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Prefabricated accessories for roofing — Individual rooflights of plastics — Product specification and test methods

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National foreword

This British Standard is the UK implementation of EN 1873:2014+A1:2016. It supersedes BS EN 1873:2014 which is withdrawn.

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English Version

**Prefabricated accessories for roofing - Individual
rooflights of plastics - Product specification and test
methods**

Accessoires préfabriqués pour couverture -
Lanterneaux ponctuels en matière plastique -
Spécifications des produits et méthodes d'essais

Vorgefertigte Zubehörteile für Dacheindeckungen -
Lichtkuppeln aus Kunststoff - Produktfestlegungen und
Prüfverfahren

This European Standard was approved by CEN on 23 February 2014 and includes Amendment 1 approved by CEN on 7 December 2015.

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European foreword

This document (EN 1873:2014+A1:2016) 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 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of an identical text or by endorsement, at the latest by August 2016, and conflicting national standards shall be withdrawn at the latest by August 2016.

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

This document includes Amendment 1 approved by CEN on 2015-12-07.

This document supersedes A1 EN 1873:2014 A1.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

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 the EU Regulation concerning the CPR, see informative Annex ZA, which is an integral part of this document.

A1 *deleted text* A1

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

1 Scope

This European Standard specifies requirements for rooflights made of plastic materials (e.g. GF-UP, PC, PMMA, PVC) and rooflights with upstands made of e.g. GF-UP, PVC, steel, aluminium or wood for installation in roofs. These rooflights serve the purpose of introducing daylight.

This European Standard applies to rooflights with a rectangular or circular ground plan (see Figures 1 and 2), with an opening span (width) or diameter not larger than 2,5 m and an opening length not larger than 3,0 m in roof pitches up to 25°. This document does not cover rooflights which contribute to the load-bearing or stiffness of the roof itself.

This European Standard applies to rooflights and rooflights with upstand, where a single manufacturer provides all components of the rooflight with upstand, which are bought in a single purchase.

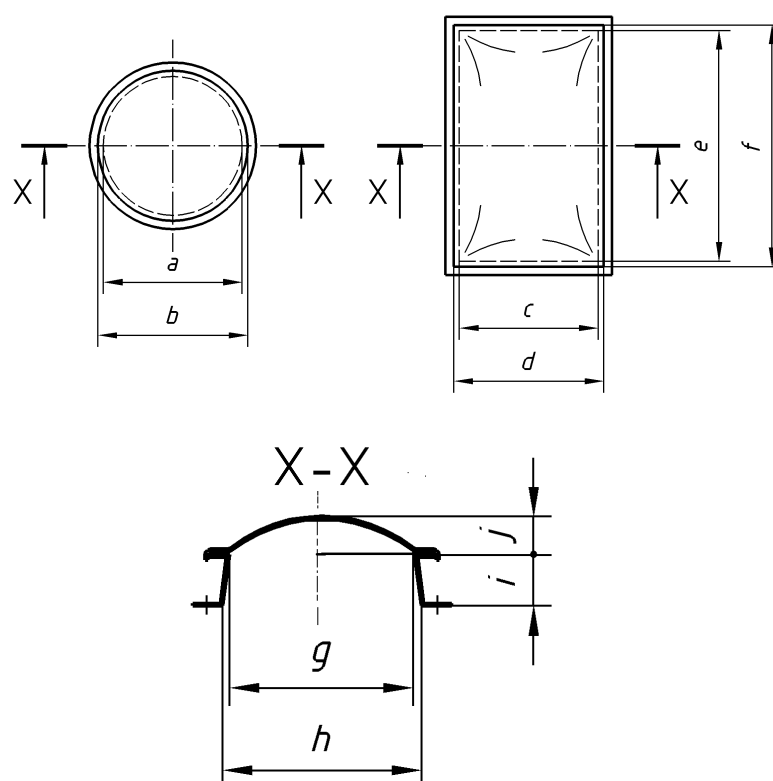
This European Standard applies to rooflights with one or several translucent parts.

Rooflights may be opened by means of opening devices in one or more parts for ventilation.

The possible additional functions of day to day ventilation, smoke and heat ventilation e.g. in case of fire in accordance with EN 12101-2, roof access, and/ or slinging point e.g. in accordance with EN 795 are outside the scope of this document.

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

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

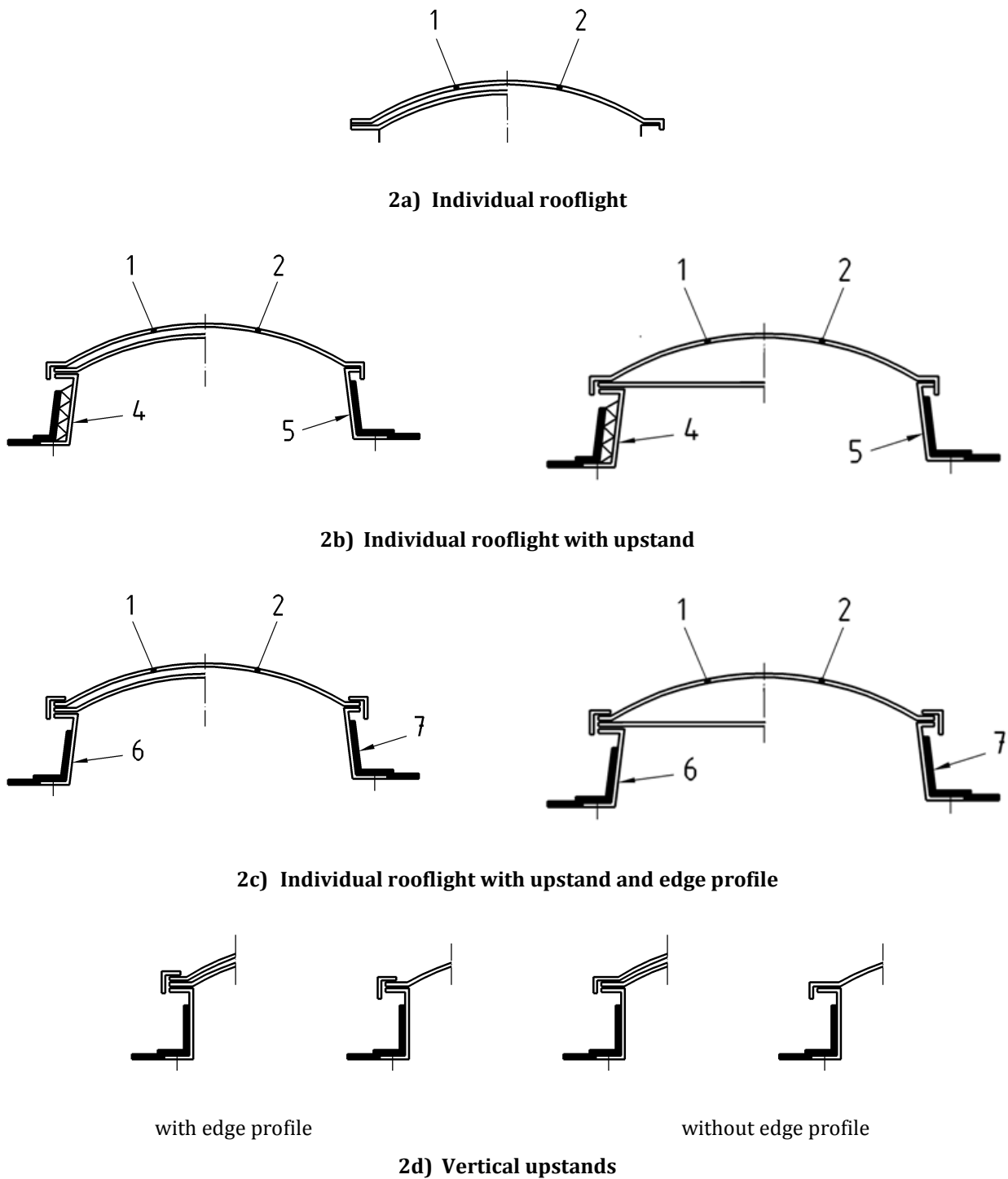


Section X -X without and with additional horizontal skin

Key

a	daylight diameter	f	roof opening length
b	roof opening diameter	g	daylight size
c	daylight width	h	roof opening size
d	roof opening width	i	upstand height
e	daylight length	j	rooflight height

Figure 1 — Typical individual rooflights



Key

- | | | |
|----------------|-------------------------|---------------|
| 1 multi skin | 4 insulated upstand | 7 roof finish |
| 2 single skin | 5 non insulated upstand | |
| 3 edge profile | 6 splayed upstand | |

Figure 2 — Cross sections of typical individual rooflights and upstands

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 410:2011, *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, *Light transmitting single skin profiled plastics sheets for internal and external roofs, walls and ceilings — Requirements and test methods*

CEN/TS 1187, *Test methods for external fire exposure to roofs*

EN 12412-2, *Thermal performance of windows, doors and shutters — Determination of thermal transmittance by hot box method — Part 2: Frames*

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

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

EN 14351-1, *Windows and doors — Product standard, performance characteristics — Part 1: Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics*

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

EN 16153, *Light transmitting flat multiwall polycarbonate (PC) sheets for internal and external use in roofs, walls and ceilings — Requirements and test methods*

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

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

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

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

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

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

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

EN ISO 10140-1, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 1: Application rules for specific products (ISO 10140-1)*

EN ISO 10140-2, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 2: Measurement of airborne sound insulation (ISO 10140-2)*

EN ISO 10140-4, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 4: Measurement procedures and requirements (ISO 10140-4)*

EN ISO 10140-5, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 5: Requirements for test facilities and equipment (ISO 10140-5)*

EN ISO 10211, *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations (ISO 10211)*

EN ISO 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers (ISO 11664-1)*

EN ISO 11664-2, *Colorimetry — Part 2: CIE standard illuminants (ISO 11664-2)*

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)*

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

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

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

EN ISO 11925-2:2010, *Reaction to fire tests — Ignitability of products subjected to direct impingement of flame — Part 2: Single-flame source test (ISO 11925-2:2010)*

3 Terms and definitions

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

3.1

rooflight

building component used to introduce daylight which consists of a translucent part and associated edge profiles, if applicable

3.2

translucent part

consists of at least an outside plastic skin and several additional translucent skins below optionally

Note 1 to entry: The additional skins can follow or be integrated with the outer skin or be an additional flat skin.

Note 2 to entry: Additional flat skin may not be in plastic.

3.3

upstand

element which is single- or multi-walled or composite with vertical and/or pitched walls; with or without thermal insulation and having the two-fold purpose of providing an area for the fixture of plastic rooflights and for connection to the substructure, the roof covering or the roof sealing

Note 1 to entry: The upstand transmits the loads acting upon the plastic rooflight into the substructure.

Note 2 to entry: Upstands may include ventilation devices.

3.4

accessories

connections, opening and locking devices and seals for the assembly of the elements (rooflight, translucent part, upstand and edge profile)

3.5

rooflight with upstand

building element which consists of at least the separate elements in accordance with rooflight, translucent part, upstand and accessories

3.6

batch

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

3.7

edge profile

any frame and/or profile necessary to fix and/or open the translucent part of the rooflight

Note 1 to entry: edge profiles can be made out of plastic materials.

3.8

junction part

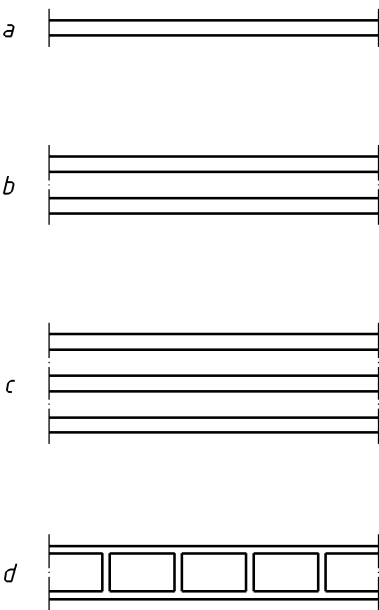
any additional element (e.g. frame and/or profile) used with the edge profile to assemble the rooflight, when made with more than one translucent part

Note 1 to entry: Junction part can be made out of plastic materials.

3.9

starting point of calculation

horizontal surface or point where adiabatic conditions are to be taken into account for calculation



Key

- a single skin, solid sheet
- b double skin, solid sheet
- c triple skin, solid sheet
- d multiwalled sheet

Note 1 to entry: In case of more than one skin, thicknesses of the sheets can be different.

Figure 3 — Cross sections of typical plastic sheets

4 Symbols and abbreviations

ΔYI	Change in the yellowness index
H_c	Energy applied during ageing procedure
L_s	Light transmission of a test piece
L_{sn}	Light transmission of the n th test piece
τ_{D65}	Total luminous transmittance for the CIE-standard illuminant D_{65} in %
M_s	Average (see B.5.1) of R_1 and R_3
M_v	Light transmission of the sample
R	Thermal resistance in $m^2 \cdot K/W$
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 in $W/(m^2 \cdot K)$
YI	Value of the yellowness index of aged test piece

YI_0	Value of the yellowness index of unaged test piece
ΔE	Variation of E-modulus in %
$\Delta \sigma$	Variation of strength in %
$X_{CIE}, Y_{CIE}, Z_{CIE}$	Colourimetric coordinates
A_e	Area of the outer exposed surface of the edge profile, in m ²
A_j	The outer exposed surface of the junction part, in m ²
A_r	The surface of the rooflight without upstand, in m ²
A_{rc}	The surface of the rooflight with upstand, in m ²
$A_{rc,ref}$	The surface of the rooflight without upstand of the reference model, in m ²
$A_{rc,ref300}$	The surface of the rooflight with upstand of the reference model, in m ²
A_t	Area of the outer exposed surface of the translucent part bordered with the perimeter of the translucent part, in m ²
$A_{t,flat}$	area of the horizontal projection of the clear opening of the translucent part of individual rooflight, in m ²
A_{up}	Area of the outer exposed surface of the rooflight upstand, in m ²
ee	The width of the edge profile, in m
ee,h	Horizontal distance between the upper outside border of the insulation and the clear opening of the translucent part, in m
ee,v	Vertical distance between the upper level of the translucent part and the upper level of the upstand, in m
ej,h	The width of the junction part, in m
eup	The height of the upstand, in m
h	Horizontal envelope boundary
k	Factor to take into account the shape of the translucent part
l_e	Length of the sealing of the edge profile, in m
l_j	Length of the transition zone between translucent part and junction part, in m
l_t	Length of the transition zone between translucent part and edge profile, in m
P_e	Perimeter of the edge profile, in m
P_t	Perimeter of the translucent part, equal to the perimeter of the clear opening of the translucent part, in m
P_{up}	The reference perimeter of the upstand
$P_{up,u}$	Upper outer perimeter of the upstand, in m
$P_{up,l}$	Lower outer perimeter of the upstand, in m
U_e	Thermal transmittance of the edge profile, in W/(m ² ·K)
U_j	Thermal transmittance of the junction part, in W/(m ² ·K)
U_r	Total thermal transmittance of rooflights including the edge profile, if applicable, in W/(m ² ·K)
$U_{r,ref}$	Total thermal transmittance of a rooflight without upstand (reference model), in W/(m ² ·K)
U_{rc}	Total thermal transmittance of rooflights including the edge profile, if applicable and upstand, in W/(m ² ·K)
$U_{rc,ref300}$	Total thermal transmittance of a rooflight with upstand (300 mm height, reference model), in

	$W/(m^2 \cdot K)$
U_t	Thermal transmittance of the translucent part, in $W/(m^2 \cdot K)$
U_{up}	Thermal transmittance of the upstand, in $W/(m^2 \cdot K)$
$U_{up,e}$	Thermal transmittance of the upstand and the edge profile, if applicable, in $W/(m^2 \cdot K)$
v	Vertical envelope boundary
Ψ_e	Linear thermal transmittance in the transition zone of edge profile and upstand, in $W/(m \cdot K)$
Ψ_j	Linear thermal transmittance in the transition zone of the translucent part and junction part, in $W/(m \cdot K)$
Ψ_t	Linear thermal transmittance in the transition zone of the translucent part and edge profile, in $W/(m \cdot K)$

5 Requirements

5.1 Radiation properties

5.1.1 General

The radiation properties of individual rooflights shall be assessed when subject to regulatory requirement and may be assessed voluntarily.

The radiation properties are essentially characterized by the light transmittance τ_{D65} , the direct solar transmittance τ_e and the total solar energy transmittance g . The spectral characteristics of the transparent part of an individual rooflight include the luminous and solar characteristics, and the reflection and transmission characteristics.

The characteristics are as follows:

- the spectral transmittance $\tau(\lambda)$ and the spectral reflectance $\rho(\lambda)$ in the wavelength range from 300 nm to 2450 nm;
- the light transmittance τ_{D65} and the light reflectance ρ_{D65} for standard illuminant D65;
- the solar direct transmittance τ_e and the solar direct reflectance ρ_e ;
- the total solar energy transmittance (solar factor) g .

The characteristics are determined for quasi-parallel, near normal radiation incidence using the radiation distribution of standard illuminant D65 (see EN 410:2011, Table 1), solar radiation in accordance with EN 410:2011, Table 2 and ultraviolet (UV) radiation in accordance with EN 410:2011, Table 3.

The solar factor depends, as all other optical material characteristics, on the angle of incidence. The angle of incidence should be taken into account for different sun positions.

5.1.2 Light transmission

The light transmission of the rooflight material is determined as total luminous transmittance of each skin and possible combinations of skins in new plastic rooflights and is stated by the manufacturer according to 6.2.1.

The recorded τ_{D65} value of the total luminous transmittance shall be within $\pm 5\%$ of the stated value.

5.1.3 Solar direct transmittance τ_e

The solar direct transmittance of the rooflight material is determined as the solar transmittance of each skin and possible combinations of skins in new plastic rooflights and is stated by the manufacturer according to 6.2.2.

The recorded τ_e value of the solar transmittance shall be within $\pm 5\%$ of the stated value.

5.1.4 Total solar energy transmittance g

The total solar energy transmittance, g , as defined in EN 410 shall be determined by calculation according to 6.2.3 or by measurement according to 6.2.3.

The calculation method is applicable only to transparent parts with symmetrical on-plan cross-section.

Where the calculation method is not applicable, then the total solar energy transmittance shall be measured.

5.2 Durability

This characteristic shall be assessed when subject to regulatory requirements and may be assessed voluntarily.

Durability of the product is evaluated by measuring the variation of total luminous transmittance, yellowness index and mechanical properties after ageing procedure of the material of the translucent part 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 6.3.

5.3 Water tightness

This characteristic shall be assessed when subject to regulatory requirements and may be assessed voluntarily. The plastic rooflight in the closed condition shall be tested in accordance with 6.4. No water shall drop from the internal surface. The design of the rooflight shall ensure that water drains away externally.

5.4 Mechanical performances

5.4.1 Resistance to upward loads

This characteristic shall be assessed.

For the determination of the resistance to upward load the plastic rooflight shall be tested and classified in accordance with 6.5.1.2.

A successful test is achieved if neither damage nor significant permanent deformation occurs.

5.4.2 Resistance to downward loads

This characteristic shall be assessed.

For the determination of the resistance to downward load the plastic rooflight shall be tested and classified in accordance with 6.5.1.3.

A successful test is achieved if neither damage nor significant permanent deformation occurs.

5.4.3 Impact resistance

5.4.3.1 Small, hard body impact

This characteristic shall be assessed when subject to regulatory requirements and may be assessed voluntarily.

A successful test is achieved when plastic rooflights are resistant to the impact of a small hard body when tested in accordance with 6.5.2.1.

The products shall always be tested with the manufacturer's corresponding or specified upstand.

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

5.4.3.2 Large soft body impact

This characteristic shall be assessed when subject to regulatory requirements and may be assessed voluntarily.

For the determination of the resistance to the impact of a large soft body the plastic rooflight shall be tested and classified in accordance with 6.5.2.3.

The products shall always be tested with the manufacturer's corresponding or specified upstand.

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

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

5.5 Reaction to fire

This characteristic shall be assessed when subject to regulatory requirements and may be assessed otherwise.

The reaction to fire of the materials of the rooflight shall be classified in accordance with EN 13501-1.

NOTE 1 In accordance with the Construction Product Regulation (CPR) products will need to be evaluated under "end use conditions" in the pre-flashover period of a fire. This generally implies that it is not possible to judge the performance of a product made up of many components (like rubber seals, aluminium frame, PE ventilator) by assessing the materials individually.

The rooflight shall be classified with the least favourable classification of any of the materials it is made of, if it can be clearly shown that the reaction to fire properties of the complete rooflight is likely not to perform worse than the worst material in terms of its reaction to fire performance. In this case tests for the purpose of classification where mounting and fixing of a material can influence the performance of a material (SBI test EN 13823 and the test with the small flame EN ISO 11925-2) shall be performed on the materials in accordance with the appropriate test method. Requirements for mounting and fixing are given in Annex E dealing with the test methods.

The product and/or individual component is considered to satisfy the requirements for performance class of the characteristic reaction to fire in accordance with the relevant EC Decision on Classified Without Further Testing (CWFT) without the need for testing on the basis of its conformity with the specification of the product detailed in that Decision and its intended end use application being covered by that decision.

The relevant components are

- Profile including thermal separation elements of thermally isolated frames (eg frame, sash, upstand);

- Infill (eg glazing, panels);
- Gasket between infill and profile;
- Gasket between frame/upstand and sash;
- Additional gasket;
- Organic coating (if relevant and not part of the profile testing);
- Opening mechanism inclusive of brackets.

Small components with dimensions not more than 50 mm x 50 mm and a weight not more than 50 g may not need to be considered for final assessment of a classification.

Gaskets shall not be considered, treat as products having small areas and/or small surfaces.

In accordance with EN 13501-1, class F is the classification used for products which are not tested at all or where the product has failed the performance criteria required for class E.

NOTE 2 Class F classification may be sufficient for many member countries in the EC. At the moment there are only some member countries which have a requirement for at least class E. Generally it is therefore not necessary to claim a higher classification other than class E to cover the requirement within the member countries in the EC unless for particular circumstances a better classification is required.

Components with their own product standard (e.g. glass products or parts of windows) do not need to be tested again. The class for those components shall to be taken from that product standard in question.

5.6 Resistance to fire

The resistance to fire is considered irrelevant for this product, because rooflights are not intended to be used specifically to provide fire resistance.

5.7 External fire performance

This characteristic shall be assessed when subject to regulatory requirements and may be assessed voluntarily. The product shall be tested according to CEN/TS 1187 method 1 or method 4 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

This characteristic shall be assessed when subject to regulatory requirements and may be assessed voluntarily.

For the determination of the air permeability the plastic rooflight shall be tested and classified in accordance with 6.7

5.9 Thermal resistance

Thermal resistance is determined by declaring the thermal transmittance of the complete rooflight.

This characteristic shall be assessed when subject to regulatory requirements and may be assessed voluntarily.

Individual rooflights are three dimensional parts that are lifted out of the surface of the roof. This has to be considered while determine the total-U-value.

All U values are determined in reference to external total surface in accordance with Annex D.

5.10 Airborne sound insulation

This characteristic shall be assessed when subject to regulatory requirements and may be assessed voluntarily.

Airborne sound insulation shall be determined as sound reduction index R_w (C_{tr} , C) of plastic rooflights and rooflights with upstands in compliance with EN ISO 10140-1, EN ISO 10140-2, EN ISO 10140-4, EN ISO 10140-5.

NOTE In the absence of measurements, it is deemed that the values given in Table 1 apply for the airborne sound insulation indexes R_{wt} of some typical translucent parts according to Figure 3.

Table 1 — Airborne sound indexes

Type of translucent part	Airborne sound index R_{wt} dB
single skin, solid sheet	12
double skin, solid sheet	20
triple skin, solid sheet	22

5.11 Release of dangerous substances

National regulations on dangerous substances may require verification and declaration on release, and sometimes content, when construction products covered by this standard are placed on those markets.

In the absence of European harmonized test methods, verification and declaration on release/content should be done taking into account national provisions in the place of use.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Construction website on EUROPA accessed through:

<http://ec.europa.eu/enterprise/construction/cpd-ds/>

6 Testing and classification

6.1 General

The validity of the results for each test on one rooflight described in this document may be extended by calculation and/or correlation to all rooflights in a family provided that the selection of tested rooflights is made in accordance with 6.9.

6.2 Radiation properties

6.2.1 Total luminous transmittance

The total luminous transmittance τ_{D65} for solid sheets shall be determined by testing using a spectrophotometer in accordance with to EN ISO 13468-1 or EN ISO 13468-2.

The total luminous transmittance of multiwalled PC sheets shall be determined as luminous transmittance τ_{D65} by testing using a spectrophotometer in accordance with EN 16153.

The total luminous transmittance of multiwalled PMMA sheets shall be determined as luminous transmittance τ_A by testing using a spectrophotometer in accordance with EN ISO 12017:1996, Annex A.

The total luminous transmittance of the combination of different material is calculated according to formulas given in EN 410.

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.

For total luminous transmittance tests, one test per material type, colour type, thickness and manufacturer of plastic/resin.

6.2.2 Determination of solar direct transmittance τ_e

The solar direct transmittance τ_e is to determine by measuring or by calculation.

For measuring, use the procedure and a calorimeter as described in [1].

For calculation, use the methods described in EN 410.

6.2.3 Determination of total solar energy transmittance g

The total solar energy transmittance g is to determine by measuring or by calculation.

For measuring, use the procedure and a calorimeter as described in [1].

For calculation, use the methods described in EN 410.

6.3 Durability

6.3.1 Classification for durability

6.3.1.1 Variation of total luminous transmittance τ_v and yellowness index YI (ΔYI)

Plastic rooflights are classified in 9 types as given in Table 2.

Table 2 — Material classification according to the change of the total luminous transmittance τ_{D65} and yellowness index YI (ΔYI)

Type	H_c GJ/m ²	Change of τ_{D65} %	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 total luminous transmittance τ_{D65} refer to variation in percentage of the initial value.

NOTE For the application of Table 1, additional information is available in EN 16153.

6.3.1.2 Variation of mechanical properties with ageing

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 6.3.5.

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 2, shall then be expressed in accordance with Tables 3 and 4.

Table 3 — Material classification according to change of E-Modulus after ageing procedure at the same energy level H_c selected from Table 2

Type	ΔE %
Cu 0	0
Cu 1	$0 > \Delta E \geq -10$
Cu 2	$-10 > \Delta E \geq -20$
Cu 3	$-20 > \Delta E \geq -30$

Table 4 — Material classification according to change of σ after ageing procedure at the same energy level H_c selected from Table 2

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

6.3.2 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.

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

- 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;

or where those facilities are not available, times of 9 min and 51 min, respectively, are allowed.

The dimensions of the test samples shall be sufficient to be subsequently tested for light transmittance (see 6.3.3), yellowness index (see 6.3.4) and mechanical properties (see 6.3.5).

Test specimens for these tests shall be representative of and not thicker than the sheets used in practice.

6.3.3 Variation of light transmission

6.3.3.1 Apparatus

Determine the total luminous transmittance using a spectrophotometer as described in 6.2 before and after the ageing procedure.

6.3.3.2 Test pieces

Use 10 test pieces chosen at random so as to be representative.

6.3.3.3 Procedure

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

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

6.3.3.4 Expression of results

The change of light transmission is expressed as the average of the variation of total luminous transmittance of each test piece. These figures are as a percentage of the initial value.

6.3.4 Variation in yellowness index

6.3.4.1 Apparatus

Determine the yellowness index using a spectrophotometer as described in 6.2 before and after the ageing procedure.

6.3.4.2 Test pieces

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

6.3.4.3 Procedure

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

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

6.3.4.4 Expression of results

Calculate the tristimulus values for CIE standard illuminant D 65 according to EN ISO 11664-2 and CIE standard observer 2° according to EN ISO 11664-1 by numerical integration of recorded spectral data or by automatic integration during spectrometer operation.

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

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

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

$$\Delta YI = YI - YI_0$$

6.3.5 Variation of mechanical properties with ageing

Measure the bending strength and the corresponding E-modulus of the sheet material according to EN ISO 14125 or EN ISO 178 for new samples and samples aged to energy exposures (H_c) as described in 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.

Four test pieces are used for evaluation, two new samples and two aged samples.

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

6.3.6 Test specimen

For durability, one test per material type, colour type, type of surface protection, thickness and manufacturer of plastic/resin.

6.4 Watertightness

6.4.1 Principle

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

6.4.2 Procedure

Rooflight shall be tested with an upstand representative of the family as defined in 6.9 or with a suitable substitute upstand to simulate an upstand provided by the customer. The rooflight, in closed position if an openable type - as installed on the roof shall be sprayed with water as follows:

- water is sprayed over the entire test area, the nozzles being in horizontal position;
- the flow volume on the test area is $2 \text{ l}/(\text{m}^2 \cdot \text{min})$ to $3 \text{ l}/(\text{m}^2 \cdot \text{min})$;
- the test duration is 60 min.

The test report shall indicate the degree of inclination at which the test was undertaken.

6.4.3 Apparatus

The apparatus used shall conform to Figure 4, which allows the water used to emanate from a rectangular grid system of nozzles. The nozzles together shall cover the whole of the square area relative to the horizontal plane as shown in Figure 4. The vertical position of the nozzle grid shall be fixed at $(200 \pm 5) \text{ mm}$ above the highest point of the plastic rooflight.

6.4.4 Test specimen

For watertightness, one test on the least favourable rooflight dimension (usually the greatest dimension in area or perimeter of the rooflight), connection between rooflight and upstand and installation pitch.