BS EN 15752-1:2014

BSI Standards Publication

Glass in building — Adhesive backed polymeric film

Part 1: Definitions and requirements

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National foreword

This British Standard is the UK implementation of EN 15752-1:2014.

The UK participation in its preparation was entrusted to Technical Committee B/520/4, Properties and glazing methods.

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

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Verre dans la construction - Film polymère adhésif - Partie 1: Définitions et exigences

Glas im Bauwesen - Selbstklebende Polymerfolie - Teil 1: Begriffe und Anforderungen

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Foreword

This document (EN 15752-1:2014) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2015, and conflicting national standards shall be withdrawn at the latest by February 2015.

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.

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Introduction

Adhesive backed polymeric film is designed to be applied to glass to modify the properties and performance of the glass.

Different types of adhesive backed polymeric films are manufactured to modify specific properties of glass including solar energy transmittance, visible light transmittance, emissivity, Ultra Violet transmittance, privacy, appearance, impact behaviour, security, electromagnetic frequency (EMF) attenuation, and surface protection.

1 Scope

This European Standard defines adhesive backed polymeric film based on biaxially oriented polyester film, and the performance characteristics of adhesive backed polymeric film for use on glass in buildings.

This European Standard does not apply to adhesive backed polymeric films manufactured using polyvinylchloride (PVC).

Other requirements, not specified in this standard, may apply to other glass or glazing products, e.g. laminated glass or insulating glass units, when adhesive backed polymeric film is included as part of the original assembly or manufacture of the glazing product. These additional requirements are specified in the appropriate product standard. Adhesive backed polymeric film, in this case, does not lose its mechanical or thermal characteristics.

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 356, *Glass in building - Security glazing - Testing and classification of resistance against manual attack*

EN 410:2011, *Glass in building - Determination of luminous and solar characteristics of glazing*

EN 572-1, *Glass in building - Basic soda lime silicate glass products - Part 1: Definitions and general physical and mechanical properties*

EN 572-2, *Glass in building - Basic soda lime silicate glass products - Part 2: Float glass*

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

EN 12600, *Glass in building - Pendulum test - Impact test method and classification for flat glass*

EN 12898, *Glass in building - Determination of the emissivity*

EN 50147-1, *Anechoic chambers - Part 1: Shield attenuation measurement*

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 8510-2, *Adhesives - Peel test for a flexible-bonded-to-rigid test specimen assembly - Part 2: 180 degree peel (ISO 8510-2)*

ISO 16933, *Glass in building — Explosion-resistant security glazing — Test and classification for arena air-blast loading*

3 Terms and definitions

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

3.1
adhesive backed polymeric film
one or more layers of polymeric film with an adhesive on one external face

Note 1 to entry: It may also incorporate one or more of the following: colouring, UV absorbers, UV inhibitors, metal layer(s), metal alloy layer(s), metal oxide layer(s), ceramic layer(s), scratch or abrasion resistant surface coating, release liner.

Note 2 to entry: The individual layers of polymeric film substrate are laminated together to form the final film.

3.2
external film
adhesive backed polymeric film designed for installation to glass surfaces that are oriented to the exterior

3.3
internal film
adhesive backed polymeric film designed for installation to glass surfaces that are oriented to the interior

3.4
solar control film
adhesive backed polymeric film designed to modify the total solar energy transmittance of a glass substrate, which may include modification of one or more of the following: direct solar transmittance, τ_e, direct solar reflectance, ρ_e, direct solar absorptance, α_e, visible light transmittance, τ_V, ultra-violet transmittance, τ_{UV}

3.5
safety film
adhesive backed polymeric film designed so that, when applied to a glass substrate, the final product can be classified in accordance with EN 12600 to at least 3(B)3

Note 1 to entry: Adhesive backed polymeric film designed as a safety film may also be a security film. In this case, the term adhesive backed polymeric safety / security film may be used.

3.6
security film
adhesive backed polymeric film designed so that, when applied to a glass substrate, the final product can be classified in accordance with one or more of the following: EN 356, EN 1063, EN 13541 and ISO 16933

Note 1 to entry: Adhesive backed polymeric film designed as a security film may also be a safety film. In this case, the term adhesive backed polymeric safety / security film may be used.

3.7
decorative film
adhesive backed polymeric film designed to alter the appearance of a glass substrate

3.8
anti-graffiti film
a sacrificial adhesive backed polymeric film designed so that, when applied to a glass substrate, scratching, etching, painting, writing or similar defacing actions of glass surfaces Is reduced

3.9
ultra violet reducing films
adhesive backed polymeric film designed so that, when applied to a glass substrate, the Ultra Violet transmittance determined in accordance with EN 410 is ≤ 0,0010

3.10
lower emissivity film
adhesive backed polymeric film designed so that, when applied to a glass substrate, the normal emissivity, εn, of a glass surface is ≤ 0,39, when determined in accordance with EN 12898

Note 1 to entry: Adhesive backed polymeric films are available with normal emissivity similar to that of modern low E glass coatings, e.g. ε_n = 0,04.

3.11
privacy film
adhesive backed polymeric film designed so that, when applied to a glass substrate, vision through the glass is reduced

3.12
radio frequency interrupter (RFI) / electro-magnetic frequency (EMF) shielding film
adhesive backed polymeric film designed so that, when applied to a glass substrate, frequencies transmitted through a glass substrate over the 30 MHz to 15 GHz frequency range are attenuated by ≥ 20 dB, when tested in accordance with EN 50147-1

3.13
release liner
a disposable film designed to protect the adhesive coating prior to installation

Note 1 to entry: Typical release liners are either polyester film or polypropylene film, with a silicone coated surface; the silicone surface faces the adhesive surface of the adhesive backed polymeric film.

3.14
splice
a transverse join in an adhesive backed polymeric film roll, i.e. across the width of the roll

3.15
scratch / abrasion resistant surface
a protective coating applied to one external surface of the adhesive backed polymeric film designed to resist scratching and abrasion

Note 1 to entry: The terms scratch resistant and abrasion resistant are used interchangeably and have identical meaning.

3.16
glare reduction
reduction in visible light transmittance after application of the adhesive backed polymeric film to a glass substrate, expressed in %

3.17
clear adhesive backed polymeric film
adhesive backed polymeric film with a visible light transmittance of ≥ 0,80, when determined in accordance with EN 410

3.18
tinted adhesive backed polymeric film
adhesive backed polymeric film modified by the presence of coating(s), fillers, dyes and / or pigments within the structure of the adhesive backed polymeric film with a visible light transmittance of < 0,80 when determined in accordance with EN 410

3.19
metallised adhesive backed polymeric film
adhesive backed polymeric film modified by coating the surface of one or more of the constituent polymeric film layers with metal, alloy, metal oxide, ceramic or other materials capable of being coated onto polymeric film

Note 1 to entry: Each coating may be a single layer of a homogenous material or multiple layers of different materials.

Note 2 to entry: Coatings may be deposited onto polymeric film surfaces by vacuum metallisation, cathodic magnetron sputtering, electron beam and similar techniques.

3.20
tinted / metallised adhesive backed polymeric film
adhesive backed polymeric film modified by the presence of fillers, dye(s) and/or pigments in at least one polymeric film layer and having one or more coating(s) of metals, alloys or metal oxides added to the surface of at least one polymeric film layer

Note 1 to entry: This is composite film containing components of 3.18 and 3.19.

3.21
translucent adhesive backed polymeric film
adhesive backed polymeric film modified by fillers, printing and/or surface roughness to prevent direct vision through the film

Note 1 to entry: The translucence may be in patterns such as stripes, squares, dots or other patterns and effects.

4 Types of adhesive backed polymeric films

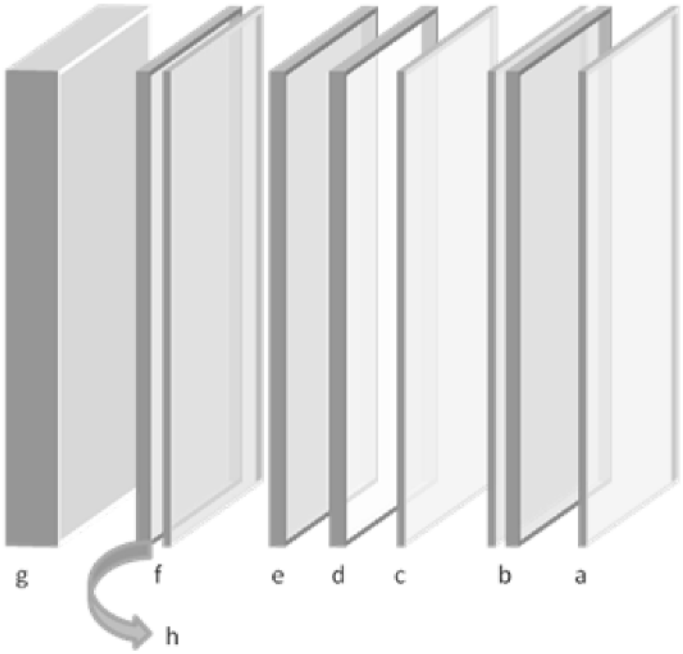
Adhesive backed polymeric films are made from one or more polymeric film layers.

The adhesive on the external surface of adhesive backed polymeric films is either a dry polyester adhesive, which is water activated, or a cross-linked acrylic pressure sensitive adhesive. There are instances where a water-based installation solution is required to facilitate the adhesion to a glass substrate. The adhesive system can be specifically designed for a performance characteristic.

A release liner or a water soluble non-sticky coating or both may be used to protect the adhesive layer. These shall be removed prior to film installation.

A typical construction of an adhesive backed polymeric film is shown in Figure 1. Other adhesive backed polymeric film constructions may be simpler or more complex than this example.

Adhesive backed polymeric film manufacturers shall provide installation recommendations.



Key

a scratch or abrasion resistant coating

b polyester film with coated layer(s)

c laminating adhesive

d polyester film with UV protection dyed into the mass of the polymeric film

e adhesive with UV protection

f protective release liner with silicone coating

g glass

h layer f is removed prior to installation

Colour may be added to layers c, d and/or layer e. UV absorbers may be added to layer d and/ or layer e. A second layer may be added, with a laminating adhesive, either for darker tints, or for safety/security performance, or for improved durability.

Figure 1- Example of a construction of an adhesive backed polymeric film (interior grade)

5 Properties of adhesive backed polymeric films

5.1 General

The properties of adhesive backed polymeric films are wide ranging. Their specific performance characteristics are given below:

5.1.1 Performance characteristics

The performance characteristics and the properties of adhesive backed polymeric film are described in relation to their class, i.e. where they can be used, and to their type, i.e. the performance of the glass that will be modified. The class of film is given in Table 1 and Figure 2 and their property modifications are given in Table 2, where surface 1 is always towards the external environment.

Table 1 - Classes of adhesive backed polymeric film

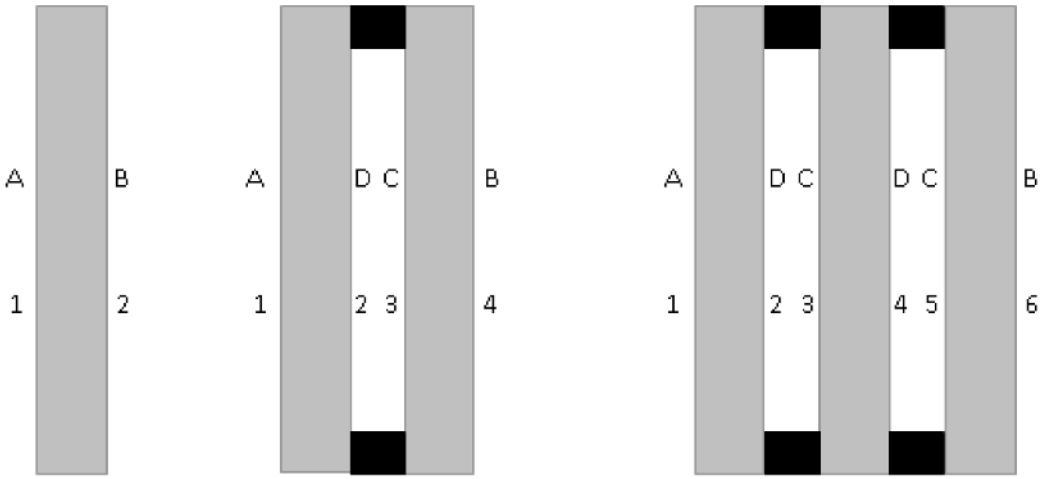
Class	Description
A	The adhesive backed polymeric film is designed to be applied to surface 1 of the glazing
B	The adhesive backed polymeric film is designed to be applied to surface 2 of single glazing, or surface 4 of double glazing, or surface 6 of triple glazing
C	The adhesive backed polymeric film is designed to be applied to surface 3 of double glazing or surface 3 and / or surface 5 of triple glazing
D	The adhesive backed polymeric film is designed to be applied to surface 2 of double glazing or surface 2 and / or surface 4 of triple glazing

NOTE 1 Class A adhesive backed polymeric film is generally described as an external film.

NOTE 2 Class B adhesive backed polymeric film is generally described as an internal film.

NOTE 3 Class C adhesive backed polymeric film is normally an external film used within the cavity of an insulating glass unit.

NOTE 4 Class D adhesive backed polymeric film is normally an internal film used within the cavity of an insulating glass unit.



Key

A – D installation position for adhesive backed polymeric film Classes A to D

1 - 6 surface number of glazing (surface 1 is to the exterior)

Figure 2 - Classes of adhesive backed polymeric filmed glass – installation position

Table 2 - Types of adhesive backed polymeric film

Film Type	Property modification
Type 1	The adhesive backed polymeric film modifies the glass to a solar control product
Type 2	The adhesive backed polymeric film modifies the glass to reduce its emissivity (U value)
Type 3	The adhesive backed polymeric film modifies the glass to a low UV transmittance product
Type 4	The adhesive backed polymeric film modifies the glass to a privacy product
Type 5	The adhesive backed polymeric film modifies the glass to a decorative product
Type 6	The adhesive backed polymeric film modifies the glass to a safety product
Type 7	The adhesive backed polymeric film modifies the glass to a security product
Type 8	The adhesive backed polymeric film modifies the glass to a radio frequency interrupter / electro-magnetic frequency shielding product
Type 9	The adhesive backed polymeric film modifies the glass surface to protect against various forms of graffiti.

EXAMPLE 1 B5 – An adhesive backed polymeric film designed to be applied on surface 2 of single glazing, surface 4 of double glazing, or surface 6 of triple glazing, generally known as an internal film, in order to modify the appearance of the glass pane to a decorative product.

EXAMPLE 2 D1248 – An adhesive backed polymeric film designed to be applied to surface 2 of double glazing or surface 2 and / or surface 4 of triple glazing in order to modify the solar control, emissivity, privacy and EMI shielding of the glazing.

5.1.2 Test specimens

The performance characteristics shall not be determined for the adhesive backed polymeric film alone, unless otherwise specified in this standard; performance characteristics shall be determined using test samples consisting of the adhesive backed polymeric film applied to clear, monolithic, uncoated float glass of nominal thickness of 4 mm. The glass shall be monolithic soda lime silicate and shall be in accordance with EN 572-1 and EN 572-2. One or more tests may be conducted on glass meeting these requirements but with a different thickness; these tests shall only be accepted if the same tests have been completed and reported in accordance with this standard for 4 mm thick glass. The adhesive backed polymeric film shall be applied to the glass substrate in accordance with the original manufacturer's recommendations.

Measurement of the properties of test specimens shall be made after the cure time has elapsed.

The adhesive backed polymeric manufacturer should supply cure time requirements.

Test specimens shall be representative of normal production material. Where the film shall be installed to a glass substrate in order to perform the test, the installation method shall be representative of the normal method used to install the adhesive backed polymeric film to the glass substrate.

5.2 Solar-optical properties

5.2.1 General

Almost all adhesive backed polymeric films can be characterized directly for solar-optical properties. Properties specific to different types of adhesive backed polymeric films are considered in 5.3 to 5.12.

The spectrophotometric properties shall be determined in accordance with EN 410 on a sample that is made up of adhesive backed polymeric film applied to clear monolithic float glass of 4 mm thickness, in accordance with the requirements in 5.1.2. If repeat measurements are required in order to obtain average values, measurements shall be made on separate samples prepared and constructed in identical manner.

The following spectral distributions have to be considered in accordance with EN 410 and EN 12898:

a) the spectral distribution for photopic vision,

b) the spectral distribution of the solar radiation,

c) the emission spectrum of the black body at 283 K

Adhesive backed polymeric filmed glass is defined in accordance with its two reflections (generally adhesive backed polymeric filmed side and non-adhesive backed polymeric filmed side) and transmittance properties in each spectral range (ultraviolet, visible, solar and thermal range, where thermal refers to emissivity over long wave infrared radiation in accordance with EN 12898).

Determination and reporting of solar-optical characteristics shall be in accordance with EN 410, which defines the principal characteristics of glazing as the visible light transmittance, τ_V, and the total solar energy transmittance (solar factor), *g*. The characteristics of glazing that may be determined in accordance with EN 410 for adhesive backed polymeric film on glass are:

- the solar direct transmittance, τ_e
- the solar direct reflectance, ρ_e
- the solar direct absorptance, a_e
- the visible light transmittance, τ_V
- the exterior visible light reflectance, $\rho_{V,e}$
- the interior visible light reflectance, $\rho_{V,i}$
- the total solar energy transmittance, *g*
- the total shading coefficient, SC
- the UV transmittance, τ_{UV}
- the general colour rendering index, R_a

The visible light characteristics are for illuminant D_{65}.

The short wave shading coefficient and long wave shading coefficient may be determined from the calculated EN 410 data.

EN 410 requires values to be given as decimals to two places; the UV transmittance shall be given to four decimal places for UV reducing film in order to distinguish between these products and other non-specialist films. If desired, the solar-optical characteristics may also be given as percentages, except for the general colour rendering index and shading coefficient; percentage values shall not be used in isolation from the decimal values.

NOTE 1 The total solar energy transmittance, *g*, is known in some regions as the Solar Factor and reported as a percentage.

Optional characteristics derived from EN 410 data may be determined as described in 5.2.2 to 5.2.4. These derived characteristics shall not be used in isolation and EN 410 values shall take precedence.

NOTE 2 The contribution of the rear side of the pane of adhesive backed polymeric filmed glass is included.

NOTE 3 Properties of the adhesive backed polymeric film alone can be determined by calculation in accordance with EN 410 using appropriate software. Hence the performance of the filmed glass can be calculated by combining the properties of the adhesive backed polymeric film with those of the glass substrate.

NOTE 4 Nominal values are given for the adhesive backed polymeric filmed glass. Due to the inherent variations in the manufacturing processes the measured values may vary from the nominal values.

5.2.2 Glare reduction

Glare reduction is the % reduction in visible light transmittance of glazing, given by:

$$\text{Glare Reduction} = \frac{\tau_{Vg} - \tau_{Vf}}{\tau_{Vg}} \times 100$$

where

τ_{Vg} = visible light transmittance through 4 mm clear glass, i.e. 0,89

τ_{Vf} = visible light transmittance through 4 mm clear glass with adhesive backed polymeric film

Visible light transmittances, τ_v, shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.1.

5.2.3 Total Solar Energy Rejected

Total Solar Energy Rejection (TSER) is the amount of solar energy that is rejected by the glazing to the outside environment; it is calculated from:

TSER = (1-g) × 100 %

where g is the total solar energy transmittance determined in accordance with EN 410 and in accordance with the requirements in 5.2.1.

5.2.4 UV Rejection

UV rejection (UVR) is the percentage of UV radiation that is not transmitted by the glazing and is calculated from:

UVR % = 100 × (1 – τ_{UV})

where τ_{UV} is the Ultra-Violet radiation transmittance determined in accordance with EN 410 and in accordance with the requirements in 5.2.1.

5.3 Solar control film

5.3.1 General

The purpose of adhesive backed polymeric solar control film applied to glass is reduction of the g value of the glass substrate to which it has been applied.

5.3.2 Measurement

Determination of the g value and other solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

5.4 Clear film

Adhesive backed polymeric film is designated as clear such that, when applied to 4 mm clear float glass and measured in accordance with EN 410 and the requirements in 5.2, and rounded to the nearest 0,01, it has a visible light transmittance greater than or equal to the values in Table 3. Clear adhesive backed polymeric film may be classified in accordance with one or more of types 1, 2, 3, 6, 7, 8 and 9, depending upon its performance characteristics.

Table 3 - Visible light transmittance of clear adhesive backed polymeric film

Adhesive backed polymeric film thickness	Visible Light Transmittance, τ_V
≤ 200 microns	≥ 0,85
> 200 microns and ≤ 350 microns	≥ 0,82
> 350 microns	≥ 0,80

Determination of the visible light transmittance and other solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

Adhesive backed polymeric film may be modified by the presence of coating(s), fillers, dyes and pigments but shall still be called clear adhesive backed polymeric film if the visible light transmittance meets the requirements in Table 3, for example, if dyes added to the film absorb only in the infrared.

5.5 Safety film

5.5.1 General

The purpose of adhesive backed polymeric safety film on glass is the modification of the breakage characteristics of the glass pane to which it has been applied.

NOTE The performance characteristics of an adhesive backed polymeric safety film cannot be determined for the film alone.

5.5.2 Measurement

EN 12600 defines three characteristics for classification of flat glass when impacted of α (β) ϕ, where α is the highest classification for impact resistance, β is the mode of breakage, and ϕ is the highest classification for containment.

The adhesive backed polymeric film, applied to float glass of nominal 4 mm thickness as described in 5.1.2, shall be tested and classified in accordance with EN 12600 with the minimum performance of 3(B)3, i.e.:

— Class 3 for impact resistance

— Type B mode of breakage

— Class 3 for containment

Solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

For specific applications classification to EN 12600 may be undertaken on additional glass types and thicknesses.

NOTE 1 Adhesive backed polymeric safety film on float glass will normally have a mode of breakage typical of laminated glass and achieve the same classification for both impact resistance and containment.

NOTE 2 The performance characteristics of an adhesive backed polymeric security film cannot be determined for the film alone.

5.6 Security film

5.6.1 General

The purpose of adhesive backed polymeric security film on glass is the modification of the breakage characteristics of the glass pane to which it has been applied.

NOTE The performance characteristics of an adhesive backed polymeric security film cannot be determined for the film alone.

5.6.2 Measurement

The adhesive backed polymeric film, applied to float glass of nominal 4 mm thickness as described in 5.1.2, shall be tested and classified to a minimum of Class P1A in accordance with EN 356.

Adhesive backed polymeric security film can also provide resistance to explosive pressure and ballistic attack; such characteristics are dependent upon the chosen glass substrate and therefore classification for these characteristics is covered by the adhesive backed polymeric filmed glass standard EN 15755-1.

Testing adhesive backed polymeric security film for performance against explosive pressure can use a hazard ranking test standard such as ISO 16933 or equivalent; adhesive backed polymeric security film tested to ISO 16933 shall be classified to a minimum of Class EXV45(E).

Solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

NOTE Adhesive backed polymeric security film used for explosion protection is often used as a retrofit installation leaving a small gap between the edge of the film and the sight lines of the glazing. Classification for resistance to explosion pressure in this type of application may require the use of a suitable edge retention system. There are several different types of edge retention systems; common systems include the use of a suitable structural silicone added around the perimeter of the film and the frame in a triangular cross section.

For specific applications classification may be undertaken on additional glass types and thicknesses.

5.7 Decorative film

5.7.1 General

The purpose of an adhesive backed polymeric decorative film is to alter the appearance of a glass pane.

5.7.2 Measurement

Some decorative films are patterned, where the components of the pattern have different solar-optical properties. If the pattern is regular, and has clearly defined areas where the solar-optical properties of each component can be determined separately, it is possible to obtain the mean solar-optical properties for the whole film by using the following process:

a) Determine the solar-optical properties of each component of the pattern

b) Determine the area of each component of the pattern in a unit area of the whole film by direct measurement or from specification drawings

c) Calculate the mean solar-optical properties for the whole film on an area-weighted basis using the properties specific to each component of the pattern

Solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2. EN 410:2011, Annex C provides more information.

5.8 Anti-graffiti film

The purpose of an adhesive backed polymeric anti-graffiti film is to protect the surface of a glass pane against scratching, etching, painting, writing or similar defacing actions, whether accidental or deliberate.

Solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

NOTE There are several national tests relevant to anti-graffiti characterization for resistance to scratching, inks, acid and alkali.

5.9 Ultra Violet reducing film

5.9.1 General

The purpose of an adhesive backed polymeric Ultra Violet reducing film is to reduce the transmittance of Ultra Violet light to ≤ 0,001.

5.9.2 Measurement

The Ultra Violet transmittance of adhesive backed polymeric film, applied to clear glass of nominal 4 mm thickness, shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2. EN 410 normally requires values to two decimal places, but in order to distinguish UV reducing films the value shall be given to four decimal places. Characterization of UV transmittance for ranges different from the full UV wavelength range in accordance with EN 410 shall not be used.

Other solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

5.10 Lower emissivity film

5.10.1 General

The purpose of an adhesive backed polymeric lower emissivity film is to reduce the thermal transmittance (U value) of the glass pane.

A lower emissivity adhesive backed polymeric film has normal emissivity $\varepsilon_n \leq 0{,}39$ when determined in accordance with EN 12898 and the requirements in 5.1.2.

NOTE Emissivity could be measured for the film alone or when applied to glass.

5.10.2 Measurement

The emissivity of an adhesive backed polymeric film shall be determined in accordance with EN 12898. The U value shall be calculated in accordance with EN 673.

Solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

NOTE EN 673 allows U value calculation of different glazing systems once the emissivities of the glass and film surfaces are known, hence only a single measurement of the emissivity of the adhesive backed polymeric film may be needed to determine U values of many different glazing systems.

5.11 Privacy film

The purpose of an adhesive backed polymeric privacy film is to reduce vision through the glass pane.

Privacy performance may be provided by one or more of the following characteristics:

- Reducing the visible light transmittance, τ_V, of the glass
- Increasing the visible light reflectance, $\rho_{V,e}$, of the glass to the observed (public) side
- Modifying the glass from transparent to opaque by using an optically diffusing adhesive backed polymeric privacy film

Solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

Privacy films may also have decorative properties.

5.12 Radio Frequency / Electro-Magnetic Frequency shield attenuating film

5.12.1 General

The purpose of an adhesive backed polymeric RFI/EMF shield attenuating film is to attenuate transmittance of electro-magnetic frequencies over the range of 30 MHz to 15 GHz by ≥ 20 dB.

5.12.2 Measurement

Performance of an adhesive backed polymeric shield attenuating film, applied to clear float glass of nominal 4 mm thickness as described in 5.1.2, shall be determined between 30 MHz and 15 GHz in accordance with EN 50147-1.

Solar-optical characteristics shall be determined in accordance with EN 410 and in accordance with the requirements in 5.2.

6 Dimensions and tolerances

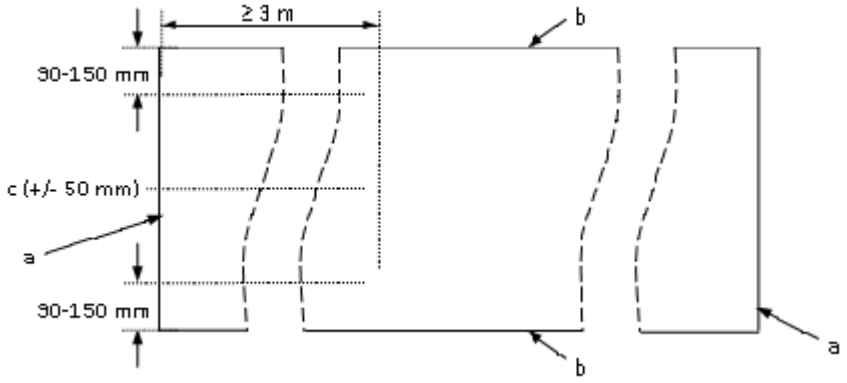
6.1 Nominal thickness and thickness tolerances

6.1.1 General

The thickness of an adhesive backed polymeric film shall be determined on the total adhesive backed polymeric film thickness, excluding release liner(s) and water soluble coating(s). Nominal thickness and tolerance shall be declared by the manufacturer of the adhesive backed polymeric film.

6.1.2 Measurement

The declared thickness shall be the average of 3 measurements taken from each edge of the roll and one from the centre as shown in Figure 3. Measurements shall be by means of an instrument of the calliper micrometre type. Care shall be taken not to compress the film during measurement.



Key

a ends of roll of film

b film edges

c centre line of film roll

x measurement points

Figure 3 - Positions for thickness measurement

The tolerance for film thickness shall be ± 5 %.

NOTE Adhesive backed polymeric film is manufactured in master rolls prior to cutting to finished roll sizes. Thickness measurements are normally done on typical master rolls and the thickness declared for each finished roll from these measurements.

6.2 Width and length (sizes)

6.2.1 General

When adhesive backed polymeric film dimensions are quoted for roll lengths; the first dimension shall be the width and the second dimension the length. The tolerance for width shall be ± 3 mm; the declared length shall be the minimum length supplied.

6.2.2 Splices

The number and position of splices shall be declared for each finished roll of film.

7 Test methods for durability

7.1 General

Durability of an adhesive backed polymeric film is generally assessed by changes in its performance properties when subjected to accelerated weathering. In addition, for those adhesive backed polymeric films that have a protective scratch or abrasion resistant coating, surface durability is assessed by the change in haze from surface abrasion.

Samples of adhesive backed polymeric film on glass substrates shall be fully cured prior to testing.

NOTE Adhesive backed polymeric films without a protective surface coating are generally used where surface scratching is unimportant, such as application to patterned glass to EN 572–5.

7.2 Accelerated weathering – test method

7.2.1 General

Accelerated weathering in accordance with EN ISO 4892-1 and EN ISO 4892-2 shall be used. The direction of transmittance of the Xenon arc radiation, either towards the glass side or the film side, depends upon the class of adhesive backed polymeric film being tested (see 5.1). Properties of the adhesive backed polymeric film are measured before and after weathering.

NOTE The Xenon arc source is understood to be a closer simulation of the solar energy spectrum reaching the earth's surface than other artificial light energy sources.

7.2.2 Preparation of test and reference specimens

The film tested shall be representative of normal production material. Film within 3 m from a roll end or within 75 mm from a roll edge shall not be used for preparation of test and reference specimens. The adhesive backed polymeric film shall be installed onto 4 mm clear uncoated float glass as described in 5.1.2.

7.2.3 Size and number of test specimens

Two sets of specimens shall be prepared, one of six specimens and the other of three specimens; the size of each specimen shall be in accordance with EN ISO 4892-1.

NOTE For adhesive strength testing of adhesive backed polymeric safety films a minimum specimen width of 35 mm is required.

The set of six specimens is used for the weathering test; the set of three specimens is kept for reference.

7.2.4 Cleaning of filmed glass specimens

The prepared and cured specimens shall be cleaned prior to test. Lightly brush any particles from the surface of the specimen using a soft bristle, anti-static brush. Clean the surface of the adhesive backed polymeric film using a mild detergent solution, as recommended by the manufacturer, wash with clean water, and allow to air dry. Using a lint free cloth and isopropyl alcohol, gently wipe both surfaces of the specimen to remove any remaining contamination. Allow the specimens to air dry for 30 min prior to test.

7.2.5 Conditioning of test and reference specimens

The cleaned test specimens shall be conditioned at (23 ± 5) °C and (80 ± 5) % Relative Humidity for 24 h prior to test. The reference specimens shall be stored in a dark weather tight container at a temperature of (23 + 5) °C, at a Relative Humidity of no more than 50 %, and without exposure to sunlight or similar sources of energy.

7.2.6 Test methodology

Dependent upon the class of adhesive backed polymeric film (see 5.1), the test specimens shall be arranged as follows:

— Test specimens of Class A adhesive backed polymeric films shall be tested with the film side facing the Xenon source.

— Test specimens of Class B adhesive backed polymeric films shall be tested with the glass side facing the Xenon source.

— Test specimens of Class C adhesive backed polymeric films shall be tested with the film side facing the Xenon source. The accelerated weathering of this class of adhesive backed polymeric also requires a

barrier of 4 mm clear monolithic glass between the film and the Xenon source as indicated in Figure 4; the two pieces of glass shall be sealed around the perimeter to give a water tight seal.

— Test specimens of Class D adhesive backed polymeric films shall be tested with the glass side facing the Xenon source. The accelerated weathering of this class of adhesive backed polymeric also requires a barrier of 4 mm clear monolithic glass to be placed on the other side of the glass with the film, opposite to the Xenon source as indicated in Figure 4; the two pieces of glass shall be sealed around the perimeter to give a water tight seal.

For testing specimens of Class C or Class D, the edge of the film shall be a suitable distance from the edge of the glass, typically 10 mm ± 2 mm, to allow the sealant to adhere correctly to the glass and provide a water resistant seal.

NOTE Table 1 section 5 gives information on these classes

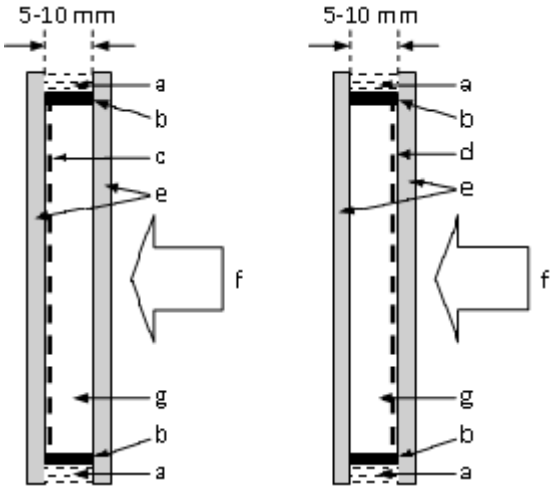


Figure 4a - Adhesive backed polymeric film Class C

Figure 4b - Adhesive backed polymeric film Class D

Key

a sealant
b spacer
c adhesive backed polymeric film Class C
d adhesive backed polymeric film Class D
e clear 4 mm monolithic glass
f xenon arc source
g space

Figure 4 - Specimen construction for accelerated weathering of adhesive backed polymeric film Class C and Class D

7.2.7 Accelerated weathering - procedure

Install the test specimens into the test equipment and perform the accelerated weathering using a Xenon arc source lamp in accordance with EN ISO 4892-2 Method A, Cycle 1.

7.2.8 Sampling points

Sampling parameters are shown in Table 4.

Table 4 - Sampling points for durability testing of adhesive backed polymeric film

Class of adhesive backed polymeric film	Test specimens	Minimum number of specimens to test
All	Before weathering, i.e. 0 h	2
	1500 h	2
	3000 h	2

Test specimens with 0 h weathering shall be tested within 4 h of removal from the conditioning conditions described in 7.2.5. Test specimens removed from the Xenon arc weathering equipment shall be tested within 4 h of removal from the weathering equipment; if the surface of a specimen is wet when removed from the weathering equipment, it shall be dried using a soft, clean cloth.

If any test specimen is removed from the test equipment, measured and replaced into the test equipment, it shall not be out of the test chamber for more than 1 h.

However, if the adhesive of a test specimen is wet, inaccurate adhesive strength values will be obtained; in this situation it is necessary to allow the adhesive to dry and regain its strength. The original manufacturer should provide information on the storage conditions required for the adhesive to dry for the particular product under test.

7.3 Accelerated weathering – changes in physical and solar-optical properties

7.3.1 General

As with many materials, the properties of the adhesive backed polymeric film are subject to change over time from the effects of solar energy, water and other environmental factors. In order to demonstrate suitable durability of an adhesive backed polymeric film, the test results from measurements of the properties of the test specimens after accelerated weathering are compared with test results from the reference specimens.

The mean of each physical and solar-optical property shall be determined for the test specimens at each sampling point.

If the adhesive backed polymeric film under test is not a lower emissivity product, measurement of emissivity may be omitted.

NOTE Adhesive backed polymeric films with high UV protection, especially those with UV protection in both the adhesive and in the polyester film, have longer durability than non UV protected films. In addition, changes in properties such as total solar energy transmittance and visible light transmission may be significantly lower for metallised adhesive backed polymeric films compared with tinted adhesive backed polymeric films.

7.3.2 Solar optical properties

The solar-optical properties shall be determined in accordance with EN 410 following the requirements in 5.2.

If third party testing is done, the test report shall contain the following minimum information:

— Date of test

— Details of the testing organization (name, address, etc.)

— Adhesive backed polymeric film type, product code, thickness

— The test standards used, i.e. EN 410 and this standard

— Film thickness in microns

— Number of specimens tested

— All test results for all test specimens

— Comments (if any)

Deviations from the requirements of this standard and deviations from EN 410 are not permitted.

7.3.3 Emissivity

The normal emissivity shall be determined in accordance with EN 12898. If the adhesive backed polymeric film under test is not a lower emissivity product, measurement of emissivity may be omitted.

The U value may be determined in accordance with EN 673 from the normal emissivity.

If third party testing is done, the test report shall contain the following minimum information:

— Date of test

— Details of the testing organization (e.g.name, address, etc.)

— Adhesive backed polymeric film type, product code, thickness

— The test standards used, i.e. EN 12898 and this standard

— Film thickness in microns

— Number of specimens tested

— All test results for all test specimens

— The U value in accordance with EN 673 may also be reported

— Comments (if any)

Deviations from the requirements of this standard and deviations from EN 12898 are not permitted.

7.3.4 Additional tests on adhesive backed polymeric safety / security films – Adhesive Strength

Adhesive strength testing of adhesive backed polymeric films designed for safety and / or security applications shall be done on fully cured test specimens. The original manufacturer shall provide information on the cure times required.

The average 180° adhesive peel strength from all test specimens shall be determined in accordance with EN ISO 8510-2 using a 25 mm wide strip and 300 mm / minute peel rate. The results shall be given as force in Newtons for the 25 mm wide strip, i.e. in N / 25 mm.

Test specimens for accelerated weathering should be greater than 25 mm in width; for each adhesive strength test, a 25 mm wide strip shall be cut along the length of the test specimen at least 5 mm from the edge of the test piece. If the test specimens are ≥ 65 mm wide, two tests per specimen should be made with a minimum of 5 mm between the two strips.

If third party testing is done, the test report shall contain the following minimum information:

— Date of test

— Details of the testing organization (e.g. name, address, etc.)

— Adhesive backed polymeric film type, product code, thickness

— Film thickness in microns

— Number of specimens tested

— All test results for all test specimens

— Comments (if any)

Deviations from the requirements of this standard and deviations from EN ISO 8510-2 are not permitted.

7.4 Scratch / abrasion resistance

7.4.1 General

The scratch / abrasion resistance of adhesive backed polymeric film is demonstrated by the change in the % haze of the adhesive backed polymeric film. Measurements are made before and after abrasion; abrasion is done using an abrader equipped with a motorised turntable, weighted abrading wheels and a vacuum system to remove abraded material. The % change in haze is known as the ΔHaze.

Adhesive backed polymeric films that do not have a scratch / abrasion resistant coating are not to be tested and shall be declared as not scratch resistant.

7.4.2 Number of test specimens

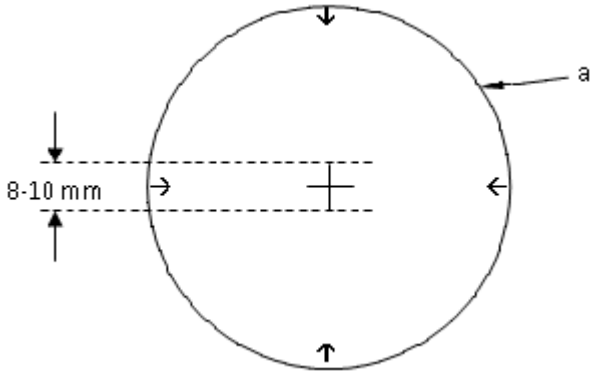
Six test specimens shall be prepared.

7.4.3 Preparation of test specimens

Test specimens shall be prepared using the adhesive backed polymeric film alone, i.e. not applied to glass, except where the presence of a water soluble coating is protecting the adhesive. Specimens shall not be taken from within 3 m from a roll end or within 75 mm from a roll edge. Each test specimen shall be a circle of 100 mm ± 2 mm diameter. Slight adjustment of this size may be necessary in order to fit onto the turntable of the abrader apparatus. However, the test specimen shall be at least 15 mm larger in diameter than the abraded circle. Specimens shall be taken of scratch-free, undamaged adhesive backed polymeric film that is representative of normal production material.

Most adhesive backed polymeric films have a release liner that protects the adhesive from damage prior to use. Some adhesive backed polymeric films have a water soluble non-sticky coating on the adhesive that protects the adhesive in a similar way; a few adhesive backed polymeric films may have both a water soluble non-sticky coating and a release liner. Sometimes the release liner and / or water soluble coating may have high haze; in this case it may be necessary to install the adhesive backed polymeric film to glass in order to perform the test. The glass shall be 4 mm glass in accordance with EN 572-1 and EN 572-2. The substrate used for holding the adhesive backed polymeric film can have a significant effect on the test results; test results of adhesive backed polymeric film alone and adhesive backed polymeric film on glass are not comparable.

A small cut in the form of a + shall be made in the exact centre of each test specimen to allow easy fixing to the abrader turntable, and small marks to indicate the measurement points shall be added, as shown in Figure 5.



Key

a adhesive backed polymeric film specimen

\+ centre cut

→ marks to identify measuring points

Figure 5 – Central cross-shaped cut in test specimen, and selection of measurement points

7.4.4 Conditioning of test specimens

Condition the test specimens at (23 ± 2) °C and (50 ± 5) % Relative Humidity for 48 h prior to test.

7.4.5 Cleaning of test specimens

Lightly brush any particles from the surface of the specimen using a soft bristle, anti-static brush. Using a lint free cloth and isopropyl alcohol, gently wipe both surfaces of the specimen to remove any remaining contamination. Allow the specimens to air dry for 30 min prior to test.

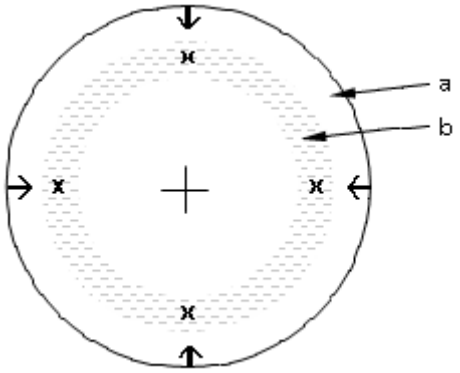
Each specimen shall be examined immediately prior to test for any contamination and/or damage that may cause invalid results, such as finger marks, cuts, serrations or tearing around the circumference of the specimen. If contamination is present, then the test specimen shall be re-cleaned; if two cleaning operations are insufficient a new specimen shall be obtained.

The brush and cloth shall not contain material that can be transferred to the specimen either by the isopropyl alcohol or by the cleaning operation.

7.4.6 Pre-abrasion haze measurement

Measurement of % haze, *H*, is given in Annex A. The % haze shall be measured with no sample present to verify that the reading of the hazemetre is 0. The sample holder shall be removed during this measurement. Three test samples shall be used for the initial haze measurements. The unabraded test specimen shall be placed in the hazemetre sample holder with the side to be abraded facing the entrance port of the integrating sphere and away from the light source.

Each test specimen shall be measured at the mid-point of the abraded area in four separate locations as shown in Figure 6, as close to centre of the area to be abraded as possible.



Key

a adhesive backed polymeric film specimen

b area to be abraded

x locations for haze measurements

→ marks to indicate measurement points

Figure 6 – Locations of haze measurements

If any % haze measurement is > 2 standard deviations away from the mean H_1, the results for the test specimen containing the % haze value shall be discarded and a further test specimen shall be tested in its place. If the range of % haze results is such that repeated discards are required, then:

— no more than six test specimens shall be tested

— if more than three test specimens have to be used in order to identify three suitable specimens for testing, the data for the test specimens with % haze values furthest from the mean shall be discarded in accordance with the procedure below, to give three remaining specimens for testing

— the remaining three test specimens and their corresponding % haze values (denoted as H_1, H_2, H_3 … H_{12}) shall be used for the remainder of the test

The procedure to discard unsuitable test specimens is applied to individual specimens, not to groups of specimens. If more than three test specimens are used, discard the test specimens with the largest cumulative difference, H_D, from the mean, leaving three specimens for testing. The cumulative difference, H_D, is given by:

$$H_D = \sum_{1}^{i} \left| \left(H_M - H_i \right) \right|$$

where:

H_D is the cumulative difference;

H_M is the mean of the % haze measurements from all the samples tested;

H_i is the value for one of the four % haze measurements on the sample;

i represents one of the four haze measurements on the test specimen, i = 1 to 4;

the summation uses the absolute values of the differences between H_M and H_i, encompassing the four haze measurements on the test sample.

Twelve measurements are obtained (four per specimen, for three specimens), which can be denoted H_1, H_2, H_3 … H_{12}. The mean % haze, H_U, for the unabraded adhesive backed polymeric film shall be obtained from the 12 measurements to the nearest 0,1 %.

7.4.7 Abrasion test method

The general experimental requirements for abrasion of test specimens are given in Annex A.

Each test specimen shall be abraded using the following conditions:

Abrasive wheels: CS-T3 / CS10F	Weight per wheel: 500 g	Abrasive cycles: 100
Vacuum: Full	Temperature: (23 ± 2) °C	Relative Humidity: (50 ± 5) %

Place the test specimen on the abrader turntable with the surface to be abraded facing up, and secure in place. To allow full vacuum to be used, it is usually necessary to adhere the perimeter of the test specimen to the turntable using adhesive tape. The material used to adhere the test specimen to the turntable shall not encroach on the abraded area or otherwise affect the test results. Adjust the vacuum nozzle to (1,2 ± 0,4) mm of the specimen surface, set the vacuum to full, set the cycle counter to 0, programme 100 cycles into the abrader, and start the test.

Changes in the abrasive characteristics of the abrading wheels are possible during testing depending upon the nature of the wheel and the test specimen. In particular, the abrading wheel may become clogged with particles abraded from the test specimen, reducing the abrasiveness of the wheel, or contaminated with chemicals given off by the material under test.

If the abrasive wheels become clogged with particles abraded from the test specimen, stop the test and brush each wheel using a soft bristle anti-static brush. Restart the test and complete the 100 cycles of abrasion.

Although unlikely with adhesive backed polymeric films of the types described in 5.1, if the abrasive wheels become contaminated with abraded material other than particles, clean the wheels in accordance with the manufacturer's recommendations; cleaning may be required every 10 - 20 cycles. Restart the test and complete the 100 cycles of abrasion.

The surface temperature of the abrasive wheel shall be stabilized prior to test by refacing the wheels for 100 cycles using an ST-11 refacing stone as described in A.3.6. Three test specimens may then be tested; if further test specimens are required, the wheels shall be stabilized for temperature by repeating the refacing procedure.

If a dual table abrader is used and the second turntable is not to be used, install a sample of the adhesive backed polymeric film to that turntable and test as for the test specimen, discarding any results obtained.

Always handle test samples by their edges to prevent contamination of the film surfaces.

7.4.8 Post-abrasion haze measurement

The % haze of the abraded test specimen shall be obtained using the same process as that in 7.4.6 and shown in Figure 6, but without discarding test samples and without discarding test results. The abraded test specimen shall be placed in the hazemetre with the abraded surface facing the entrance port of the integrating sphere and away from the light source; no part of the light beam shall be within 1 mm of the edges of the abraded track.

The mean % haze, H_A, for the abraded adhesive backed polymeric film shall be obtained from the 12 measurements (four per specimen for three test specimens) to the nearest 0,1 %.

7.4.9 Calculation of ΔHaze

The ΔHaze shall be quoted as a percentage. The ΔHaze equals the difference in the % haze values H_U and H_A obtained from 7.4.6 and 7.4.8 and is given by:

$$\Delta\text{Haze} = H_A - H_U\%$$

7.4.10 Test report

If third party testing is done, the test report shall contain the following minimum information:

— Date of test

— Details of the testing organization (name, address, etc.)

— Adhesive backed polymeric film type, product code, thickness

— Film thickness in microns

— Number of specimens tested

— Type of abrading wheels used (e.g. CS-T3)

— Load on each wheel and the number of cycles used

— Rotational speed of abrader turntable

— Change in % haze, ΔHaze, as calculated in 7.4.9 to the nearest 0,1 %

— Wheel cleaning interval(s)

— Temperature stabilization details

— Either a description of the integrating sphere photometer including: sphere geometry; exit light beam diameter with and without the diaphragm inserted; and location of the diaphragm in the light beam, or the make and model of the hazemetre used

— Standard illuminant used (A.3.5.6)

— Any deviations from the requirements of this standard and the referenced test standards, and an explanation of why the deviations were made

— Comments (if any)

If abrasion and measurement of ΔHaze values are done with the specimen adhered to a glass substrate, the use of the glass substrate shall be included in the deviations from the test method

7.5 Acceptance criteria – changes in performance after accelerated weathering

7.5.1 Solar optical properties

Determination of solar-optical characteristics shall be in accordance with EN 410 and following the requirements in 5.2. Acceptance criteria comparing the mean values of the test results at 0 h with the mean values after durability testing are:

— The visible light transmittance, τ_V, shall change by no more than 0,05

— The total solar transmittance, *g*, shall change by no more than 0,05

For adhesive backed polymeric Ultra Violet reducing film the Ultra Violet transmittance, τ_{UV}, shall increase to no more than 0,03.

7.5.2 Emissivity

Determination of normal emissivity, ε_n, shall be in accordance with EN 12898. The normal emissivity shall increase by no more than 0,05 for adhesive backed polymeric films with $\varepsilon_n \geq 0{,}20$ and by no more than 0,03 for adhesive backed polymeric films with $\varepsilon_n < 0{,}20$. If the adhesive backed polymeric film under test is not a lower emissivity film, measurement of emissivity may be omitted.

A lower emissivity adhesive backed polymeric film that increases its normal emissivity to more than 0,44 shall lose its classification as a lower emissivity adhesive backed polymeric film.

7.5.3 Adhesive strength for adhesive backed polymeric safety / security film

The mean adhesive strength shall not reduce by more than 25 % after accelerated weathering.

7.5.4 Change in ΔHaze after abrasion

The ΔHaze shall be ≤ 5 % for an adhesive backed polymeric film to be declared scratch resistant. Non-scratch resistant coated films, which are not tested for abrasion resistance, shall be declared as “not scratch or abrasion resistant”.

NOTE Higher performing scratch / abrasion resistant coatings on adhesive backed polymeric film have lower ΔHaze values.

Annex A
(normative)

Abrasion testing of adhesive backed polymeric film with measurement of haze

A.1 Introduction

Haze measurements are affected by test conditions and can vary between laboratories, samples and test operatives. Values of haze measurements obtained before and after abrasion and ΔHaze provide a comparative basis for the abrasion resistance of different adhesive backed polymeric films but cannot be used as absolute values.

A.2 Definitions and Descriptions

A.2.1 Haze

The percentage of transmitted light deviating due to forward scattering of the incident light beam by > 0,044 radians (approximately 2,5°).

A.2.2 ΔHaze

The change in haze obtained from haze values measured before and after abrasion.

A.3 Test Equipment

A.3.1 Abrader

The abrader consists of a horizontal turntable rotating at (60 ± 2) revolutions / minute, a pair of pivoted arms which provide fixing points for the abrasive wheels and weights, a vacuum system to remove abraded material from the sample surface during test, and a counter to record the number of revolutions made by the turntable during the test. The turntable consists of a rubber pad, a clamp pate and a means of securely fixing the test specimen to the turntable. The vacuum system includes an adjustable height nozzle of 11 mm internal diameter.

The abrader shall be calibrated in accordance with the manufacturer's recommendations (see A10).

NOTE The abrader has a standard nozzle internal diameter of 8 mm; a replacement nozzle of 11 mm internal diameter can be purchased or the standard nozzle drilled out to 11 mm, taking care to only drill out the nozzle opening.

A.3.2 Refacing Stone

An ST-11 refacing stone (or equivalent) is used for refacing the abrasive wheels.

A.3.3 Abrasive Wheels

Abrasive wheels shall be used of (12,7 ± 0,3) mm width and external diameter of (51,9 ± 0,5) mm when new; when the external diameter of an abrasive wheel is < 44,4 mm it shall be discarded. An abrasive wheel shall not be used after the date stamped on it.

CS-10F wheels manufactured between October 2002 and September 2004 should not be used since results inconsistent with historical values have been obtained.

A.3.4 Specimen Holder

The specimen holder shall permit positioning of the abraded specimen in the hazemetre so that the light beam is centred on the abraded track and the specimen is flush with the measurement port.

A.3.5 Hazemetre

A.3.5.1 Instrument

An integrating sphere photoelectric photometer shall be used to measure haze. The sphere may be of any diameter provided the total port areas do not exceed 4,0 % of the internal reflecting area of the sphere.

A.3.5.2 Interior surfaces

All interior surfaces (including the integrating sphere, baffles, and reflectance standard, if used), shall be of equal reflectance, matte, and highly reflecting throughout the visible spectrum.

A.3.5.3 Light trap

A light trap shall be provided that will absorb the beam completely when no specimen is present, or the instrument design shall obviate the need for a light trap.

A.3.5.4 Entrance and exit ports

The entrance and exit ports of the integrating sphere shall be centred on the same great circle of the sphere; there shall be ≥ 2,97 radians (≥170°) of arc between centres. The exit port shall subtend an angle of 0,14 radians (8°) at the centre of the entrance port. With the light trap in position, without the specimen, the axis of the incident light beam shall pass through the centres of the entrance and exit ports.

A.3.5.5 Photocells position

The position of the photocell or photocells on the sphere shall be at (1,57 ± 0,17) radians (90 ± 10)° from the entrance port; there shall no direct exposure of the photocell or photocells to the entrance port. Where a hazemeter has a pivotable modification, where the interior wall adjacent to the exit port is used as the reflectance reference, the angle of rotation of the sphere shall be (0,140 ± 0,008) radians (8,0 ± 0,5)°.

A.3.5.6 Light source and photodetector

A light source and a photodetector shall be an integral part of the hazemetre, with filtering to provide an output corresponding to the luminosity response of the 1931 CIE Standard Colourimetric Observer with CIE Standard Illuminant C or Illuminant A. The output shall be proportional to within 1 % to the incident flux over the range of flux used. The photometric stability for source and detector shall be constant throughout the test of each specimen.

A.3.5.7 Incident light beam

The incident light beam shall be unidirectional with a maximum angle of any component of the beam to the main axis of ≤ 0,05 radians (3°); no part of the beam shall be visible at either entrance or exit port. The light beam shall be centred on the abraded track and, using an aperture or diaphragm located at the centre point of the haze measuring equipment, adjusted to a diameter of (7 ± 1) mm.

The light beam, without a test specimen in position, shall have an approximately circular cross section at the exit port and shall be sharply defined, uniformly bright and shall be concentric within the exit port, having an annulus of (0,023 ± 0,002) radians (approximately (1,3 ± 0,1)° subtended at the entrance port.

A.3.5.8 Specimen position

When the specimen is placed against the entrance port of the integrating sphere, the angle between the perpendicular to the specimen and a line connecting the centres of entrance and exit ports shall not exceed 0,14 radians (8°).

A.3.5.9 Validity

The hazemetre requirements above are essential to ensure that comparisons of different test laboratories results are valid. In particular:

— The surface of an abraded track scatters light at a narrow angle, but light diffused internally by a specimen is scattered at a wide angle.

— In many hazemetres, insertion of an aperture or diaphragm (A.3.5.2) may cause the specular beam at the exit port to become smaller. The dark annulus will then be greater than (0,023 ± 0,002) radians (1,3 ± 0,1)°. A large percentage of the light scattered from the reference or test sample will not impinge on the sphere wall and haze readings become smaller.

The unobstructed-beam diameter and its centre at the exit port shall be maintained, especially if the source aperture and / or focus are changed.

NOTE The tolerance for the annulus of ± 0,002 radians (±0,1°) corresponds to an uncertainty of ± 0,6 % in a haze reading.

Haze measurements may be made using different equipment and/or methods to those contained in this standard. However, the correlation should be established between the equipment and test methods used and those given in this standard. If no or poor correlation is found then the alternative equipment and/or method should not be used.

Uniformity of light intensity may be checked by placing thin paper at the exit port and visually observing the appearance of the beam.

A.3.6 Preparation of abrading wheels

The abrading wheels shall be prepared immediately prior to each test. Place the abrading wheels onto their respective holders, fasten in place and attach the 750 g weights to the abrader (one for each wheel). Place the ST-11 refacing stone onto the abrader turntable with the fine abrading surface facing upwards and secure the stone in place. Lower the vacuum nozzle, adjust its height to (1,2 ± 0,4) mm from the surface of the stone, and set the vacuum to 100 %. Swing the wheel holders down and gently rest the abrading wheels on the surface of the stone. Reface abrader wheels as follows:

— Reface used abrader wheels for 25 cycles of the turntable.

— Reface new abrader wheels for 100 cycles of the turntable.

— If abrader wheels are not square when viewed end on, they shall first be made square using a diamond refacing tool, then refaced as for new wheels with 100 cycles of the refacing stone.

Whenever refacing for 100 revolutions, the abrader wheels shall immediately be tested on a suitable material to verify that abrading performance is within normal limits. The abrading wheels shall be used for abrading the test specimens within 2 min of preparation.

Abrader wheels can be refaced and used repeatedly until the external diameter is < 44,4 mm when they shall be discarded. If a small protrusion of material develops as an abrader wheel is being refaced (usually on the left hand edge of the wheel), carefully rub the edge of the wheel to remove this excess material but without touching the abrading surface. The refacing stone shall be replaced after 10 000 cycles.

If the abrading surface of an abrading wheel is contaminated, e.g. with finger marks, the refacing procedure shall be redone.

A.4 Haze Measurement

The test specimen shall be placed into the instrument, taking care not to damage it, and secured in place. The % haze shall be measured in accordance with the manufacturer's instructions. For each % haze value required, four separate measurements shall be taken:

Table A.1 – Measurements necessary for determination of % haze

Measurement	Specimen in position	Light trap in position	Reflectance Standard in position	Property measured
T_1	no	no	yes	Incident light
T_2	yes	no	yes	Total light transmitted by specimen
T_3	no	yes	no	Light scattered by instrument
T_4	yes	yes	no	Light scattered by instrument and specimen

Calculate % Haze from:

$$\%\text{Haze}=\left[\frac{T_4}{T_2}-\frac{T_3}{T_1}\right]\times 100$$

It is preferable to use a double beam instrument, but if using a single beam instrument, a calibrated standard should be used in order to obtain accuracy in measuring haze; the standard should be calibrated using a double beam instrument. This is because placing a test specimen in a single beam instrument changes the efficiency of the integrating sphere. Particularly note that false % Haze values are possible for clear and heavily tinted/metallised adhesive backed polymeric films if a calibrated standard is not used. With these types of adhesive backed polymeric films, the photometer should be used as a comparison instrument with a standard of known transmittance similar to that of the specimen. For greatest accuracy of luminous transmittance measurement, compare the transmittance of the specimen with that of a calibrated standard of similar luminous transmittance.

A.5 Calibration

The abrader shall be calibrated in accordance with the manufacturer's recommendations. Abrader equipment manufacturers provide kits that check wheel alignment relative to the centre of the test specimen, wheel tracking, wheel bearings, vacuum force, turntable position, turntable speed, and the additional weights. These kits are not a substitute for regular calibration; the following guidelines apply:

— The abrasive wheels shall be (12,7 ± 0,3) mm wide.

— When resting on the refacing stone or on the test specimen, the abrasive wheels shall be positioned equidistant from the centre of the turntable. The abrasive wheel internal faces shall be (52,4 ± 1,0) mm apart and the minimum distance from an imaginary line drawn through the central axes of the wheels and the centre of the turntable shall be (19,05 mm ± 0,30) mm.

— The abrasive wheel bearings shall rotate freely on their axes without vibration, sticking or similar defects.

— The vacuum shall be a minimum of 137 millibar. The collection bag used to check the vacuum shall be emptied immediately prior to testing the vacuum and shall be free from leaks and tears; if necessary, a new collection bag shall be used.

— The distance between the centre of the pivot point of the abrader arms and the top of the turntable shall be approximately 25 mm.

— The turntable shall rotate in a horizontal plane with a deviation of ≤ ± 0,05 mm at 1,6 mm from its edge.

— The turntable shall rotate at a speed of (60 ± 2) revolutions / minute.

— The weight labelled 500 g shall weigh (250 ± 1) g and the weight labelled 1000 g shall weigh (750 ± 1) g.

NOTE 1 The combined weight of the abrading wheel and its supporting assembly is nominally 250 g, so when the 250 g and 750 g weights are added a total weight of 500 g and 1000 g respectively is obtained.

NOTE 2 A series of calibrated haze standards is used during calibration purposes.

Bibliography

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