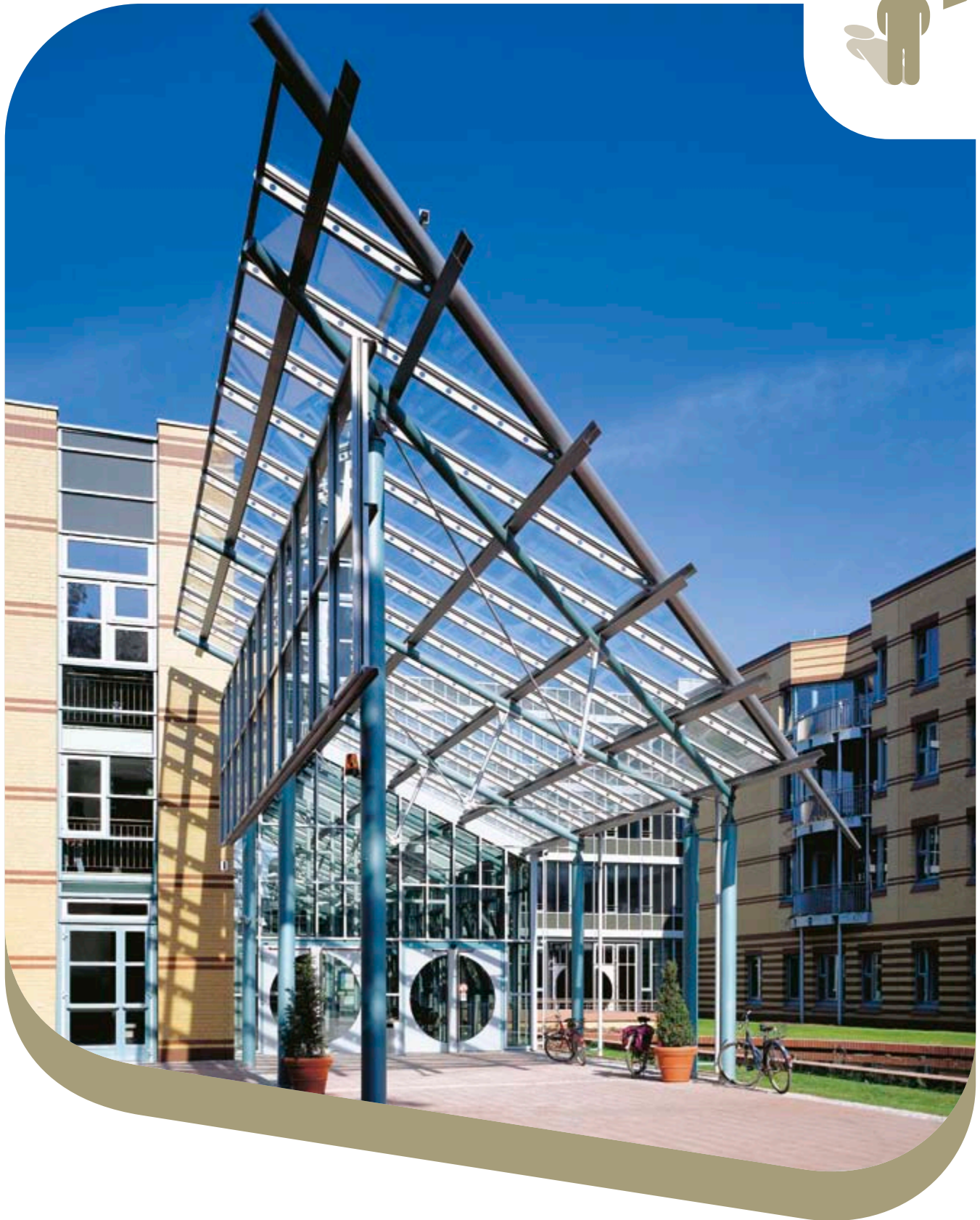




Safety/Security glass

Pilkington **Optilam**™

Pilkington Toughened Safety Glass



Pilkington **Optilam**™

The importance of Safety/Security glass

Demanding safety legislation has highlighted the critical areas where modern safety glazing must comply with the required safe practice. Innovations in the development of Safety/Security glass has opened up new avenues of design, allowing people to be protected from personal injury or in the most extreme cases protecting buildings from various forms of attack.

With this in mind, we have developed a wide range of sophisticated products, in order to meet these ever increasing demands, without compromising on the design criteria of natural light and visibility. And, we are always at the forefront in developing products and industry standards, so that personal accident and serious injuries resulting from glass impact are further prevented or minimized.



Pilkington **Optilam**™ OW T

What does "Safety" and "Security" mean?

Although Safety and Security are closely linked topics, it is important to understand the distinction between the two terms, to ensure the right glass is specified.

The term "Safety" is applied to glazing used to reduce the risk of accident by impact, fracture, shattering, or in a fire. The term "Security" is applied to glazing, which in addition to "Safety", is able to withstand a variety of deliberate attacks such as manual, ballistic or blast resistant.

Using the right type of glass for security applications is not enough to ensure the necessary resistance to severe loads. Since the glass can behave differently in different framing systems, it is imperative to combine high performance glazing with high performance framing systems to achieve the level of protection required.

Pilkington **Optilam**™ 9.5 mm



The standards

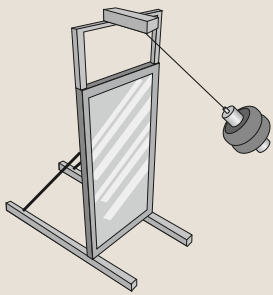
EN 12600 Glass in building - Pendulum Test - Impact test method and classification for flat glass

This is the standard for testing and classifying flat glass products by performance under impact and by mode of breakage. It is similar to the previously used swing bag test whereby a weight cushioned with two rubber tyres is allowed to swing at the glass from 3 heights.

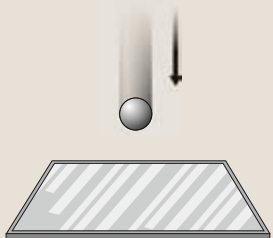
The classifications are summarised in Table 1.

Table 1.

Classification	Mode of breakage types	Drop height [mm]
3	A, B, C	190
2	A, B, C	450
1	A, B, C	1200



The Pendulum Test
50 kg impactor
(2 × pneumatic tyres)
Comprises 3 × drop height
In accordance with EN 12600



Hard Body Drop Test
4.11 kg steel sphere
(100 mm diameter)
Comprises 4 × drop heights
In accordance with EN 356

The classification has three components:

- The first is the drop height class (i.e. 1, 2 or 3) at which the product did not break or where it broke in accordance with the first two types of breakage as follows:
 - Numerous cracks appear, but no shear or opening that allows 76 mm diameter sphere to pass through when a maximum force of 25 N is applied. Additionally, if particles are detached from the test piece up to three minutes after impact, they shall, in total, weigh no more than a mass equivalent to 10,000 mm² of the original test piece.
 - Disintegration occurs and the 10 largest crack free particles are collected within three minutes and weighed, all together, weigh no more than the mass equivalent to 6,500 mm² of the original test piece.

- The second component is the mode of breakage defined as:
 - TYPE A: numerous cracks appear forming separate fragments with sharp edges, some of which are large, typical of annealed glass.
 - TYPE B: numerous cracks appear, but the fragments hold together and do not separate, typical of laminated glass.
 - TYPE C: disintegration occurs, leading to a large number of small particles that are relatively harmless, typical of toughened glass.
- The third is the highest drop height at which the product did not break or when it broke, broke in accordance with the mode of breakage #1 from paragraph 1) above. If the glass breaks at the minimum drop height and the breakage is not in accordance with the mode of breakage #1 from paragraph 1) above then the last classification figure is zero.

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

This specifies the requirements and test methods for glass designed to be resistant to manual attack. The glass is subjected to impact from a steel ball with a mass of 4.11 kg for classes P1A to P5A and an axe for classes P6B to P8B.

The classes of resistance are summarised below in Table 2.

Table 2.

Class of resistance	Drop height [mm]	The number of strikes	Code designation of resistance class
P1A	1500	3 in a triangle	EN 356 P1A
P2A	3000	3 in a triangle	EN 356 P2A
P3A	6000	3 in a triangle	EN 356 P3A
P4A	9000	3 in a triangle	EN 356 P4A
P5A	9000	3 × 3 in a triangle	EN 356 P5A
P6B	-	from 30 to 50	EN 356 P6B
P7B	-	from 51 to 70	EN 356 P7B
P8B	-	more than 70	EN 356 P8B

EN 1063 Glass in building - Security glazing - Testing and classification of resistance against bullet attack

This specifies the performance requirements and test methods for the classification of bullet resistant glass, based on attacks by handguns, rifles and shotguns.

Dependent on the classification, the test consists of 3 shots fired at the vertices of an equilateral triangle with the side length equal to the striking distance (or one shot at the centre point for class SG).

If the glass sample has not been pierced by the shots then the required class is achieved. Behind the glass sample is an aluminium witness sheet. If after the shots have been fired there are some perforations on it, then the resistance class must have the suffix S (splinters), otherwise it is classified NS (no splinters).

The classes of resistance are summarised below in Table 3.



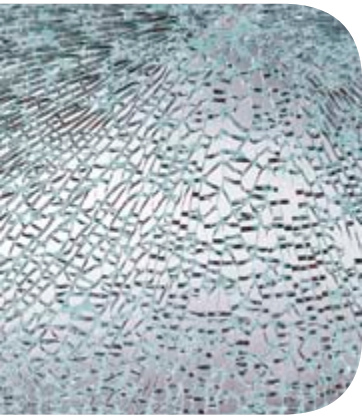
Pilkington **Optilam™** Therm

Table 3.

Class of resistance	Calibre	Bullet mass [g]	Bullet velocity [m/s]	Test range [m]
BR1-S BR1-NS	0.22 LR	2.6	360	10
BR2-S BR2-NS	9 mm Luger	8.0	400	5
BR3-S BR3-NS	0.357 Magnum	10.2	430	5
BR4-S BR4-NS	0.44 Rem. Magnum	15.6	440	5
BR5-S BR5-NS	5.56 × 45	4.0	950	10
BR6-S BR6-NS	7.62 × 51	9.5	830	10
BR7-S BR7-NS	7.62 × 51	9.8	820	10
SG1-S SG1-NS	Shotgun 12/70*	31.0	420	10
SG2-S SG2-NS	Shotgun 12/70	31.0	420	10

* One strike only.

The Complete Safety and Security Solution. Pilkington Toughened Glass



Typical fragmentation pattern
of toughened glass

What is toughened glass?

Toughened glass is manufactured by subjecting the final glass size to a heating and cooling treatment which sets up high compressive stresses at the surface, and balancing tensile stresses in the centre of the glass, which increases its strength. The result is a glass that is 4 or 5 times stronger than ordinary glass of the same thickness.

How it works

The high compressive surface stresses give the glass its increased resistance to mechanical and thermal stresses. It can, however, break under extreme loads or by severe impact. When broken, toughened glass shatters into small, blunt-edged fragments, reducing the risk of personal injury.

Heat strengthened glass is produced by a similar process to toughened glass, however, the strength developed is about half that of toughened glass. It does not meet the safe break criteria for safety glass because its breakage pattern resembles that of annealed glass. It is used to provide glass that is resistant to thermal stress and for laminating where greater glass strength is required.

Most Pilkington glass is available in toughened form.

Pilkington **Optifloat™** Clear T



Applications

Pilkington Toughened Safety Glass provides an economical and proven solution where national standards or Codes of Practice specifically require the use of safety glazing material. Examples include passageways, areas of high pedestrian traffic, in doors and adjacent panels, shower and bath enclosures, balconies and barriers amongst others.

Pilkington Toughened Safety Glass product features:

- up to 5 times stronger than ordinary glass of the same thickness; offering a proven solution to safety and strength concerns;
- can be heat soaked for extra confidence in use;
- reduces the risk of thermal stress breakage of glass exposed to solar radiation;
- conforms to all EN 12150-1 requirements and is CE marked in accordance with EN 12150-2;
- achieves Class 1 to EN 12600 with a mode of breakage type C;
- thicker glass achieves the highest classification of 1 (C) 1 to EN 12600.



Pilkington **Optifloat™** Clear T

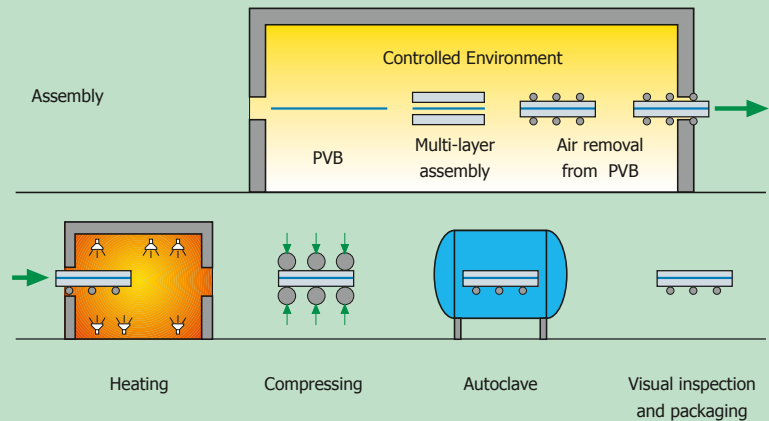


Pilkington **Optifloat™** Clear T

Introducing Pilkington **Optilam**™ laminated glass

What is laminated glass?

Laminated glass is produced by combining two or more sheets of float glass with one or more interlayers. The most popular interlayer used is a polyvinylbutyral (PVB) interlayer, which is processed with heat and pressure under factory conditions.



How it works

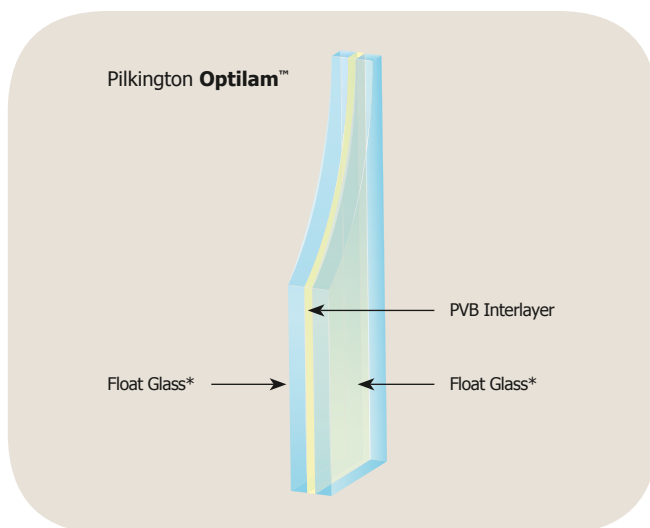
The interlayers ensure the integrity of the glass, by holding the broken pieces in place should any damage occur. In fact, glass fragments adhere strongly to the interlayer, while the resistant cushioning effect dissipates the energy. Our laminated glass is called Pilkington **Optilam**™. Its performance can be influenced simply by changing the number and thickness of each layer of glass and PVB interlayer. By doing this, we can offer a wide range of products suitable for many applications.

For additional noise control performance, the product is further enhanced by using specially developed acoustic interlayers (i.e. Pilkington **Optiphon**™).

If you would like more detailed information on Pilkington **Optiphon**™, please ask for our separate brochure.

Pilkington **Optilam**™ safety glass product features:

- class 2(B)2 performance to EN 12600 achieved through Pilkington **Optilam**™ 6.4 mm, which is the most widely used thickness for protecting people against risk of accidental injury;
- up to Class 1 (B) 1 can be achieved (dependent upon thickness and type);
- can be used in many applications including glazed building entrances, internal doors, overhead and roof glazing, swimming pools and windows in critical risk locations;
- available in a wide range of thicknesses;
- available incorporating Pilkington **Optifloat**™ Tint and Pilkington **Suncool**™ range of glass, or a tinted PVB interlayer (Pilkington **Optilam**™ I) to provide both safety and solar control properties;
- available in combination with Pilkington **K Glass**™ or Pilkington **Optitherm**™ to enhance thermal insulation whilst providing safety, or with Pilkington **Activ**™ to provide additional self-cleaning properties.



* NB: Clear float, tinted or low-iron glass may be used.

The above diagram illustrates the multiple layer system in its simplest form of 2 × glass sheets and 1 × PVB interlayer.



Pilkington **Optilam**™

Applications

In addition to safety, security and noise control, Pilkington **Optilam**™ may also be used to provide supplementary benefits such as solar control, thermal insulation, self cleaning and decoration.

Pilkington **Optilam**™ security glass product features (in addition to safety):

- meets EN 356 in addition to safety glass requirements (EN 12600);
- retains its overall integrity and continues to act as a barrier even if the glass breaks;
- protects from vandalism and burglary;
- protects against break-ins by preventing or slowing down burglary attempts;
- able to withstand repeated blows from heavy objects such as bricks, hammers or crowbars;
- can be used in typical applications which display valuable goods, such as banks, building societies, museums, as well as safety glazing in hospitals and prisons;
- provides higher levels of UV protection than monolithic glass types.

Pilkington **Optilam**™ product features, suitable for bullet resistance (in addition to safety and security):

- conforms to EN 1063 or to national specifications;
- protects and gives peace of mind from armed aggressors;
- penetration resistant from bullets fired from handguns, shotguns, modern high performance firearms and high velocity military rifles;
- available in 11.5 mm to 73 mm thicknesses to suit different levels of threat;
- may be used in applications in high risk buildings such as banks, post offices, building societies, embassies, cash offices, military establishments and VIP residences.



Protection against ultraviolet radiation

Pilkington **Optilam**™ absorbs UV radiation (UVB and UVA) which can affect the colour of objects exposed to it. The very low UV transmittance of Pilkington **Optilam**™ helps to protect materials prone to fading when subjected to prolonged exposure to UV radiation*.

* Fading of materials may also be influenced by factors other than exposure to UV radiation.

Solar control laminated glass

Pilkington **Optilam**™ can be manufactured with different types of interlayers or it can be combined with solar control glass to provide medium, good or high solar control and is aesthetically pleasing.

Product range:

Pilkington **Suncool Optilam**™

Pilkington **Eclipse Advantage Optilam**™

Pilkington **Optilam**™ Tint – manufactured with body tinted glass

Pilkington **Optilam**™ I – manufactured with a tinted interlayer



Thermal insulation laminated glass

To ensure thermal comfort Pilkington **Optilam**™ can be supplied incorporating low-emissivity glass such as Pilkington **K Glass**™ or Pilkington **Optitherm**™ range of products.

Product range:

Pilkington **Optilam K Glass**™

Pilkington **Optilam**™ Therm

Self-cleaning laminated glass

Pilkington **Activ**™ self-cleaning glass is available in a range of laminated products:

Pilkington **Activ Optilam**™

Pilkington **Activ Suncool Optilam**™

Pilkington **Activ Optilam**™ Therm

Decorative laminated glass

Decorative laminated glass provides designers with considerable artistic freedom to allow their designs to be fully realised.

Product range:

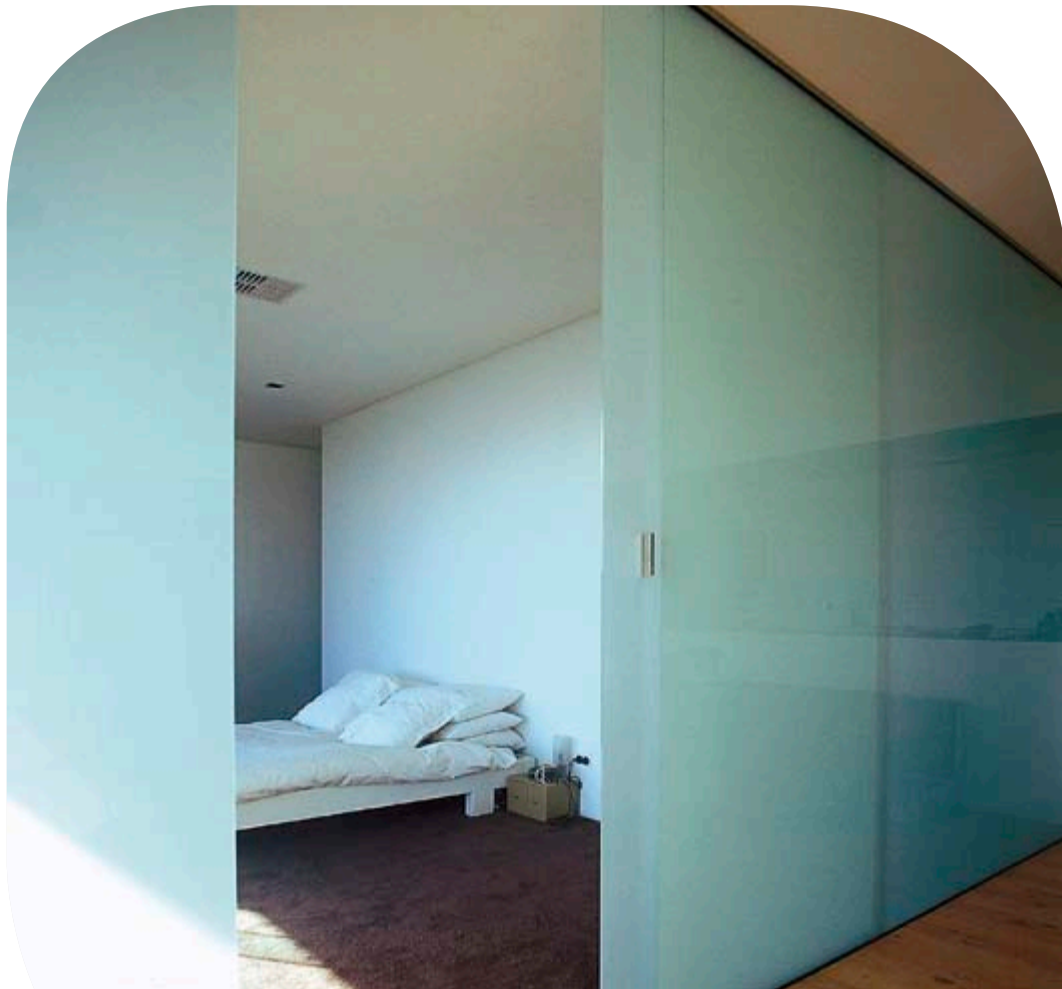
Pilkington **Optilam**™ made of textured glass

Pilkington **Optilam**™ OW manufactured with Pilkington **Optiwhite**™

Pilkington **Optilam**™ I made with a coloured or white translucent interlayer



Pilkington **Optilam**™



Pilkington **Optilam**™ I
Translucent White

This publication provides only a general description of the products. Further, more detailed, information may be obtained from your local supplier of Pilkington products. It is the responsibility of the user to ensure that the use of these products is appropriate for any particular application and that such use complies with all relevant legislation, standards, codes of practice and other requirements. To the fullest extent permitted by applicable laws, Nippon Sheet Glass Co. Ltd. and its subsidiary companies disclaim all liability for any error in or omission from this publication and for all consequences of relying on it. Pilkington, "Optilam", "Optifloat", "Optiphon", "Suncool", "K Glass", "Activ", "Eclipse Advantage", "Optitherm" and "Optiwhite" are trademarks owned by Nippon Sheet Glass Co. Ltd, or a subsidiary thereof.



CE marking confirms that a product complies with its relevant harmonised European Norm.

The CE marking label for each product, including declared values, can be found at www.pilkington.com/CE



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