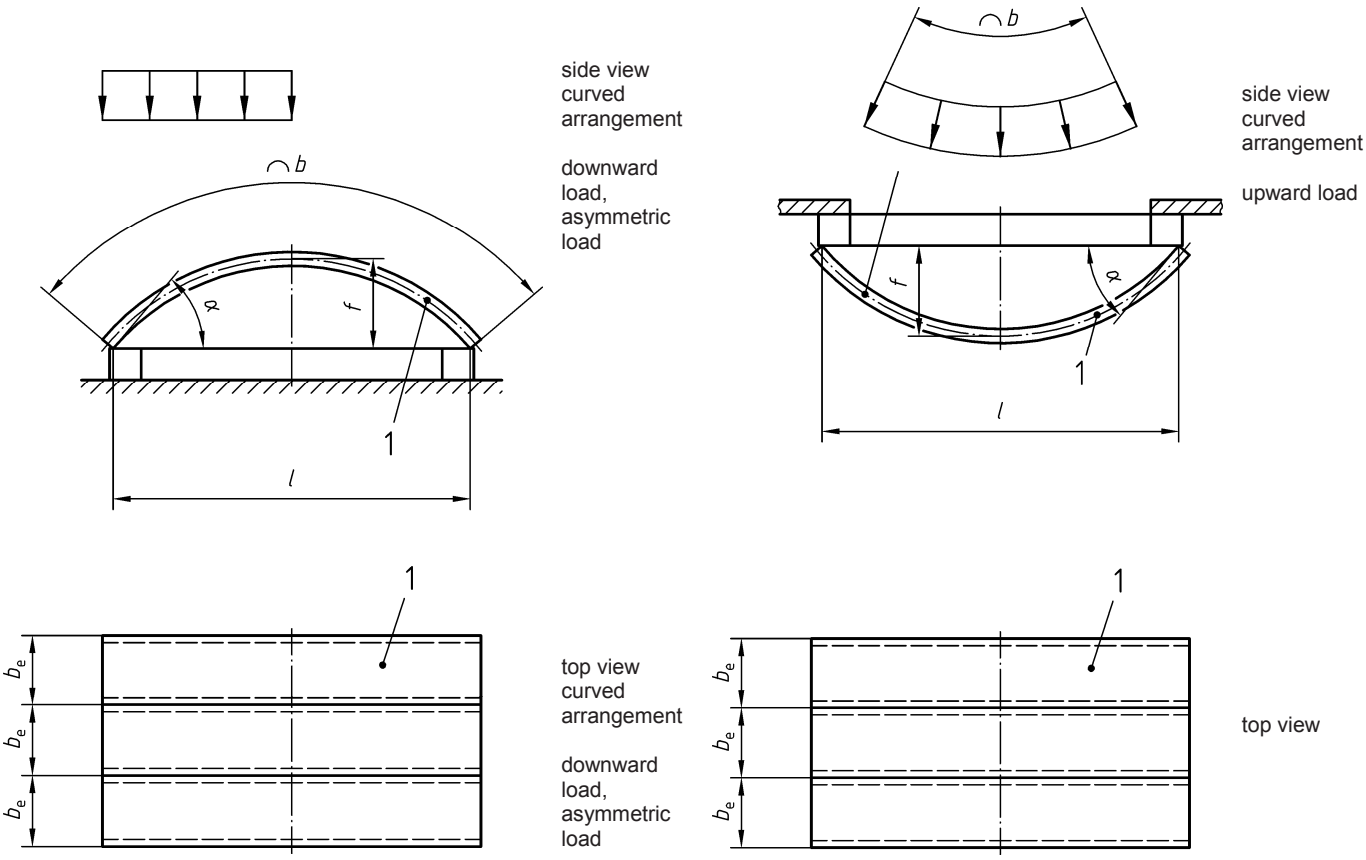


Key

1 auxiliary construction
2 bearing profile
3 testing sheet
4 covering profile
5 marginal sheet
6 testing sheet
7 marginal sheet

a_r spacing of the bearing profiles for marginal sheets
a_p spacing of the bearing profiles
l span
l_e sheet width

Figure 7 — Test setup (schematic) under downward and upward loads for flat continuous rooflights with bearing profiles

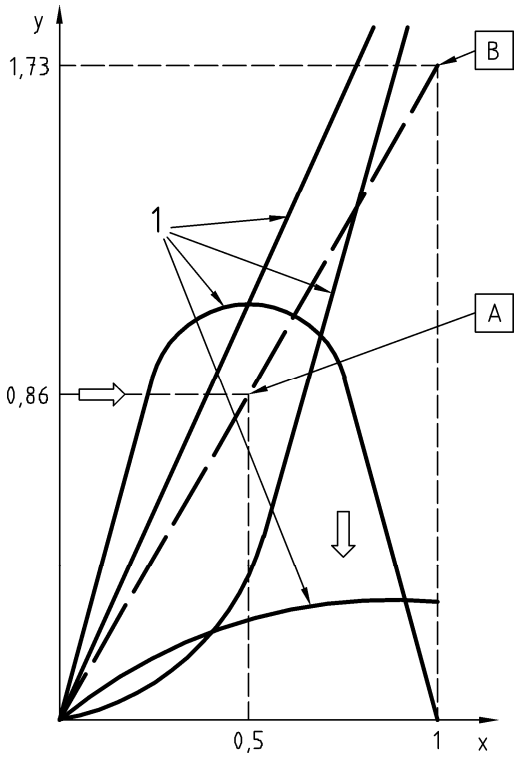


Key

1 sheet

a inclination measured to the horizontal at the line of fixing
b arc length
b_e built-in width
f height of arch
l span
R radius

Figure 8 — Test setup (schematic) under downward load (asymmetric load) and upward load for curved continuous rooflights without bearing profiles and with single- or multi-layer sheet with joints



Key

A see 6.4.2.2.2

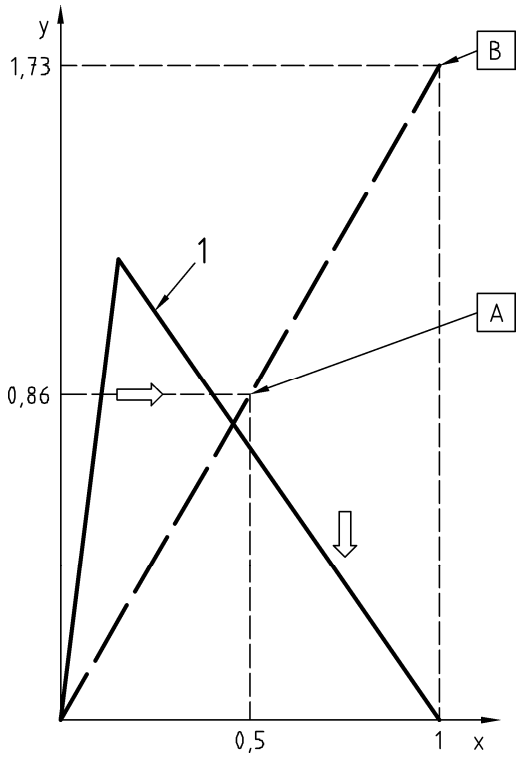
B see 6.4.2.2.2

x distance from the outer edge of the continuous rooflight in m

1 examples for different shapes of outer skins of continuous rooflights

⇨ impact

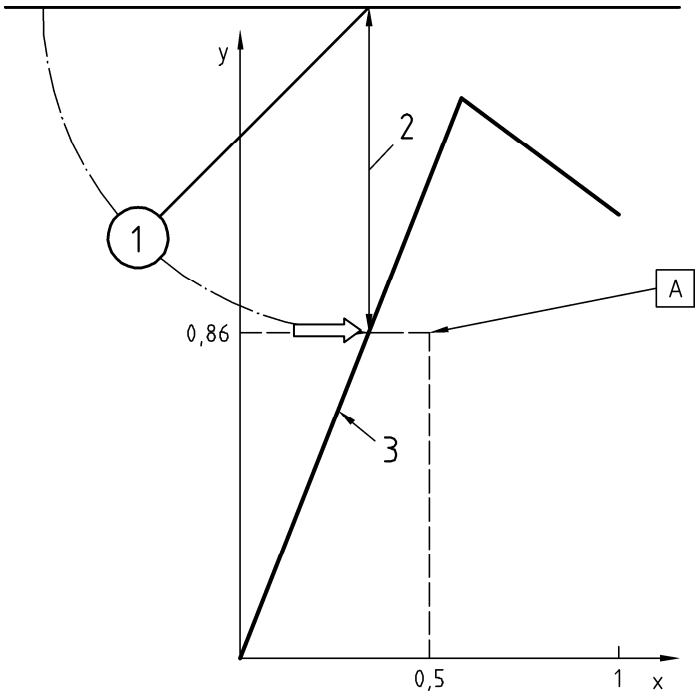
Figure 9 — Considerations for determining whether to perform a horizontal or a vertical impact test on the continuous rooflight



Key

A see 6.4.2.2.2
B see 6.4.2.2.2
x distance from the outer edge of the continuous rooflight in m
y height above the upstand in m
1 example for shape of outer skin of the continuous rooflight
⇨ impact

Figure 10 — Example of rooflight shape that needs to be tested both vertically and horizontally



Key

A see 6.4.2.2.2
x distance from the outer edge of the continuous rooflight in m
y height above the upstand in m
1 bag
2 height for horizontal impact
3 example for shape of outer skin of the continuous rooflight
⇨ impact

Figure 11 — Example for horizontal impact test

6.5 Number and dimensions of test specimens

6.5.1 Continuous rooflights which consist of the same construction materials and have the same construction features manufactured in various sizes form a family.

6.5.2 For total luminous transmittance tests, 3 tests per material type and colour type.

6.5.3 For durability, 3 tests per material type and colour type.

6.5.4 For water tightness, 1 test on the most unfavourable continuous rooflight dimension (usually, at the greatest dimension in area or perimeter), connection between rooflight element and upstand/support and inclination.

6.5.5 For resistance to upward loads, 3 tests on the most unfavourable continuous rooflight dimension, material type and type of rooflight element connection, bearing profile and upstand/support.

6.5.6 For resistance to downward loads, 3 tests on the most unfavourable continuous rooflight dimension, material type and type of rooflight element connection, bearing profile and upstand/support. This test shall be conducted in real configuration of supports. It is allowed to test the rooflight with all skins; this shall be, however, indicated in the test report.

6.5.7 For impact test - small hard body, 1 test on the most unfavourable continuous rooflight dimension (usually the smallest dimension in the area or perimeter of the rooflight), material type, type of rooflight element connection, bearing profile and upstand/support.

6.5.8 For impact test - large soft body, 1 test on the most unfavourable continuous rooflight dimension (usually, the smallest dimension in the area or perimeter of the rooflight), material type, type of rooflight element connection, bearing profile and upstand/support.

6.6 Test report

The test report shall include at least the following items:

a) name of manufacturer of the continuous rooflight;

b) sampling method;

c) test conditions;

d) date of test;

e) individual results of the test with reference to EN 14963;

f) description and drawing of the continuous rooflight in accordance with Clause 3 including specification of the construction material used;

g) indication on restrictions in use if applicable.

7 Evaluation of conformity

7.1 General

The compliance of a continuous rooflight with the requirements of this European Standard and with the stated values (including types) shall be demonstrated by:

— initial type testing;

— factory production control by the manufacturer, including product assessment.

For the purposes of testing and calculation, continuous rooflights may be grouped into families, where it is considered that the result for a given characteristic from any one product in the family is representative for all other products within that family.

NOTE Products may be in different families for different characteristics.

7.2 Initial type testing

Initial type testing shall be performed on first application of this European Standard. Tests previously performed in accordance with the provisions of this European Standard (same product, same characteristic(s), test method, sampling procedure, system of attestation of conformity etc.) may be taken into account. In addition, initial type testing shall be performed at the beginning of the production of a new rooflight type (unless a member of the same family) or at the beginning of a new method of production where this may affect the stated properties.

Where characteristics have been determined on the basis of conformity with this European Standard, these characteristics need not be reassessed provided that the manufacturer ensures the validity of the results. Products CE marked in accordance with appropriate harmonised European specifications may be presumed

to have the performances stated of them, although this does not replace the responsibility of the continuous rooflight manufacturer to ensure that the rooflight as a whole is correctly designed and its component products have the necessary performance values.

Whenever a change occurs in the continuous rooflight design, the raw material or supplier of the components, or the production process (subject to the definition of a family), which would change significantly one or more of the characteristics, the type tests shall be repeated for the appropriate characteristic(s).

The results of all type tests shall be recorded and held by the manufacturer for at least 10 years after the date of last manufacture of the product to which they relate.

7.3 Factory production control (FPC)

7.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market conform to the stated performance characteristics. The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product.

An FPC system conforming to the requirements of EN ISO 9001, and made specific to the requirements of this European Standard, is considered to satisfy the above requirements.

The results of inspections, tests or assessments requiring action shall be recorded, as shall any action taken. The action to be taken when control values or criteria are not met shall be recorded.

7.3.2 Equipment

All weighing, measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures, frequencies and criteria.

7.3.3 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their conformity.

7.3.4 Design process

The factory production control system shall document the various stages in the design of products; identify the checking procedure and those individuals responsible for all stages of design.

During the design process itself, a record shall be kept of all checks, their results, and any corrective actions taken. This record shall be sufficiently detailed and accurate to demonstrate that all stages of the design phase, and all checks, have been carried out satisfactorily.

7.3.5 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the stated values of all characteristics are maintained. The characteristics, and the means and frequency of control, are presented in Table 9.

Table 9 — Verifications in the framework of Factory Production Control

Characteristics	Verification method [a]	Minimum frequency
For light transmitting sheets, upstands, accessories etc.		
Material properties of upstand material, insulation products, accessories etc.	Compliance with supplier's declaration	Every delivery
Geometry (all declared parameters, e.g. length, width, height, …)	Manufacturer's methods	Every unit light transmitting sheet and upstand (if relevant)
For light transmitting sheets only		
Composition	Manufacturer's methods	Continuously or every production batch
Density weight per m²		Every production batch or daily for continuous production
Bending or tensile strength (initial)	6.2.4	
Impact resistance (hard body)	6.4.2.1	
Heat resistance [b]	EN 1013-3	
Glass content [c]	EN 1013-5	
Curing [c]	EN 1013-5	
Light transmittance	6.1 (or Annex B) [d]	

a Different test equipment to that required by this table may be used for FPC purposes, as long as a correlation with ITT results is established.

b Only applicable for PVC light transmitting sheets.

c Only applicable for GRP sheet material.

c By colour judging comparison at a checked reference pattern in accordance with manufacturer's methods.

8 Classification and designation

Continuous rooflights shall be designated at least by the following items:

a) wording "continuous rooflight with or without upstand";

b) reference to this European Standard, i.e. EN 14963;

c) height(s) of the upstand, if included;

d) material classification according to change of total luminous transmittance τ_V (or τ_A) and yellowness index YI (ΔYI);

e) material classification according to change of E-modulus after an ageing procedure;

f) material classification according to change of σ after an ageing procedure;

g) mechanical performances (types of upward, downward and impact loads).

EXAMPLE OF DESIGNATION:

Continuous rooflight with upstand, EN 14963, 0,3 m; ΔA, Cu 0, Ku 0, UL 1500, DL 750, SB 300

9 Marking

Continuous rooflights shall be marked with the following items (designation is acceptable):

NOTE 1 It is recommended to repeat the same details on any wrapping supplied with the consignment units.

a) name or trademark of the manufacturer or responsible supplier;

b) type and model;

c) month and year of manufacture;

d) designation (see Clause 8);

e) maximum inclination;

f) light transmittance.

NOTE 2 Where ZA.3 covers the same information as this clause, the requirements of this clause are met.

Annex A
(informative)

Guidelines for safety, application, use and maintenance

A.1 General

Within the continuous rooflight construction, materials should be mutually compatible and suitable for their respective purposes.

A.2 Guidelines for safety

A.2.1 Continuous rooflights according to this European Standard are not intended to be walked on. Barriers could be used where necessary to prevent this. Ventilation panels are not meant to be open during windy conditions unless specified by the manufacturer.

A.2.2 Continuous rooflights, glazing elements, ventilation panels and accessories should be designed to minimise risk to personnel. In particular, there should be no possibility of falling debris which can cause bodily injuries, except under extraordinary conditions

A.2.3 Continuous rooflights should be equipped with fixing elements which cannot be removed from the outside without tools. Opening panels should be secure in closed position.

A.3 Guidelines for application and use

A.3.1 Where not otherwise defined in this European Standard, European and/or national regulations and codes of practice applicable to the design and installation of continuous rooflight systems should be used. Where relevant, the methods of application laid down by suppliers of special roofing material should be always considered. The manufacturer should specify the installation conditions.

A.3.2 For continuous rooflights, especially for such of large dimensions, the effects of glare and heat transition by passive solar heat should be taken into consideration.

A.3.3 The connection of the separate continuous rooflight element to the supporting substructure should be realised in such a way that the loads acting upon the connection are transferred to the substructure. A load-bearing or racking function of the upstands for the roof surface cannot be assumed without special test or calculation.

A.3.4 Storage, transportation, assembling and installation of the continuous rooflights, elements, ventilation panels and accessories should be carried out in accordance with the manufacturer's instructions.

A.3.5 The manufacturer's installation and maintenance instructions should be adhered to at all times with respect to the temperature and environmental compatibility such as the effect of cleaning agents, fluids, gaseous and solid substances (particularly organic solvents).

A.3.6 Continuous rooflights made of plastic materials are water vapour permeable. For this reason, surface and interstitial condensation may temporarily occur, although this will not affect the function of the continuous rooflight.

A.3.7 The height between the upper surface of the roof finish and the top of the upstand/support should not be less than 150 mm.

A.4 Maintenance

Continuous rooflights should be subjected to periodic maintenance according to the manufacturer's instructions. Maintenance should include:

— cleaning of structural and glazing elements;

— checking and possible replacement of seals;

— checking, maintenance and possible replacement of accessories;

— maintenance of the opening mechanism (if any);

— all relevant details of maintenance shall be logged.

The maintenance measures should be safely and easily implemented without the need to dismantle the continuous rooflights. Failure to comply with these maintenance requirements will affect the performance, the life expectancy and product warranty.

Annex B
(normative)

Alternative test method for determination of light transmittance

B.1 General

The test method described in this annex may be used for quality control purposes provided that the manufacturer can demonstrate correlation with the method described in 6.1. In this case the manufacturer has to use as reference the light transmittance figure relative to the box method equivalent to the stated value. The tolerance of ± 5 % applies to this reference.

B.2 Apparatus

The apparatus consists of:

— an open box painted inside matt white[1)] with internal dimensions of 600_{0}^{+5} mm square in plan by (900 ± 5) mm high. An internal flange 25_{0}^{+5} mm wide by 25_{0}^{+5} mm deep has to be provided at a distance (from the top of the box) of 100 mm, or the maximum depth of profile to be tested, plus 5 mm, whichever is the greater;

— a 40 mm colour and cosine-corrected selenium photocell shall be mounted in accordance with EN 1013-1, at the centre of the aperture formed by the flange but 600_{0}^{+5} mm below it. The spectral response of this photocell shall be such as to give a maximum reading between 380 nm to 780 nm. The photocell shall be connected to a galvanometer;

— a light source designed to have a colour temperature of about 6 500 K is fitted to the top of the box. It consists of an optically neutral opal acrylic plastic diffuser (opal polymerized methyl methacrylate or equivalent may be used[2)]) mounted flush with the top of the box, with eight 600 mm long 20 W fluorescent "cold white" tubes above it and control apparatus mounted outside;

— a regulator circuit, if necessary, to maintain a constant voltage supply to the lamps;

— suitable devices to measure temperature;

1) in the centre of and on the surface of the diffuser;

2) immediately above the photocell.

B.3 Test pieces

The five test pieces are cut from the sheet and are square in shape, each side being 575 mm in length.

[1)] Colour RAL 9003 matt can be used.

[2)] For example, "Perspex", grade 040, is a suitable product available commercially. This information is given for the convenience of users of this European Standard and does not constitute an endorsement by CEN of this product.

B.4 Procedure

B.4.1 Before testing, fit the top to the box, switch on the lamps and leave to stabilise for a minimum period of 30 min.

B.4.2 The temperature levels from each device has to be monitored. Tests shall be discontinued if the temperatures recorded in the centre and on the surface of the diffuser exceed 35 °C and/or the temperature recorded immediately above the photocell exceeds 30 °C.

B.4.3 Note the reading R_1 of the galvanometer without any test piece in position.

B.4.4 Remove the top from the box and place the test piece on the internal flange. Refit the top to the box and with the sample in position and note the reading R_2 of the galvanometer.

B.4.5 Remove the top from the box and remove the test piece. Refit the top to the box and note the reading R_3 of the galvanometer.

B.4.6 Compare R_1 and R_3, and if the difference related to the greater value is not greater than 5 % accept the results. If the difference is greater than 5 % repeat the test until satisfactory results are obtained.

B.4.7 Repeat B.4.3 to B.4.6 four times with different test pieces.

B.5 Expression of results

B.5.1 Determine the mean value M_s of R_1 and R_3 for each test piece as

$$M_s = \frac{R_1 + R_3}{2} \tag{B.1}$$

B.5.2 Express the light transmittance L_s of each test piece as

$$L_s = \frac{R_2}{M_s} \cdot 100 \text{ in \%} \tag{B.2}$$

B.5.3 Determine the mean value of the light transmittance of the test pieces as

$$M_v = \frac{1}{5} \cdot \sum_{n=1}^{n=5} L_{sn} \tag{B.3}$$

Annex C
(informative)

Information regarding light transmittance

C.1 General

Definitions according to CIE Publ. No. 38 (TC-2.3) Radiometric and Photometric Characteristics of Materials and their Measurement, 1977. [7]

C.2 Material characteristics

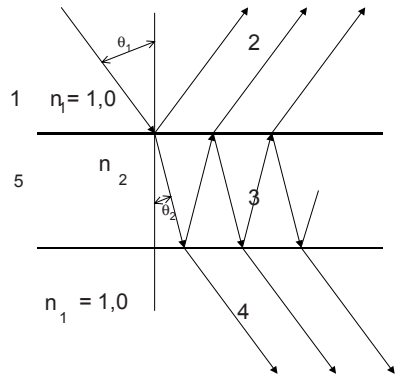
In general, material characteristics refer to the characteristics of materials that depend on the interaction with optical radiation or light. They are very much affected by the spectral distribution of radiation, its state of polarisation, the angles of incidence and observation, the angular extent of the incident radiation and the viewing beam, the thickness of the sample, the temperature, the state of the surface and the weighting function.

Radiation can be absorbed, reflected or transmitted by a sample.

Refraction occurs when the radiation propagates in different optical media. The refractive indices n_1 and n_2 determine the new direction of propagation θ_2 if the radiation incidence is under the angle θ_1:

$$n_1 \cdot \sin(\theta_1) = n_2 \cdot \sin(\theta_2) \qquad \text{(C.1)}$$

As shown in the Figure C.1, all rays are within one plane. The angles θ_1 and θ_2 are the plane angles determined by the rays and the according surface normal.



Key
1 air
2 reflected
3 absorbed
4 transmitted
5 transparent material

Figure C.1 — Propagation of radiation through two media with different refractive indices

C.3 Transmission

The passage of radiation through a medium without change of wavelength is called transmission. Differentiation is made between direct transmission, diffuse transmission and mixed transmission.

The spectral transmittance $\tau(\lambda)$ is the ratio of the transmitted radiant flux $\Phi_{e\lambda\tau}$ to the incident flux $\Phi_{e\lambda}$ at a given wavelength λ:

$$\tau(\lambda) = \frac{\Phi_{e\lambda\tau}(\lambda)}{\Phi_{e\lambda}(\lambda)} \tag{C.2}$$

This factor is also called transmission factor.

For double glazing, the spectral transmittance can be computed by the spectral transmittances and reflectance's of each glazing (Index 1 refers to the outer glazing; index 2 refers to the inner glazing):

$$\tau(\lambda) = \frac{\tau_1(\lambda)\cdot\tau_2(\lambda)}{1-\rho'_1(\lambda)\cdot\rho_2(\lambda)} \tag{C.3}$$

$\rho'_1(\lambda)$ is the spectral reflectance of the outer glazing measured against the direction of incident radiation. $\rho_2(\lambda)$ is the spectral reflectance measured in parallel to the incident radiation.

Accordingly, the spectral transmittance of a triple glazing can be obtained by the equation:

$$\tau(\lambda) = \frac{\tau_1(\lambda)\cdot\tau_2(\lambda)\cdot\tau_3(\lambda)}{[1-\rho'_1(\lambda)\cdot\rho_2(\lambda)]\cdot[1-\rho'_2(\lambda)\cdot\rho_3(\lambda)]\cdot\tau_2^2(\lambda)\cdot\rho'_1(\lambda)\cdot\rho_3(\lambda)} \tag{C.4}$$

Regular transmittance can be calculated by the spectral transmittance for a given relative spectral power distribution $S_\lambda(\lambda)$ and a weighting function $s_{rel}(\lambda)$:

$$\tau = \frac{\int_0^\infty S_\lambda(\lambda)\cdot\tau(\lambda)\cdot s_{rel}(\lambda)\,d\lambda}{\int_0^\infty S_\lambda(\lambda)\cdot s_{rel}(\lambda)\,d\lambda} \tag{C.5}$$

For radiant characteristics, the weighting function is independent of wavelength; $s_{rel}(\lambda) = 1$.

For photometric characteristics, the weighting function is $V(\lambda)$. The luminous transmittance is given for a defined illuminant $S_\lambda(\lambda)$. In daylight applications the standard illuminant D65 is used mostly.

Transmittance is the sum of direct transmittance τ_r and diffuse transmittance τ_d:

$$\tau = \tau_r + \tau_d \tag{C.6}$$

C.4 Reflectance factor (according to CIE)

The reflectance factor R is the ratio of radiant flux reflected in the direction delimited by the cone to that reflected in the same directions by a perfect reflecting diffuser identically irradiated.

C.5 Absorptance

The spectral absorptance $\alpha(\lambda)$ is the ratio of absorbed spectral radiant flux $\Phi_{e\lambda\alpha}$ to the incident flux $\Phi_{e\lambda}$:

$$\alpha(\lambda) = \frac{\Phi_{e\lambda\alpha}(\lambda)}{\Phi_{e\lambda}(\lambda)} \tag{C.7}$$

Luminous absorptance for a given illuminant can be calculated by weighting the absorbed and the incident flux with the V(λ)-function.

C.6 Solar gain

C.6.1 General information

Direct solar radiation and diffuse sky radiation entering a building can be used for illumination purposes. In addition to that, the radiation may lead to a heat gain. The luminous, radiant and energetic characteristics of the materials used affect the inner situation of a building. Colour-related quantities of the light entering the building also depend on the spectral characteristics of the materials.

While, in winter, the energy for heating can be decreased by solar heat gain, this effect should be prevented in summer, because the cooling loads will be increased by this.

C.6.2 Illuminance

The illuminance is the ratio of the differential luminous flux $d\Phi$ hitting the differential area dA_2:

$$E = \frac{d\Phi}{dA_2} \tag{C.8}$$

The index 2 indicates in photometry that the area receives light.

The unit of illuminance is lux (lx).

With the luminance distribution of the sky and the spatial distribution of the luminance coefficient q of a daylighting system for different incidences, the illuminance inside a building can be computed.

C.6.3 Correlated colour temperature and colour rendering

The correlated colour temperature T_{cp} on an illuminant allows a comparison of this illuminant with a Planckian radiator. The correlated colour temperature is the temperature of a black body whose perceived colour matches most closely the illuminant. Depending on the correlated colour temperature the illuminant can be called warm, neutral or daylight white.

The colour rendering properties are determined primarily by the general colour rendering index R_a. This index is the arithmetic mean of the first eight special colour rendering indices R_1 to R_8 representing the colour rendering characteristics for eight test colours. The colour perceived by illuminating the test colour with a given illuminant is compared with the colour perceived with a reference illuminant. By the colour difference, the special colour rendering index R_i is calculated.

For some visual tasks, a higher quality of colour rendering is needed. In these cases, other special colour rendering indices are additionally calculated.

C.6.4 Solar factor (according to EN 410)

The total solar energy transmittance (solar factor) g is the sum of the direct radiant transmittance τ_e for global radiation and the secondary internal heat transfer factor q_i. The secondary internal heat transfer factor is a measure for secondary effects of heat transfer such as convection and infrared radiation of rather big wavelengths.

The direct transmittance for global radiation (300 nm to 2 500 nm) can be obtained by:

$$\tau_e = \frac{\sum_{\lambda=300nm}^{2500nm} S_\lambda(\lambda) \cdot \tau(\lambda) \cdot \Delta\lambda}{\sum_{\lambda=300nm}^{2500nm} S_\lambda(\lambda) \cdot \Delta\lambda} \quad \text{(C.9)}$$

In this case S_λ is the relative spectral distribution of solar radiation.

For the calculation of the secondary internal heat transfer factor, the external and internal heat transfer coefficients (h_e and h_i) are used.

For single glazing, it can be computed by:

$$q_i = \alpha_e \cdot \frac{h_i}{h_e + h_i} \quad \text{(C.10)}$$

α_e is the solar absorptance and can be obtained indirectly by the solar reflectance and solar transmittance:

$$\alpha_e = 1 - (\rho_e + \tau_e) \quad \text{(C.11)}$$

EN 410 gives additional equations for double and triple glazing.

The solar factor depends, as all other material characteristics, on the angle of incidence. For different sun positions, this should be taken into consideration.

Annex ZA
(informative)

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

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under mandate M/122 "Roof coverings, rooflights, roof windows and ancillary products" 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 continuous rooflights covered by this annex for the intended uses indicated herein; reference shall be made to the information accompanying the CE marking.

WARNING: Other requirements and other EU Directives, not affecting the fitness for intended uses, may be applicable to the continuous rooflights falling within the scope of this standard.

NOTE In addition to any specific clauses relating to dangerous substances contained in this standard, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, 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. 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/comm/enterprise/construction/internal/dangsub/dangmain.htm).

This annex establishes the conditions for the CE marking of the continuous rooflights intended for the use indicated in Table ZA.1 and ZA.1.2 and shows the relevant clauses applicable, and is the same as Clause 1.

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

Table ZA.1 — Relevant clauses for continuous rooflights with or without upstands

Product: Continuous rooflights of plastics with or without upstands **Intended use:** Light transmittance for use in flat and inclined roofs of buildings			
Essential Characteristics	**Requirement clauses in this European Standard**	**Levels and/or classes**	**Notes**
Mechanical resistance[1]	5.4.2, 5.4.3	–	Type
Reaction to fire	5.5	Classes A1 to F	-
Resistance to fire[1]	5.6	See EN 13501-2	-
External fire performance[1]	5.7	See EN 13501-5	-
Water tightness	5.3.1 and 5.3.2	–	Pass / Fail
Impact resistance	5.4.4	–	Pass / Fail and Type
Direct airborne sound insulation[1]	5.10	-	R_w index
Thermal resistance	5.9.1 and 5.9.2.	–	U-values
Light transmittance Solar factor	5.1	–	τ_V, τ_e value g-value
Air permeability	5.8.1 and 5.8.2	–	Type
Durability:			
- variation of total luminous transmittance	5.2.2	–	Type
- variation of yellowness index	5.2.2	–	Type
- variation of mechanical properties	5.2.3	–	Type
[1] This characteristic does not apply to continuous rooflights without upstands.			

The requirement on a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, manufacturer's placing their products on the market of these MSs 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 Clause ZA.3) may be used. The NPD option may not be used, however, where the characteristic is subject to a threshold level.

ZA.2 Procedures for attestation of conformity of continuous rooflights

ZA.2.1 Systems of attestation of conformity

The systems of attestation of conformity of the construction products indicated in Table, in accordance with the Decision of the Commission 98/436/EC of 1998-07-10 (L194) as given in Annex III of the mandate M/122 are shown in Table ZA.2 for the indicated intended uses and relevant levels or classes:

Table ZA.2 — Systems of attestation of conformity

Product(s)	Intended use(s)	Level(s) or class(es)	Attestation of conformity systems [d]
Continuous rooflights	For uses subject to reaction to fire regulations	A1 [a], A2 [a], B [a] and C [a]	1
		A1 [b], A2 [b], B [b], C [b], D and E	3
		(A1 to E) [c] and F	4
	For uses subject to external fire performance regulations	Products requiring testing	3
		F_{ROOF} and products "deemed to satisfy" without testing	4
	For uses subject to resistance to fire regulations	See EN 13501-2	3
	For uses subject to regulations on dangerous substances	-	3
	For other uses than those above mentioned	–	3

[a] Products/materials for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material).

[b] Products/materials not covered by footnote a.

[c] Products/materials that do not require to be tested for reaction to fire (e.g. products/materials of Class A1 to Commission Decision 96/603/EC, as amended by Commission Decision 2000/605/EC).

[d] Only products in reaction to fire Class F and/or external fire performance Class F_{ROOF}, and for which no other characteristics are declared, come under attestation system 4. All other products come under either system 3 or system 1

System 1: See Directive 89/106/EEC (CPD) Annex III.2.(i), without audit testing of samples.

System 3: See Directive 89/106/EEC (CPD) Annex III.2.(ii), second possibility.

System 4: See Directive 89/106/EEC (CPD) Annex III.2.(ii), third possibility.

The attestation of conformity of the continuous rooflights in Table ZA.1 shall be in accordance with the evaluation of conformity procedures indicated in Tables ZA.3.1, ZA.3.2 or ZA.3.3 resulting from application of the clauses of this European Standard indicated therein.

Table ZA.3.1 — Assignment of evaluation of conformity tasks for continuous rooflights under system 1

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks under the responsibility of the manufacturer	Factory production control (F.P.C)	Parameters related to all characteristics of Table ZA.1 relevant for the intended end use.	7.3
	Further testing of samples taken at factory	All characteristics of Table ZA.1 relevant for the intended end use.	7.3
	Initial type testing by a notified test laboratory	Those characteristics of Table ZA.1 relevant for the intended use, except for reaction to fire in the classes below	7.2
Tasks under the responsibility of the notified product certification body	Initial type testing	Reaction to fire (Classes A1 [a], A2 [a], B [a] and C [a])	7.2
	Initial inspection of factory and of F.P.C	Parameters related to all characteristics of Table ZA.1 relevant for the intended use, in particular to reaction to fire	7.3
	Continuous surveillance, assessment and approval of F.P.C.	Parameters related to all characteristics of Table ZA.1 relevant for the intended use, in particular to reaction to fire	7.3

[a] Products/materials for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material).

Table ZA.3.2 — Assignment of evaluation of conformity tasks for continuous rooflights under system 3

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks under the responsibility of the manufacturer	Factory production control (F.P.C)	Parameters related to all characteristics of Table ZA.1 relevant for the intended end use	7.3
	Initial type testing by a notified test laboratory	All characteristics of Table ZA.1 relevant for the intended use, i.e.: Reaction to fire (A1 [b], A2 [b], B [b], C [b], D and E) Resistance to fire External fire performance (products requiring testing) Mechanical resistance Dangerous substances Water tightness Thermal properties Direct airborne sound insulation Light transmittance, solar factor Air permeability Impact resistance Durability: - variation of total luminous transmittance - variation of yellowness index - variation of mechanical properties	7.2

[b] Products/materials not covered by footnote a (see Table ZA.3.1).

Table ZA.3.3 — Assignment of evaluation of conformity tasks for continuous rooflights under system 4 [a]

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks for the manufacturer	Factory production control (F.P.C)	Parameters related to all characteristics of Table ZA.1 relevant for the intended use	7.3
	Initial type testing	All characteristics of Table ZA.1 relevant for the intended use	7.2

[a] Only products in reaction to fire Class F and/or external fire performance Class F_{ROOF}, and for which no other characteristics are declared, come under attestation system 4. All other products come under either system 3 or system 1.

ZA.2.2 EC Certificate and Declaration of conformity

In case of products under system 1:

When compliance with the conditions of this annex is achieved, the certification body shall draw up a certificate of conformity (EC Certificate of conformity), which entitles the manufacturer to affix the CE marking. The certificate shall include:

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

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

— description of the product (type, identification, use, ...);

— provisions to which the product conforms (i.e. Annex ZA of this EN) and a reference to ITT and FPC reports as appropriate;

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

— number of the certificate;

— conditions of validity of the certificate, where applicable;

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

In addition, the manufacturer shall draw up a declaration of conformity (EC Declaration of conformity) including the following:

— name and address of the manufacturer, or his authorised representative established in the EEA;

— name and address of the certification body;

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

NOTE Where some of the information required for the Declaration is already given in the CE marking information, it does not need to be repeated.

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

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

— number of the accompanying EC Certificate of conformity;

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

In case of products under system 3:

When compliance with the conditions of this annex is achieved, the manufacturer or his agent established in the EEA shall prepare and retain a declaration of conformity (EC Declaration of conformity), which authorises the affixing of the CE marking. This declaration shall include:

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

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

NOTE Where some of the information required for the Declaration is already given in the CE marking information, it does not need to be repeated.

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

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

— name and address of the notified laboratory(ies) and a reference to the ITT report(s) and factory production control records as appropriate;

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

In case of products under system 4:

When compliance with this annex is achieved, the manufacturer or his agent established in the EEA shall prepare and retain a declaration of conformity (EC Declaration of conformity), which authorises the affixing of the CE marking. This declaration shall include:

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

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

NOTE Where some of the information required for the Declaration is already given in the CE marking information, it does not need to be repeated.

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

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

— a reference to the ITT report(s) and factory production control records as appropriate;

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

The above mentioned declaration and certificate shall be presented in the language or languages accepted in the Member State in which the product is to be used.

ZA.3 CE marking and labelling

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the rooflight upstand (for rooflights with upstand) or on the product or packaging (for rooflights without upstand) or on the accompanying commercial documents. If only part of the information is presented on the rooflight upstand, product or packaging, then this information shall also be part of the information presented on the accompanying commercial document(s). The following information on the product and its essential characteristics shall accompany the CE marking symbol:

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

— name or identifying mark and registered address of the producer;

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

— number of the EC Certificate of conformity (only for products under system 1);

— reference to this European Standard;

— description of the product (generic name, material, dimensions etc.) and intended use;

— information on the relevant essential characteristics in Table ZA.1 (information indicated by (*) does not apply to rooflights without upstands):

  — resistance to upward load(*): type (e.g. UL 1500) or NPD;

  — resistance to downward loads(*): type (e.g. DL 750) or NPD;

  — reaction to fire: class (e.g. B-s3,d0) and reference to a uniquely identifiable manufacturer's document specifying the end use conditions in which the product has been tested, if relevant or Class F;

  — resistance to fire(*): class (e.g. EI30) and reference to a uniquely identifiable manufacturer's document specifying the end use conditions in which the product has been tested, if relevant, or NPD;

  — external fire performance(*): class (e.g. B_{ROOF}(t1) and reference to a uniquely identifiable manufacturer's document specifying the end use conditions in which the product has been tested, if relevant, or F_{ROOF};

  — water tightness:

    — for the continuous rooflight with upstand(*): pass or NPD and

    — for the light transmitting sheet material: pass or NPD;

  — impact resistance:

    — for the small hard Body: pass or NPD and

    — for the large, soft body(*): type (e.g. SB 1200) or NPD;

  — thermal transmittance:

- for the continuous rooflight with upstand(*): U-value or NPD and
- for the light transmitting sheet material: U-value or NPD;

- direct airborne sound insulation(*): R_w-value or NPD;
- radiation transmittance:
  - light transmittance: τ_V-value or NPD;
  - solar direct transmittance: τ_e-value or NPD;
- solar factor: g-value or NPD;
- air permeability:
  - for the continuous rooflight with upstand(*): type (e.g. A3) or NPD and
  - for the light transmitting sheet material: pass or NPD;
- durability: types (e.g. ΔA, Cu 0, Ku 0).

The “No performance determined” (NPD) option may not be used where the characteristic is subject to a threshold level. Otherwise, the NPD option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements.

Figures ZA.1 and ZA.2 are examples of the information to accompany the CE Symbol for continuous rooflights with and without upstand.

CE 01234	*CE conformity marking, consisting of the* *"CE"-symbol given in directive 93/68/EEC.* *Identification number of the certification body (where relevant)*
AnyCo Ltd. PO Box 21, B 1050	*Name or identifying mark and registered address of the producer*
06 01234-CPD-00234	*Last two digits of the year in which the marking was affixed* *Certificate number (where relevant)*
EN 14963 Continuous rooflight with upstand, intended to be used for light transmittance for flat and/or inclined roofs	*No. of European Standard* *Description of the product*
Resistance to upward load: UL 1500 Resistance to downward loads: DL 2500 Reaction to fire: B-s3,d0 (mounting and fixing provisions: see manufacturer's specification X1) Resistance to fire: EI30 (mounting and fixing provisions: see manufacturer's specification X2) External fire performance: F_{ROOF} Water tightness: – Rooflight: Pass Impact resistance: – Small hard Body: Pass – Large, soft body: SB 1200 Thermal transmittance: – Rooflight: 2,6 W/(m²·K) – Light transmitting sheet material: 2,2 W/(m²·K) Direct airborne sound insulation: R_W 20 dB Radiation transmittance: - Light transmittance: 55 % - Solar direct transmittance: 48 % - Solar factor: 0,60 Air permeability: – Rooflight: A3 Durability: ΔA, Cu 0, Ku 0	*and* *Information on regulated characteristics*

Figure ZA.1 — Example for CE marking information for continuous rooflights with upstand

CE 01234	*CE conformity marking, consisting of the "CE"-symbol given in directive 93/68/EEC.* *Identification number of the certification body (where relevant)*
Any Co Ltd. PO Box 21, B 1050	*Name or identifying mark and registered address of the producer*
06 01234-CPD-00234	*Last two digits of the year in which the marking was affixed* *Certificate number (where relevant)*
EN 14963	*No. of European Standard*
Continuous rooflight without upstand, intended to be used for light transmittance for flat and/or inclined roofs	*Description of the product and intended use*
Reaction to fire: B-s3,d0 (mounting and fixing provisions: see manufacturer's specification Y1) Water tightness: Pass Impact resistance: Pass Thermal resistance: – Rooflight: 2,6 W/(m²·K) – Light transmitting sheet material: 2,2 W/(m²·K) Radiation transmittance: – Light transmittance: 55 % – Solar direct transmittance: 48 % – Solar factor: 0,60 Air permeability: Pass Durability: ΔA, Cu 0, Ku 0	*and* *Information on regulated characteristics*

Figure ZA.2 — Example for CE marking information for continuous rooflights without upstand

In addition to any specific information relating to dangerous substances shown above, the product should also be accompanied, when and where required and in the appropriate form, by documentation listing any other legislation on dangerous substances for which compliance is claimed, together with any information required by that legislation.

NOTE European legislation without national derogations need not be mentioned.

Bibliography

[1] EN 1013-2, *Light transmitting profiled plastic sheeting for single skin roofing — Part 2: Specific requirements and test methods for sheets of glass fibre reinforced polyester resin (GRP)*

[2] EN 1013-4, *Light transmitting profiled plastic sheeting for single skin roofing — Part 4: Specific requirements, test methods and performance of polycarbonate (PC) sheets*

[3] EN 1873, *Prefabricated accessories for roofing — Individual roof lights of plastics — Product specification and test methods*

[4] EN 1994-1-1, *Eurocode 4 : Design of composite steel and concrete structures — Part 1-1: General rules and rules for buildings*

[5] EN ISO 9001, *Quality management systems — Requirements (ISO 9001:2000)*

[6] EOTA ETA-*Guideline 010 "Self supporting translucent roof kits"*

[7] CIE Publ. No. 38 (TC-2.3), 1977, *Radiometric and Photometric Characteristics of Materials and their Measurement*

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