



Pilkington Glass Handbook 2010



PILKINGTON
NSG Group Flat Glass Business

Pilkington Glass Handbook 2010

Introduction

Solar Control



Thermal Insulation



Fire Protection



Noise Control



Safety / Security



Self-cleaning



Decoration



Glass Systems



Special Applications



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Introduction

General description

Our Glass Handbook has been designed to act as an easy-to-use reference document providing consistent information on our range of products for buildings that are distributed in the Eastern European region.

We have tried to highlight the benefits of the product as well as the technical specification to the user.

Our publication is not exhaustive, and therefore does not cover all products, combinations and applications. For additional information or advice, please get in contact with one of our Pilkington representatives (see: **Contact list** at the end of the book).

Pilkington Glass Handbook 2010 covers the range of products as it applied in January 2010.

Changes to the product range since then have not been incorporated.

Guide for Use:

Our Glass Handbook is organised into benefit-led categories. Please note that some of our products have multiple benefits and therefore may be found in more than one benefit-led categories. If you are searching for a solution to a particular problem, you may need to consider products in more than one category.

Acknowledgements:

We wish to acknowledge the assistance of all those people throughout the Pilkington employees who have contributed to the compilation of our Glass Handbook.

Disclaimer:

This publication provides only a general description of the product. Further, more detailed information may be obtained from your local Pilkington Building Products supplier. It is the responsibility of the user to ensure that the use of any product is appropriate for any particular application and that such use complies with all relevant legislation, standards, code 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.

Performance data

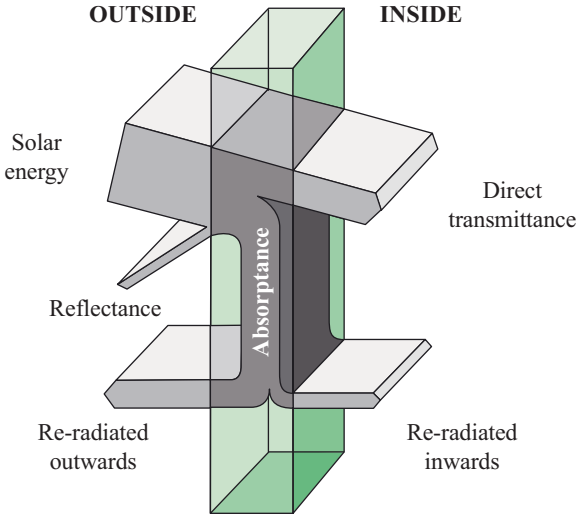


Figure 1.

Visible Light

Light Transmittance (LT) is the proportion of visible light at near normal incidence that is transmitted through the glass.

Light Reflectance (LR) is the proportion of visible light at near normal incidence that is reflected by the glass.

Colour Rendering Index (Ra) expresses the colour rendering properties of glass in transmission.

Solar Energy

Glass transmits solar radiation from the sun by three mechanisms: reflection, transmission and absorption, which for solar control purposes are defined in terms of the following parameters:

Direct Solar Energy Transmittance (ET) is the proportion of solar radiation at near normal incidence that is transmitted directly through the glass.

Solar Energy Reflectance (ER) is the proportion of solar radiation at near normal incidence that is reflected by the glass back into the atmosphere.

Solar Energy Absorptance (EA) is the proportion of solar radiation at near normal incidence that is absorbed by the glass.

Total Solar Energy Transmittance (TET), also known as g value or solar factor, is the fraction of solar radiation at near normal incidence that is transferred through the glazing by all means. It is composed of the direct transmittance, also known as the short wave component, and the part of the absorptance dissipated inwards by longwave radiation and convection, known as the longwave component. The proportions of the absorbed energy that are dissipated either inside or outside depend on the glazing configuration and the external exposure conditions.

Selectivity index S: light to heat ratio ($S = LT / TET$).

The solar control mechanism is illustrated in Figure 1.

The solar radiant heat admission properties of glasses can be compared by their shading coefficients.

The Total Shading Coefficient (TSC) is derived by comparing the properties of any glass with a clear float glass having a total energy transmittance of 0,87 (such a glass would have a thickness of about 3 mm). It comprises a short wavelength and long wavelength shading coefficient.

The Short Wavelength Shading Coefficient (SWSC) is the direct energy transmittance divided by 0,87.

The Long Wavelength Shading Coefficient (LWSC) is the fraction of the absorptance released inwards, again divided by 0,87.

Thermal Insulation

Heat loss is quantified by the thermal transmittance or U-value (U). The U-value, usually expressed in S.I. units (Système Internationale d'Unités) of W/m^2K , is the heat flux density through a given structure divided by the difference in environmental temperatures on either side of the structure in steady state conditions. It is more generally referred to as the rate of loss of heat per square metre, under steady state conditions, for a temperature difference of one Kelvin (or degree Celsius) between the inner and outer environments separated by the glass, or other building element.

Performance data for Pilkington products

Performance data given in the following tables has been determined in accordance with European Standards (EN). Data for insulating glass units have been based on 90% argon filling unless otherwise stated, construction based on a 16 mm argon filled cavity, except for triple glazing where the cavities are 12 mm.

(Note: U-values should be rounded to the nearest 0,1 in accordance with EN 673)

Light and solar energy technical data have been determined in accordance with EN 410.

Unless otherwise stated all the calculations are based on 4 mm glass thickness.

Glass surfaces:

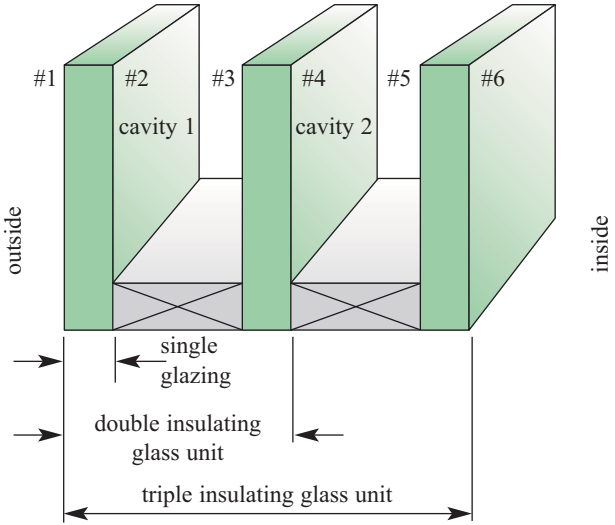


Figure 2.

#: indicates the surface number (counting from the outside).



1.0 Solar Control



Solar control is a key issue in terms of energy saving. In hot conditions or for buildings with high internal loads, solar control glass is used to minimise solar heat gain by rejecting solar radiation and help control glare. In more temperate conditions, it can be used to balance solar control with high levels of natural light.

The topic of air-conditioning is a major concern to building designers and architects. Often, more energy is used to operate air-conditioning systems during the summer months than to heat the building in winter thereby increasing the carbon footprint. It is therefore essential to improve the energy efficiency of buildings during the summer as well as in the winter.

Note: The potential for solar control glass to cut CO₂ emissions from buildings has been analysed by the Dutch scientific institute TNO in a study undertaken for Glass For Europe. The study concludes that between 15 and 80 million tonnes of CO₂ emissions annually - roughly between 5% and 25% of the EU's target - could be saved by the year 2020 by optimal use of solar control glass. Reference: "Impact of Solar Control Glazing on energy and CO₂ savings in Europe" (TNO Report 2007-D-R0576/B by TNO Built Environment and Geosciences, Delft, The Netherlands). www.glassforeurope.com.

In cold weather conditions, our low-emissivity glass reduces heat loss while allowing high levels of valuable free solar gain to heat buildings without significant loss in natural light. However, unless combined with solar control, in the summer it can become uncomfortably hot. The correct choice of glass can help to reduce the capital outlay, running costs and associated carbon emissions of a building throughout the year.

Given the variety of building designs and climatic conditions and the different levels of exposure to solar radiation during the year, the choice of glass must be able to protect the inside of the building to ensure maximum comfort, minimise energy consumption, guarantee safety and, not least, provide the optical and aesthetic qualities that satisfy the designer.



We are continually innovating and developing products that satisfy the full range of architectural requirements. Over the years we have developed a wide range of energy management solutions for large and small glazed areas on all types of building.

Our innovative solar control products cover the whole range:

- from the highest performing, off-line coated, solar control and low-emissivity products within the Pilkington **Suncool™** range;
- through on-line environmental control glasses that combine good performance solar control with low-emissivity such as Pilkington **Eclipse Advantage™**;
- to low-performance, body-tinted glass in the Pilkington **Optifloat™** Tint range;
- and even to solar control glass combined with the revolutionary, self-cleaning Pilkington **Activ™**.

In addition to the above ranges our solar control range can be used with many other Pilkington solutions, to achieve countless benefits in terms of safety, functionality and cost-efficiency.

How it works? – Glass controls solar heat radiation by the three mechanisms: reflection, transmission and absorption, which for solar control purposes are defined in terms of the following parameters:

Direct transmittance – the proportion of solar radiation transmitted directly through the glass.

Reflectance – the proportion of solar radiation reflected back into the atmosphere.

Absorptance – the proportion of solar radiation absorbed by the glass.

Total transmittance (also known as g value or solar factor) – the proportion of solar radiation transmitted through the glass by all means. This is composed of the direct transmittance and that which is absorbed by the glass and reradiated inwards.



Further parameters given to glass are as follows:

Light transmittance – the proportion of the light that is transmitted by the glass.

Light reflectance – the proportion of the light that is reflected by the glass.

Total shading coefficient – the ratio between total solar heat transmittance of the glass and that of a single 3 mm thick clear float glass.

Shortwave shading coefficient

$$\text{SWSC} = \frac{\text{ET}}{\text{total solar heat transmittance of standard glass}}$$

Longwave shading coefficient

$$\text{LWSC} = \text{TSC} - \text{SWSC}$$

Total shading coefficient

$$\text{TSC} = \frac{\text{TET}}{\text{total solar heat transmittance of standard glass}}$$

where:

SWSC – shortwave shading coefficient

LWSC – longwave shading coefficient

TSC – total shading coefficient

ET – direct solar heat transmittance

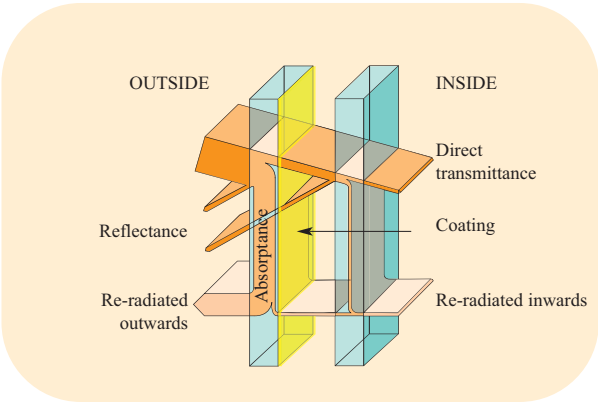
TET – total solar heat transmittance

Example for Pilkington **Optifloat™** Green 6 mm glass:

$$\text{TSC} = \frac{59}{87} = 0,68$$

Selectivity index – the ratio between light transmittance and total solar heat transmittance

$$S = \frac{\text{LT}}{g}$$



Insulating glass unit incorporating coated solar control glass.



Tinted solar control glass

Description

Pilkington Arctic Blue™ is a unique blue body-tinted float glass for high daylight transmittance, good solar control and cool comfortable colour without the use of a surface coating. Its solar control properties and colour densities vary with each available thickness so that glass with properties appropriate to a particular application can be chosen.

Applications

Pilkington Arctic Blue™ is ideally suited to climates or conditions where energy costs for cooling are a consideration.

Pilkington Arctic Blue™, can be specified as toughened or laminated glass. Due to its high solar heat absorptance,

Pilkington Arctic Blue™ may be subject to thermal breakage. The risk of thermal breakage may occur on façades exposed to the sun, and in situations where high temperature differences across the glass pane are expected. In such cases it is advisable to specify toughened or heat strengthened glass.


Features and benefits

- Improved solar performance compared to traditional tinted float glass, reducing the need for air-conditioning.
- Solar control performance and colour density vary with the thickness.
- Cool and distinctive rich blue colour, offering possibility for unique aesthetics and innovative design.
- High visibility properties providing a crisp, undistorted, natural view from the interior.
- High daylight transmittance, reducing the need for artificial lighting.
- Low internal and external reflection.
- Low UV transmittance.
- Additional thermal insulation performance when combined in an insulating glass unit with a low-emissivity glass.
- Easy to handle and process.
- No edge deletion required.
- Can be laminated, toughened, bent and enamelled using standard techniques.



- Can be used in monolithic form or incorporated in insulating glass units, and has an unlimited shelf-life.
- Available in 4 mm, 6 mm and 10 mm thicknesses.
- Satisfies the requirements for harmonised European Norm EN 572.



Pilkington Arctic Blue™		performance code		light			energy							S, UV						
		U	LT	g	LT	LRo	LRi	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV			
 PILKINGTON NSG Group Flat Glass Business	glass configuration		W/m ² K	%	%	%	%	%	%	%	%	%	%	%	%	%	%			
	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.



Pyrolytic on-line coated solar control glass with low-emissivity properties

Description

A range of good solar control performance pyrolytic on-line coated clear or body-tinted glass, with unique colour appearances, medium light transmittance, low, medium or high light reflectance and low-emissivity. The durable coating is applied pyrolytically during float glass manufacture to a variety of substrates giving a range of colours in reflection – Clear, Blue-Green, EverGreen, Bronze, Grey and Arctic Blue.

Pilkington **Eclipse Advantage™** can be used in single glazing applications provided that the coating faces the interior of the building.

Applications

Pilkington **Eclipse Advantage™** provides a versatile and attractive solution to all applications where a brightly coloured glass is needed, with enhanced solar control performance. It is equally suited for all applications, from the small refurbishment to the largest prestige commercial development, where a comparatively low cost but high impact solution is demanded. Where a safety glass is required, Pilkington **Eclipse Advantage™** can be specified as toughened or laminated glass. Due to its high solar heat absorbance, Pilkington **Eclipse Advantage™** may be subject to thermal breakage. The risk of thermal breakage may occur on façades exposed to the sun, and in situations where high temperature differences across the glass pane are expected. In such cases it is advisable to specify toughened or heat strengthened glass.


Features and benefits

- Good solar control performance with some low-emissivity properties, reducing the need for heating and cooling the building.
- Choice of colours, light transmittance, reflectivity and appearance, providing increased design flexibility.
- Less heat absorption compared to other tinted reflective glasses, eliminating the need for heat treat vision glass under normal glazing conditions.
- Additional thermal insulation performance when combined in an insulating glass unit with a low-emissivity glass.



- Durable pyrolytic on-line coating easy to handle and process, providing low cost solution with high visual impact.
- Can be laminated, toughened, bent and enamelled using standard techniques
- Can be used in monolithic form or incorporated in insulating glass units, and has unlimited shelf-life.
- No edge deletion required.
- Harmonising spandrel panels available.
- Available in 4 and 6 mm thicknesses.
- Achieves Class B to EN 1096 for coated glass.




 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Eclipse Advantage™ Clear													
		glass	performance code		light			energy				S, UV			
	I	W/m ² K	%	%	%	%	%	%	%	%	%	%	%	%	%
		monolithic glass #2													
		U	LT	g	LT	ET	ER	EA	TET	SSC	LSC	TSC	S	UV	
		U value		energy	light	direct transmittance	reflectance	absorptance	total transmittance	shortwave shading coeff.	longwave shading coeff.	total shading coefficient	selectivity index	UV transmittance	
4	mm	3,8	67	64	67	61	20	19	64	0,70	0,04	0,74	1,05	27	
6	mm	3,8	67	62	67	58	19	23	62	0,67	0,04	0,71	1,08	25	

Notes:

Maximum size: 5180 mm x 3300 mm.




 Pilkington Eclipse Advantage™ Clear		glass configuration		performance code		light			energy						S, UV							
		II	II	W/m ² K	%	LT	%	g	LT	%	ET	%	ER	%	EA	%	TET	SSC	LSC	TSC	S	%
		II	insulating glass unit, Pilkington Optitherm™ S3 #3	1,6	60	55	55	60	29	31	99	47	22	31	55	0,54	0,09	0,63	1,09	19		
		II	insulating glass unit, Pilkington Optitherm™ S1 #3	1,3	56	53	53	56	31	30	98	42	23	35	53	0,48	0,13	0,61	1,06	15		
		II	insulating glass unit, Pilkington K Glass™ #3																			
		II	insulating glass unit, primary product outside #2																			
				1,0	53	37	37	53	33	35	98	31	34	35	37	0,36	0,07	0,43	1,43	14		
				1,1	59	46	46	59	28	30	98	39	28	33	46	0,45	0,08	0,53	1,28	12		

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.




 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Eclipse Advantage™ Arctic Blue																
		glass configuration	performance code		light			energy					S, UV					
		W/m ² K	%	%	%	LT	LRo	LRi	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
	II	U	LT	g	energy	LT	LRo	LRi	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
	II	1,6	35	28		35	13	30	81	21	9	70	28	0,24	0,08	0,32	1,25	6
	II	1,3	33	26		33	14	29	82	19	9	72	26	0,22	0,08	0,30	1,27	5
	II	1,0	31	21		31	15	34	81	16	11	73	21	0,18	0,06	0,24	1,48	5
	II	1,1	35	24		35	13	29	81	19	9	72	24	0,22	0,06	0,28	1,46	4
	II				insulating glass unit, Pilkington Optitherm ™ S3 #3													
	II				insulating glass unit, Pilkington Optitherm ™ S1 #3													
	II				insulating glass unit, Pilkington K Glass ™ #3													
	II				insulating glass unit, primary product outside #2													

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.




 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Eclipse Advantage™ Blue-Green														
		glass	performance code			light			energy						S, UV	
	I	W/m ² K	%	%	%	LT	g	ET	ER	EA	TET	SSC	LSC	TSC	S	%
	monolithic glass #2						energy	direct transmittance	reflectance	absorptance	total transmittance	shortwave shading coeff.	longwave shading coeff.	total shading coefficient	selectivity index	UV transmittance
4	mm	3,8	60	51				44	14	42	51	0,51	0,08	0,59	1,18	16
6	mm	3,8	57	45				37	12	51	45	0,43	0,09	0,52	1,27	12

Notes:

Maximum size: 5180 mm x 3300 mm.




 PILKINGTON <small>Pilkington Group Flat Glass Business</small>		Pilkington Eclipse Advantage™ Bronze															
		glass	performance code		light			energy				S, UV					
	I	W/m ² K	%	%	%	LT	%	ER	EA	TET	SSC	LSC	TSC	%	UV		
	monolithic glass #2																
		U	g	energy	Ra	reflectance inside	reflectance outside	transmittance	direct transmittance	reflectance	absorptance	total transmittance	shortwave shading coeff.	longwave shading coeff.	total shading coefficient	selectivity index	UV transmittance
4	mm	3,8	46	50	92	27	15	46	43	13	44	50	0,49	0,08	0,57	0,92	12
6	mm	3,8	38	44	90	27	11	38	34	10	56	44	0,39	0,12	0,51	0,86	8

Notes:

Maximum size: 5180 mm x 3300 mm.




 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Eclipse Advantage™ Bronze																
		glass configuration	performance code		light			energy				S, UV						
		W/m ² K	%	%	LT	LRo	LRI	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV	
	II	U	LT	g	energy	LT	LRo	LRI	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
	II	1,6	34	35		34	13	29	92	28	11	61	35	0,32	0,08	0,40	0,97	7
	II	1,3	32	34		32	13	29	90	25	11	64	34	0,29	0,10	0,39	0,94	5
	II	1,0	30	24		30	14	34	91	18	15	67	24	0,21	0,07	0,28	1,25	5
	II	1,1	34	29		34	12	29	91	23	13	64	29	0,26	0,07	0,33	1,17	5

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.




 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Eclipse Advantage™ EverGreen															
		glass	performance code			light			energy					S, UV			
	I	W/m ² K	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
		U	LT	g	LT	g	LT	ER	EA	TET	SSC	LSC	TSC	S	UV		
		U value	light	energy	transmittance	reflectance outside	reflectance inside	reflectance	absorptance	total transmittance	shortwave shading coeff.	longwave shading coeff.	total shading coefficient	selectivity index	UV transmittance		
4	mm	3,8	54	42	54	18	27	11	56	42	0,38	0,10	0,48	1,29	8		
6	mm	3,8	48	36	48	16	27	9	66	36	0,29	0,12	0,41	1,33	5		

Notes:

Maximum size: 5180 mm x 3300 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Eclipse Advantage™ EverGreen																		
		glass configuration		performance code		light			energy				S, UV							
		W/m ² K	%	%	LT	g	energy	LT	LRo	LRI	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
	II							43	17	30	88	22	9	69	28	0,25	0,07	0,32	1,54	4
	II							40	18	29	89	19	10	71	26	0,22	0,08	0,30	1,54	3
	II							38	19	34	87	17	11	72	22	0,20	0,05	0,25	1,73	3
	II							43	17	29	88	19	10	71	25	0,22	0,07	0,29	1,72	3

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.



Tinted solar control glass

Description

Pilkington EverGreen™ establishes new standards of quality, aesthetics and performance for green body-tinted glass.

Pilkington EverGreen™ glass offers good solar control characteristics and responds to the demand for high light transmittance without the use of a surface coating. Its solar control properties and colour densities vary with each available thickness so that glass with properties appropriate to a particular application can be chosen.

Applications

Pilkington EverGreen™ is ideally suited to climates or conditions where energy costs for cooling are a consideration.

Pilkington EverGreen™ absorbs much of the sun's heat and UV rays while still letting through a high level of daylight. Where a safety glass is required, Pilkington EverGreen™ can be specified as toughened or laminated glass.

Due to its high solar heat absorptance, Pilkington EverGreen™ may be subject to thermal breakage. The risk of thermal breakage may occur on façades exposed to the sun, and in situations where high temperature differences across the glass pane are expected. In such cases it is advisable to specify toughened or heat strengthened glass.


Features and benefits

- Improved solar control performance compared to traditional tinted float glass, reducing the need for air-conditioning.
- Solar control performance and colour density vary with the thickness.
- Refreshing soft green colour, offering a crisp, clean view of the outside.
- High daylight transmittance, reducing the need for artificial lighting.
- Low internal and external reflection.
- Low UV transmittance.
- Additional thermal insulation performance when combined in an insulating glass unit with a low-emissivity glass.



- Easy to handle and process.
- Can be laminated, toughened, bent and enamelled using standard techniques.
- Can be used in monolithic form or incorporated in insulating glass units, and has an unlimited shelf-life.
- Available in 6 mm thickness.
- Satisfies the requirements for harmonised European Norm EN 572.



 PILKINGTON <small>NSG Group Flat Glass Business</small>	Pilkington EverGreen™					
	glass I monolithic glass	performance code W/m ² K % U U value LT light g energy	light % LT transmittance % LR _o reflectance outside % LRI reflectance inside % Ra colour rendering index	energy % ET direct transmittance % ER reflectance % EA absorptance % TET total transmittance % SSC shortwave shading coeff. % LSC longwave shading coeff. % TSC total shading coefficient	S, UV % UV transmittance % S selectivity index	6 mm ⇄

Notes:
 Maximum size: 5180 mm x 3300 mm.



Body tinted solar control glass

Description

A range of low solar control performance uncoated body-tinted glass, with low light reflection and high energy absorption.

Please note that in all body-tinted glass products, the properties and colour density vary with the thickness; this needs to be considered when designing façades where colour uniformity is aesthetically important. All of the body-tinted glasses can be toughened or laminated and/or incorporated into insulating glass units.

Applications

Pilkington **Optifloat™** Tint glass products can be used wherever a coloured glass without surface coating is required for visual appeal or where a degree of solar control performance is necessary to improve or control the internal environment of the building. Where a safety glass is required, they can be specified as toughened or laminated glass.

Due to its high solar heat absorptance, Pilkington **Optifloat™** Tint may be subject to thermal breakage. The risk of thermal breakage may occur on façades exposed to the sun, and in situations where high temperature differences across the glass pane are expected. In such cases it is advisable to specify toughened or heat strengthened glass.

Designed to improve conditions within buildings by reducing glare, solar radiation and heat transfer into the building, they also reduce UV radiation and offer improved privacy, when compared with clear glass.


Features and benefits

- Solar control performance, reducing the need for air-conditioning.
- Solar control performance and colour density vary with the thickness.
- Available in a choice of colours (Green, Blue-Green, Bronze and Grey), offering flexibility for original and innovative architectural design even where low reflection is required.
- Subdued colour range, complementing other building materials and natural surroundings.



- Low to high light transmission.
- Low internal and external reflection, reducing uncomfortable glare from the sun, and offering improved privacy compared to clear glass.
- Can reduce UV radiation.
- Additional thermal insulation performance when combined in an insulating glass unit with a low-emissivity glass.
- Can be laminated, toughened, bent and enamelled using standard techniques.
- Can be used in monolithic form or incorporated in insulating glass units, and has unlimited shelf-life.
- Available in a wide range of sizes from 3 mm to 10 mm (thickness depending on the colour).
- Satisfies the requirements for harmonised European Norm EN 572.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Optifloat™ Blue-Green															
		glass	performance code		light			energy				S, UV					
	I	W/m ² K	%	%	%	g	LT	U	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
	monolithic glass					energy	light		direct transmittance	reflectance	absorptance	total transmittance	shortwave shading coeff.	longwave shading coeff.	total shading coefficient	selectivity index	UV transmittance
6	mm	5,7	75	62	75	62	75	5,7	50	6	44	62	0,57	0,14	0,71	1,21	26
8	mm	5,7	71	57	71	57	71	5,7	43	6	51	57	0,49	0,17	0,66	1,25	20
10	mm	5,6	66	52	66	52	66	5,6	38	5	57	52	0,44	0,16	0,60	1,27	16

Notes:

Maximum size: 5180 mm x 3300 mm.




Pilkington Optifloat™ Blue-Green		glass configuration		performance code		light		energy							S, UV						
		II	II	W/m ² K	%	LT	%	g	energy	ET	%	ER	%	EA	%	TET	SSC	LSC	TSC	S	%
 PILKINGTON <small>NSG Group Flat Glass Business</small>	II	insulating glass unit, Pilkington Optitherm™ S3 #3	2,6	67	51	67	12	14	14	88	42	8	50	51	0,48	0,11	0,59	1,31	20	1,31	20
	II	insulating glass unit, Pilkington Optitherm™ S1 #3	1,5	62	46	62	14	15	90	37	9	54	46	0,43	0,10	0,53	1,35	16	1,35	16	
	II	insulating glass unit, Pilkington K Glass™ #3	1,0	58	35	58	16	22	88	29	15	56	35	0,33	0,07	0,40	1,66	14	1,66	14	
	II	insulating glass unit, primary product outside	1,1	66	43	66	10	13	89	36	10	54	43	0,41	0,08	0,49	1,53	13	1,53	13	

Notes:


1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.



 PILKINGTON <small>NISG Group Flat Glass Business</small>		Pilkington Optifloat™ Green																
		glass	performance code		light			energy				S, UV						
	I	W/m ² K	U	LT	g	LT	energy	ET	ER	EA	TET	SSC	LSC	TSC	S	UV		
			U value	light	energy	transmittance	reflectance outside	reflectance inside	colour rendering index	direct transmittance	reflectance	absorptance	total transmittance	shortwave shading coeff.	longwave shading coeff.	total shading coefficient	selectivity index	UV transmittance
4	mm	↔	5,8	80	66	80	7	7	93	56	6	38	66	0,64	0,12	0,76	1,21	27
5	mm	↔	5,8	78	62	78	7	7	92	51	6	43	62	0,59	0,12	0,71	1,26	23
6	mm	↔	5,7	75	59	75	7	7	90	46	6	48	59	0,53	0,15	0,68	1,27	19
8	mm	↔	5,7	71	54	71	7	7	87	40	5	55	54	0,46	0,16	0,62	1,31	15
10	mm	↔	5,6	67	51	67	7	7	85	35	5	60	51	0,40	0,19	0,59	1,31	12


Notes:
Maximum size: 6000 mm x 3210 mm.



 PILKINGTON <small>NBC Group Flat Glass Business</small>		Pilkington Optifloat™ Grey																	
		glass	performance code		light			energy				S, UV							
I		W/m ² K	%	%	LT	g	LT	g	energy	ET	ER	EA	TET	SSC	LSC	TSC	S	UV	
	monolithic glass																		
3	mm	↔	5,8	65	72	65	6	6	98	65	6	29	72	0,75	0,08	0,83	0,90	30	
4	mm	↔	5,8	57	67	57	6	6	98	57	6	37	67	0,66	0,11	0,77	0,85	24	
5	mm	↔	5,8	50	62	50	6	6	97	51	5	44	62	0,59	0,12	0,71	0,81	19	
6	mm	↔	5,7	44	58	44	5	5	96	45	5	50	58	0,52	0,15	0,67	0,76	16	
8	mm	↔	5,7	35	51	35	5	5	95	36	5	59	51	0,41	0,18	0,59	0,69	11	
10	mm	↔	5,6	27	46	27	5	5	93	28	5	67	46	0,32	0,21	0,53	0,59	8	

Notes:
 Maximum size: 6000 mm x 3210 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Optifloat™ Grey																				
		glass configuration		performance code		light			energy				S, UV									
		W/m ² K	%	%	LT	g	%	LT	LRo	LRI	Ra	%	ET	ER	EA	TET	SSC	LSC	TSC	%	UV	
	II	2,6	39	46	39	7	12	94	36	7	57	46	0,41	0,12	0,53	0,85	13					
	II	1,5	36	42	36	8	14	96	31	8	61	42	0,36	0,12	0,48	0,86	10					
	II	1,0	34	28	34	8	21	93	22	15	63	28	0,25	0,07	0,32	1,21	9					
	II	1,1	39	35	39	6	12	95	28	12	60	35	0,32	0,08	0,40	1,11	8					
	II																					

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.



Pyrolytic on-line coated reflective solar control glass

Description

A range of medium solar control performance on-line coated clear or body-tinted glass, with low light transmittance and medium light reflectance.

Pilkington **Reflite**[™] may be used in single glazing applications (with coating on surface #2), as well as in insulated glass units. They can also be laminated, heat strengthened, toughened and curved (or bent) using standard techniques.

Pilkington **Reflite**[™] can be used in a wide range of residential and commercial applications.

Due to their high solar heat absorptance, Pilkington **Reflite**[™] may be subject to thermal breakage. The risk of thermal breakage may occur on façades exposed to the sun, and in situations where high temperature differences across the glass pane are expected. In such cases it is advisable to specify toughened or heat strengthened glass.

Features and benefits

- Medium solar control performance, reducing the need for air-conditioning.
- Attractive colours (Clear, Arctic Blue, Emerald Green and Bronze) providing a solution for a wide variety of design requirements.
- Colour stability whether toughened or annealed.
- Medium reflectivity providing privacy whilst still allowing a clear view to the outside.
- Durable pyrolytic on-line coating easy to handle and process, providing low cost solution with high visual impact.
- Can be laminated, toughened, bent and enamelled using standard techniques.
- Can be used in monolithic form or incorporated in insulating glass units, and has unlimited shelf-life.
- Additional thermal insulation performance when combined in an insulating glass unit with a low-emissivity glass.


Pilkington **Reflite**[™]



- All colours available in 4 mm, 5 mm, 6 mm and 8 mm.
- Available in sizes 3210 x 2250 mm and 3048 x 2134 mm.*


* Other sizes may also be available against specific orders in the future.



		Pilkington Reflite™ Arctic Blue																															
		glass	performance code	light	energy	S, UV																											
4	6	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔																						
		monolithic glass #2																															
		U	W/m ² K	LT	g	LT	energy	LT	transmittance	LRo	reflectance outside	LRi	reflectance inside	Ra	colour rendering index	ET	direct transmittance	ER	reflectance	EA	absorptance	TET	total transmittance	SSC	shortwave shading coeff.	LSC	longwave shading coeff.	TSC	total shading coefficient	S	selectivity index	UV	UV transmittance
		5,8	20	37	20	27	55	92	20	17	63	37	37	0,23	0,20	0,43	20	13	13	74	74	32	32	0,15	0,22	0,37	0,54	2	0,50	1			


Notes:
Maximum size: 3302 mm x 2438 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Reflite™ Bronze														
		glass	performance code	light	energy	S, UV										
4	mm	↔	W/m ² K U U value	% LT light	% g energy	% LRo reflectance outside % LRI reflectance inside - Ra colour rendering index	% ET direct transmittance % ER reflectance % EA absorptance % TET total transmittance - SSC shortwave shading coeff. - LSC longwave shading coeff. - TSC total shading coefficient	- s selectivity index - UV UV transmittance	5,8 22 45	5,7 18 42	22 25 53 73	33 19 48 45 42 0,38 0,14 0,52	27 14 59 42 0,31 0,17 0,48	6 mm	4 mm	
6	mm	↔														

Notes:
 Maximum size: 3302 mm x 2438 mm.




 PILKINGTON NSG Group Flat Glass Business		Pilkington Reflite™ Bronze															
		glass configuration		performance code		light			energy				S, UV				
		U	LT	g	LT	LRo	LRI	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
		W/m ² K	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
II	II	2,6	16	31	16	18	51	73	21	14	65	31	0,24	0,12	0,36	0,52	I
	II	1,5	15	27	15	18	48	72	17	15	68	27	0,20	0,11	0,31	0,56	I
	II	1,0	15	16	15	18	52	73	11	21	68	16	0,13	0,05	0,18	0,94	I
II	II	1,1	16	20	16	18	50	73	14	19	67	20	0,16	0,07	0,23	0,80	I

Notes:


1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.



		performance code		light		energy		S, UV																														
		W/m ² K	%	%	%	%	%	%	%																													
4	6	↔	↔	monolithic glass #2	U	5,8	24	35	ET	16	ER	13	EA	71	TET	35	SSC	0,18	LSC	0,22	TSC	0,40	S	0,69	UV	2												
					LT	24	26	21	49	90	LRo	26	21	49	90	LRI	49	90	LRi	49	90	Ra	90	direct transmittance	11	reflectance	11	reflectance	11	absorptance	78	total transmittance	31	shortwave shading coeff.	0,13	longwave shading coeff.	0,23	total shading coefficient

Notes:
Maximum size: 3302 mm x 2438 mm.



 Pilkington Reflite™ Emerald Green		glass configuration		performance code		light			energy							S, UV			
		II	II	U	LT	g	energy	LT	LRo	LRI	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S
		II	II	2,6	19	20	19	21	48	89	10	11	79	20	0,11	0,12	0,23	0,95	1
		II	II	1,5	18	15	18	21	45	89	8	11	81	15	0,09	0,08	0,17	1,20	1
		II	II	1,0	17	12	17	21	49	88	7	11	82	12	0,08	0,06	0,14	1,42	1
		II	II	1,1	18	13	18	21	47	89	8	11	81	13	0,09	0,06	0,15	1,38	1

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.



Pyrolytic on-line coated solar control glass with low-emissivity properties

Description

A good solar control performance pyrolytic on-line coated glass with neutral appearance, medium light transmittance, low light reflectance and low-emissivity. Used in insulating glass unit the product provides colour-neutral aesthetics and reduces external glare.

Applications


Pilkington Solar-E™ provides attractive solution to various applications where high light transmittance with enhanced solar control performance is required. Thanks to low exterior light reflectance the product is widely used for modern glass façades where high reflectance is prohibited or undesirable.

Pilkington Solar-E™ can be toughened or laminated where a safety glass is required. Toughened or heat strengthened glass should also be specified in applications where Pilkington Solar-E™ may be at risk of thermal breakage.

Features and benefits

- Good solar control performance with some low-emissivity, reducing the need for heating and cooling the building.
- Medium light transmittance and low light reflectance for undistorted, natural views.
- Additional thermal insulation performance when combined in an insulating glass unit with a low-emissivity glass.
- Durable pyrolytic on-line coating easy to handle and process, providing low cost solution with high visual impact.
- Can be laminated, toughened, bent and enamelled using standard techniques.
- Can be used in monolithic form or incorporated in insulating glass units, and has unlimited shelf-life.
- No edge deletion required.
- Available in 6 and 8 mm thickness.
- Achieves Class B to EN 1096 for coated glass.



Pilkington Solar-E™		performance code		light		energy		S, UV	
glass	I	W/m ² K	%	%	%	%	%	%	%
 PILKINGTON <small>HSG Group Flat Glass Business</small>	monolithic glass #2	U	LT	g	LT	LRo	LRI	Ra	ET
	6 mm	↔	3,6	60	53	60	59	52	46
8 mm	↔	3,6	59	52	60	59	52	44	46
				g	energy	ER	EA	TET	SSC
				g	light	ER	EA	TET	SSC
				g	U value	ER	EA	TET	SSC
				g	energy	ER	EA	TET	SSC
				g	light	ER	EA	TET	SSC
				g	U value	ER	EA	TET	SSC
				g	energy	ER	EA	TET	SSC
				g	light	ER	EA	TET	SSC
				g	U value	ER	EA	TET	SSC
				g	energy	ER	EA	TET	SSC
				g	light	ER	EA	TET	SSC
				g	U value	ER	EA	TET	SSC
				g	energy	ER	EA	TET	SSC
				g	light	ER	EA	TET	SSC
				g	U value	ER	EA	TET	SSC
				g	energy	ER	EA	TET	SSC
				g	light	ER	EA	TET	SSC
				g	U value	ER	EA	TET	SSC
				g	energy	ER	EA	TET	SSC
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				g	energy	ER	EA	TET	SSC
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				g	light	ER	EA	TET	SSC
				g	U value	ER	EA	TET	SSC
				g	energy	ER	EA	TET	SSC
				g	light	ER	EA	TET	SSC
				g	U value	ER	EA	TET	SSC
				g	energy	ER	EA	TET	SSC
				g	light	ER	EA	TET	SSC



Superior solar control performance glass with outstanding thermal insulation

Description

A range of superior solar control performance off-line coated glass, with high light transmittance, low, medium or high light reflectance and outstanding thermal insulation.

The wide range of products is available in clear or neutral appearance and in two distinctive colours, blue and silver.

The appearance of the Pilkington Suncool™ product range

Product	IGU construction (6 mm external pane – 16 mm – 4 mm Pilkington Optifloat™ Clear)		
	Appearance in reflection (external view)	Level of reflection†	Appearance in transmission (internal view)
Pilkington Suncool™ 70/40	neutral	low	neutral
Pilkington Suncool™ 70/35	neutral/blue	medium	neutral
Pilkington Suncool™ 66/33	neutral	medium	neutral
Pilkington Suncool™ 50/25	neutral/blue	medium	neutral
Pilkington Suncool™ Blue 50/27	blue	medium	neutral
Pilkington Suncool™ Silver 50/30	silver	high	neutral
Pilkington Suncool™ 40/22	neutral/blue	medium	neutral
Pilkington Suncool™ 30/17	neutral/blue	medium	neutral

† Level of reflection: low < 15%, medium 15-25%, high > 25%.



For additional thermal insulation, Pilkington Suncool™ insulating glass units can be filled with an inert gas such as argon.

We have has developed a range of Pilkington Spandrel Glass products for use with Pilkington Suncool™ solar control glass, to ensure continuity in the aesthetic design of façades. Pilkington Spandrel Glass Coated products are available in thicknesses 6 mm, 8 mm and 10 mm in toughened form.

The Pilkington Spandrel Glass Coated product range and appearance

Product	Appearance in reflection	Level of reflection †	Light reflection [%]
Pilkington Spandrel Glass Coated E200	neutral	medium	19
Pilkington Spandrel Glass Coated E140	neutral/blue	high	28
Pilkington Spandrel Glass Coated E120	silver	high	35

† Level of reflection: low < 15%, medium 15-25%, high > 25%.



The full Pilkington **Suncool™** range and recommended off-line coated spandrels are shown below.

Product	Spandrel offering
Pilkington Suncool™ 70/40	*
Pilkington Suncool™ 70/35	(E200)**
Pilkington Suncool™ 66/33	(E200)**
Pilkington Suncool™ 50/25	E200
Pilkington Suncool™ Blue 50/27	–
Pilkington Suncool™ Silver 50/30	E120
Pilkington Suncool™ 40/22	(E140)***
Pilkington Suncool™ 30/17	E140

* Due to its low reflection, the appearance of Pilkington **Suncool™** 70/40 is dominated by the transmission. However Pilkington Spandrel Glass Coated E200 can be offered as a spandrel solution for Pilkington **Suncool™** 70/40 when the colour match is not expected to be perfect.

** Pilkington Spandrel Glass Coated E200 is the recommended solution for Pilkington **Suncool™** 70/35 and Pilkington **Suncool™** 66/33. Whilst not a perfect colour match this is the most harmonising offering in comparison to an enamelled spandrel solution.

*** Pilkington Spandrel Glass Coated E140 is the recommended solution for Pilkington **Suncool™** 40/22. Whilst not a perfect colour match this is the most harmonising offering in comparison to an enamelled spandrel solution.

As with all spandrel constructions, it is strongly advised that the customer conducts a visual ‘mock-up’ test to ensure an acceptable match.



Applications


Pilkington **Suncool™** can only be used in insulating glass units. Designed to achieve optimum performance in large glazed areas, Pilkington **Suncool™** products are suitable for commercial and residential applications that demand high light transmission properties. The high selectivity index (light-to-heat ratio) combined with outstanding thermal insulation makes the range ideally suited for large areas of glazing, where the need is to control solar gains without significantly reducing the internal light levels.

Where a safety glass is required, Pilkington **Suncool™** can be specified as toughened or laminated glass. Toughened or heat strengthened glass should also be specified in applications where Pilkington **Suncool™** may be at risk of thermal breakage.


Features and benefits

- Superior solar control performance with the highest level of thermal insulation (U-value down to 1,0 W/m²K in a double insulating glass unit with 90% argon filled), reducing the need for cooling and heating the building.
- High selectivity index (light transmittance divided by total solar heat transmittance), offering low solar gains without significantly reducing the internal light levels.
- Wide choice of colours and appearances, providing solutions for the most demanding designs.
- Range of light transmission and reflection.
- Can only be used in insulating glass units; argon gas filling can be used to achieve higher thermal insulation.
- Can be enhanced when combined with other Pilkington products to provide additional benefits such as self-cleaning, noise control, safety or security properties.
- Can also be combined with Pilkington **Optiwhite™** for improved light and solar transmittance properties.
- Harmonising spandrel panels available, allowing freedom in design of complete glass façades.
- Available in 6 mm, 8 mm and 10 mm thickness in annealed and toughened form (4 mm available in some products, 12 mm may be available on special request).



 PILKINGTON <small>NSG Group Plc Glass Business</small>	Pilkington Suncool™ 70/35		
	glass configuration	performance code	light
II	U U value	LT light	g energy
II	W/m²K	LRo reflectance outside LRi reflectance inside Ra colour rendering index	ET direct transmittance ER reflectance EA absorptance TET total transmittance SSC shortwave shading coeff. LSC longwave shading coeff. TSC total shading coefficient
II	III	III	S, UV
insulating glass unit, Pilkington K Glass™ #3	insulating glass unit, Pilkington Optitherm™ S3 #3	triple insulating glass unit, Pilkington Optitherm™ S3 #5	UV transmittance selectivity index
insulating glass unit, primary product outside #2	1,0	69	1,86
↑	↑	↑	↑
↑	↑	↑	↑
↑	↑	↑	↑
↑	↑	↑	↑
↑	↑	↑	↑
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 PILKINGTON <small>NSG Group Flat Glass Business</small>	Pilkington Suncool™ 50/25										
	glass configuration		performance code	light	energy			S, UV			
II	II	III	W/m ² K U	% LT U	% g	% LT U	% ER EA TET SSC LSC TSC	% ET ER EA TET SSC LSC TSC	% UV	% S	% UV
insulating glass unit, Pilkington Optitherm™ #3			1,0		49		27			7	
insulating glass unit, Pilkington Optitherm™ #3			-		-		0,31			-	
insulating glass unit, Pilkington K Glass™ #3			-		-		0,28			-	
insulating glass unit, primary product outside #2			-		-		0,27			-	
triple insulating glass unit, Pilkington Optitherm™ S3 #5			-		-		0,31			-	
Ra			91		-		-			-	
LRI			19		-		-			-	
LRo			18		-		-			-	
LT			49		-		-			-	
g			27		-		-			-	
LT			49		-		-			-	
U			1,0		-		-			-	

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm (double glazed units) and 12 mm (triple glazed units) argon filled (90%) cavities.
3. The primary product shall only be used in insulating glass units.
4. Maximum size of primary monolithic product is 6000 mm x 3210 mm.




 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Suncool™ 40/22																																	
		glass configuration		performance code			light			energy				S, UV																					
II	II	W/m ² K	U	U value	%	LT	LT	light	%	EA	EA	absorptance	%	TET	TET	total transmittance	%	SSC	SSC	shortwave shading coeff.	%	LSC	LSC	longwave shading coeff.	%	TSC	TSC	total shading coefficient	1,7	7	-	-	-	-	
II	II	g	g	energy	%	LT	LT	light	%	ER	ER	reflectance	%	ET	ET	direct transmittance	19	35	46	23	0,22	0,04	0,26	-	-	-	-	-	-	-	-	-	-		
II	II	III	III	triple insulating glass unit, Pilkington Optitherm™ S3 #5																															
				insulating glass unit, Pilkington Optitherm™ S3 #3																															
				insulating glass unit, Pilkington K Glass™ #3																															
				insulating glass unit, primary product outside #2																															

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm (double glazed units) and 12 mm (triple glazed units) argon filled (90%) cavities.
3. The primary product shall only be used in insulating glass units.
4. Maximum size of primary monolithic product is 6000 mm x 3210 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>	Pilkington Suncool™ 30/17			S, UV		% UV UV transmittance	1,58 6	-	-	-	-
	energy		- TSC total shading coefficient - LSC longwave shading coeff. - SSC shortwave shading coeff. % TET total transmittance % EA absorptance % ER reflectance % ET direct transmittance	0,22 0,05 0,17 19 48 37 15	- - - - - - -	- - - - - - -	- - - - - - -	- - - - - - -	- - - - - - -	- - - - - - -	- - - - - - -
light		- Ra colour rendering index % LRI reflectance inside % LRo reflectance outside % LT transmittance	87 16 26 30	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
performance code		% g energy % LT light W/m ² K U U value	19 30 1,1	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
glass configuration		III triple insulating glass unit, Pilkington Optitherm™ S3 #5 II insulating glass unit, Pilkington Optitherm™ S3 #3 II insulating glass unit, Pilkington K Glass™ #3 II insulating glass unit, primary product outside #2	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm (double glazed units) and 12 mm (triple glazed units) argon filled (90%) cavities.
3. The primary product shall only be used in insulating glass units.
4. Maximum size of primary monolithic product is 6000 mm x 3210 mm.



2.0 Thermal Insulation

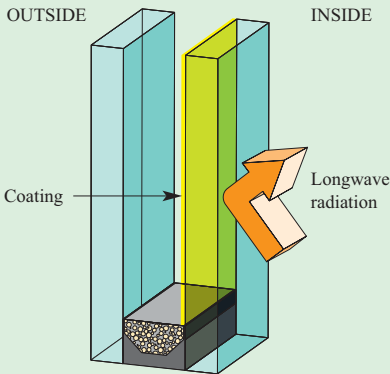


Low-emissivity

Advances in low-emissivity (low-e) glass technology have made windows an essential contributor to energy conservation and comfort, minimising heat loss and internal condensation.

The measure of heat loss is usually expressed in terms of U-value, which is the rate of heat loss in Watts per square metre per degree Kelvin temperature difference between inside and outside (expressed as W/m^2K). The lower the U-value, the better the insulation of the product.

How it works – Effectively, low-emissivity glass will reflect energy back into a building, to achieve much lower heat loss than ordinary float glass. Additionally, different types of low-emissivity glass allow different amounts of passive solar heat gain which helps reduce heating requirements and costs, especially in colder months.



Insulating glass unit incorporating low-e glass.



Solar energy enters the building mainly as shortwave radiation but, once inside, it is reflected back by objects towards the glass as long-wave radiation. Low-emissivity glass has a coating that allows the transmission of the sun's shortwave radiation at a much higher rate than longwave radiation (from the heaters, electrical equipment and occupants in the room), providing an effective barrier to heat loss.

Note: The potential for low-e glass (double and triple glazing) to cut CO₂ emissions from new and existing buildings has been analysed by the Dutch scientific institute TNO in a study undertaken for Glass For Europe. Up to 90 million tonnes of CO₂ emissions could be saved annually by 2020 if all Europe's buildings (existing and new residential and non-residential buildings) were fitted with double-glazed low-e insulating glass units. An additional 7 million tonnes of CO₂ emissions could be cut thanks to the greater use of triple-glazed low-e insulating glass units for new buildings, where appropriate. Reference: "Potential impact of Low-Emissivity Glazing on energy and CO₂ savings in Europe" (TNO Report 2008-DR1240/B by TNO Built Environment and Geosciences, Delft, The Netherlands). www.glassforeurope.com.

To maximise energy efficiency all year round, often the ideal glazing solution balances both solar control and low-emissivity performance. Our products offer two ways in which this can be achieved:

- by applying a single product which provides both solar control and low-emissivity in an insulating glass unit,
- by using both a solar control product and a separate low-emissivity product within an insulating glass unit.

Our low-emissivity range covers all levels of requirements:

- from on-line products such as Pilkington **K Glass™**,
- to extremely low U-value off-line solutions in the Pilkington **Optitherm™** range,
- through to Pilkington **Suncool™** Pilkington **Solar-E™** and Pilkington **Eclipse Advantage™** which provide both low-emissivity and solar control properties in a single product.



High quality insulating glass units

Description

Pilkington insulating glass units called Pilkington **Insulight**[™] or Pilkington **Insulight**[™] Triple are technically advanced, dual sealed, double or triple glazed units.

They are designed to accommodate a variety of cavity widths. The dual seal design is able to withstand a wide temperature range and can be supplied with edge seals designed to withstand UV exposure as well as moisture vapour permeation.

Applications

Pilkington **Insulight**[™] offers a whole family of different variants, each one utilising a product from the specialist Pilkington glass range, to meet a particular requirement such as: safety, security, thermal insulation, solar control, noise control etc.

Below you can find our complete range of Pilkington **Insulight**[™] products, which take their names from the main benefit provided by the glazing.

- Pilkington **Insulight Activ**[™] – self-cleaning units
- Pilkington **Insulight**[™] Sun – solar control units
- Pilkington **Insulight**[™] Phon – noise control units
- Pilkington **Insulight**[™] Protect – safety, security and fire protective units
- Pilkington **Insulight**[™] Décor – decorative units
- Pilkington **Insulight**[™] Therm – thermal insulation units

Features and benefits

- Wide range of technical performance options.
- Range of cavity widths from 6 to 22 mm (including traditional and warm edge spacers).
- Seal design is able to withstand a wide temperature range.
- Can be delivered with UV resistant seals for use in structural glazing.
- Standard 5 years warranty.
- Tested to European Standards EN 1279-2 and EN 1279-3 and satisfies the requirements of the product standard EN 1279-5.
- Available with Georgian bars.
- Maximum size 3000 x 5000 mm.



Pyrolytic on-line coated low-emissivity glass

Description

Pilkington **K Glass**[™] is a durable, pyrolytic on-line coated, neutral coloured, low-emissivity glass, with high solar gain, which provides improved thermal insulation to multiple-glazed windows so reducing condensation and maximising comfort. A specially formulated, permanent, transparent low-emissivity coating is applied pyrolytically to one surface of clear float glass during glass manufacture. The coating allows the 'free' shortwave energy from the sun to enter the building, but acts as a barrier to the escape of expensive longwave energy from internal heat sources.


Applications

Extremely versatile, Pilkington **K Glass**[™] is recommended for new buildings and renovations/modernisations where high solar heat gain is beneficial.

Features and benefits

- Substantially improved thermal insulation compared to conventional double glazing; U-value of 1,5 W/m²K in 4-16-4 standard constructions with argon (90%), reducing the need for heating the building.
- High solar heat gain offering overall energy saving performance.
- Substantially reduced condensation.
- High light transmission, reducing the need for lighting the building.
- Neutral colour in transmission and reflection.
- Can be combined with a body-tinted or reflective solar control glass in an insulating glass unit to provide both thermal insulation and solar control.
- Durable pyrolytic on-line coating easy to handle and process, providing low cost solution with high visual impact.
- Can be laminated, toughened and bent using standard techniques.
- Can be used in monolithic form or incorporated in insulating glass units, and has unlimited shelf-life.
- No edge deletion required.
- Available in 3 mm, 4 mm, 5 mm and 6 mm.
- Achieves Class B to EN 1096 for coated glass.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington K Glass™																															
		glass		performance code		light			energy					S, UV																			
	I	W/m ² K	%	%	LT	g	energy	LT	transmittance	LRo	reflectance outside	LRI	reflectance inside	Ra	colour rendering index	ET	direct transmittance	ER	reflectance	EA	absorptance	TET	total transmittance	SSC	shortwave shading coeff.	LSC	longwave shading coeff.	TSC	total shading coefficient	S	selectivity index	UV	UV transmittance
3	mm	3,7	83	76	↔	↔	↔	83	11	12	99	73	10	17	76	0,84	0,03	0,87	1,09	48	1,11	45	74	0,82	0,03	0,85	1,11	45	1,14	40			
4	mm	3,7	82	74	↔	↔	↔	82	11	12	99	71	10	19	74	0,82	0,03	0,85	1,11	45	1,14	40	71	0,78	0,04	0,82	1,14	40					
6	mm	3,7	81	71	↔	↔	↔	81	11	11	99	68	9	23	71	0,78	0,04	0,82	1,14	40	1,14	40	71	0,78	0,04	0,82	1,14	40					

Notes:

1. It is recommended that this product should not be used in single glazing applications.
2. Coating on surface 2 (facing inside).
3. Maximum size: 6000 mm x 3210 mm.



Description

A wide range of thicknesses of high quality clear float glass manufactured by the float process.


Applications

Pilkington **Optifloat™** Clear can be used in wide variety of applications, often representing a practical and stylish alternative to solid materials. It may be used in the exterior and interior of buildings to permit the transmission of daylight, thus reducing the cost of artificial lighting and allowing occupants to view their surroundings. In thicknesses above 6 mm, it can be used for a variety of commercial applications where superior strength, greater spans, reduced deflection, high daylight transmission and enhanced noise suppression are required. Where a safety glass is required, Pilkington **Optifloat™** Clear can be toughened or laminated.

Features and benefits

- High quality float glass.
- Very high light transmission.
- Extremely durable material.
- Maintenance-free and easily cleaned.
- Easily processed and fabricated.
- Can be used in insulating units in combination with other glasses.
- Can be toughened or laminated for safety and security.
- Manufactured in accordance with EN 572-2.
- Wide range of thicknesses – 2 mm to 19 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Optifloat™ Clear																
		glass configuration		performance code			light			energy						S, UV		
I		U	LT	g	%	LT	LRo	LRi	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
2	mm	5,9	90	88	90	90	8	8	99	86	8	6	88	0,99	0,02	1,01	1,02	69
3	mm	5,8	90	87	90	8	8	8	99	84	8	8	87	0,97	0,03	1,00	1,03	64
4	mm	5,8	90	85	90	8	8	8	99	83	7	10	85	0,95	0,03	0,98	1,06	60
5	mm	5,8	89	84	89	8	8	8	98	81	7	12	84	0,93	0,04	0,97	1,06	56
6	mm	5,7	88	82	88	8	8	8	98	79	7	14	82	0,91	0,03	0,94	1,07	53
8	mm	5,7	88	80	88	8	8	8	97	76	7	17	80	0,87	0,05	0,92	1,10	49
10	mm	5,6	87	78	87	8	8	8	97	72	7	21	78	0,83	0,07	0,90	1,12	45
12	mm	5,5	85	75	85	8	8	8	96	68	7	25	75	0,78	0,08	0,86	1,13	42
15	mm	5,5	83	71	83	8	8	8	94	63	6	31	71	0,72	0,10	0,82	1,17	38
19	mm	5,3	81	67	81	7	7	7	92	57	6	37	67	0,66	0,11	0,77	1,21	35

Notes:

Maximum size: 6000 mm x 3210 mm.



Off-line coated high performance low-emissivity glass

Description

Pilkington **Optitherm**[™] S1 and Pilkington **Optitherm**[™] S3 are high quality clear glasses with specially formulated off-line low-emissivity coatings applied to one surface after glass manufacture. The effect of the low-emissivity coating is to reflect the long wavelength energy (generated by heating systems, lighting and building occupants) back into the building. However, the transparent coating still permits the transmission of short wavelength energy originating from the sun. This solar energy is absorbed by the internal surfaces of the building and re-radiated at the longer wavelengths that are then reflected by the coating into the building. The visual appearance of Pilkington **Optitherm**[™] S1 and Pilkington **Optitherm**[™] S3 is almost identical to that of ordinary clear glass. As the coating is transparent and neutral in colour, its effect on light transmission and reflection is barely perceptible.

Applications

Pilkington **Optitherm**[™] S1 and Pilkington **Optitherm**[™] S3 can only be used in insulating glass units. They are popular low-emissivity glasses because of their neutral colours, their high light transmissions and their excellent thermal insulation characteristics. They can be used from the smallest installation to the most prestigious curtain walling applications – anywhere where there is concern for reduced energy consumption and heat loss. Pilkington **Optitherm**[™] S1 has a higher performance low-emissivity coating than Pilkington **Optitherm**[™] S3, to further reduce heat loss through the unit for more demanding applications. Available in 3, 4, 6, 8, 10 and 12 mm thicknesses, they are often used in combination with other environmental control glasses. Pilkington **Optitherm**[™] S1 and Pilkington **Optitherm**[™] S3 cannot be toughened or laminated after coating. However, where a safety glass is required, the coatings can be applied to toughened or laminated glass.

For safety applications, Pilkington offers Pilkington **Optitherm**[™] S3 Pro T. This glass has to be toughened and its colour is matched to Pilkington **Optitherm**[™] S3. After toughening the product has similar technical performance to Pilkington **Optitherm**[™] S3.



Features and benefits

- High to very high thermal insulation performance with U-values down to 1,0 W/m²K in 4-16-4 standard constructions with argon (90%), reducing the need for heating the building.
- Substantially reduced condensation.
- High light transmission, reducing the need for lighting the building.
- Neutral colour in transmission and reflection.
- Can only be used in insulating glass units (coating generally on surface #3); argon gas filling can be used to achieve higher thermal insulation.
- Can be combined in an insulating glass unit with solar control glass to improve both solar control and thermal insulation performance.
- Can be enhanced when combined with other Pilkington products to provide additional benefits such as self-cleaning, noise control, safety or security properties.
- Available in annealed, toughened and laminated form.
- Available in a “to be toughened” version – Pilkington **Optitherm™** S3 Pro T.
- Available in 3, 4, 6, 8, 10 and 12 mm thicknesses.



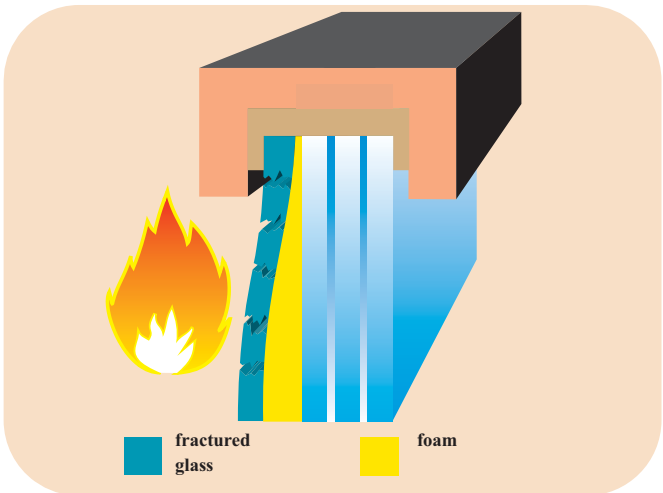
3.0 Fire Protection



The wide range of modern functional glazings now available has opened up remarkable scope for creative design in today's architecture. Transparent design from façades and roofs right through to the centre of the building is no longer a vision, it is reality.

State-of-the-art glazing can now be used in high performance designs to provide a protected, yet comfortable and versatile building environment, founded on daylighting, brightness and clear vision, replacing solid roofs, doors and partitions which block out views and natural light. Our fire protection range of products, Pilkington **Pyrostop**[®] and Pilkington **Pyrodur**[®], combine fire resistance and design flexibility, for peace of mind, elegant and functional buildings.

New and existing buildings according to regulations in force should provide suitable level of fire safety. The ordinary clear float glass widely used in buildings is not resistant to fire at all. It breaks at temperature difference equal to about ΔT 40°C. Ordinary laminated safety glass is also not resistant to fire – the glass breaks as quickly as clear float. Furthermore, at temperature of about 250°C, when the PVB foil melts and fails to retain the glass fragments, the glass collapses. Whilst standard toughened glass is more resistant to high temperatures, it generally cannot survive temperatures higher than about 300-350°C.



The reaction of Pilkington **Pyrostop**[®] and Pilkington **Pyrodur**[®] in case of fire.



That is why it was necessary to introduce products that could withstand typical temperature of fire of 1000°C, and additionally in the event of fire, would be able to give people the maximum amount of time for safe escape. Pilkington **Pyrostop**[®] and Pilkington **Pyrodur**[®] meet these criteria.

Pilkington **Pyrostop**[®] and Pilkington **Pyrodur**[®] are clear, multi-layered fire resistant glasses made of clear or extra clear float glass (Pilkington **Optifloat**[™], Pilkington **Optiwhite**[™]), laminated with transparent intumescent interlayer. When exposed to fire, the pane facing the flames fractures but remains in place, and the interlayer immediately foams up to form a thick, resilient and tough insulating shield that absorbs the energy of the blaze. This takes place at only modest temperatures around 120°C, such that protection is provided right from the early stages of a fire. The resilient sandwich structure of Pilkington **Pyrostop**[®] and Pilkington **Pyrodur**[®] ensures that they stay in place and continue to act as an insulating fire-resistant wall for the required time periods, as defined in the standard approvals tests.

Pilkington **Pyrostop**[®] and Pilkington **Pyrodur**[®] have been tested in more fire doors, fire protection framing and façade systems than any other fire-resistant glass product, covering vertical, horizontal and inclined glazing situations.

Definitions:

Integrity (class E)

The ability of the system to keep back flames, smoke and hot gases. No flaming on the non-fire side is permitted within the approved time classification.

Insulation (class I)

The ability of glazed screens or doors to limit the temperature rise on the non-fire side to an average of no more than 140°C and in any one position by no more than 180°C.

Radiation (class W)

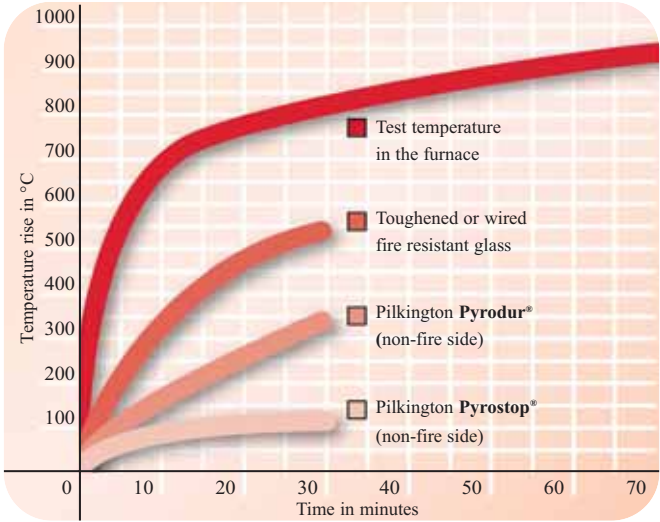
The ability of the element of construction to reduce the probability of transmission of fire as a result of significant radiated heat, either through the element or from its unexposed surface to adjacent materials on the non-fire side.



Safety

Pilkington **Pyrodur**[®] and Pilkington **Pyrostop**[®] have been successfully tested for impact safety according to EN 12600 and provide safety up to Class 1(B)1.

Typical temperature curves



Summary data from standard fire tests.

CEN Classification according to EN 13501-2

CEN introduced the following classes:

E = integrity (Pilkington **Pyrodur**[®])

EW = integrity plus reduced heat radiation (Pilkington **Pyrodur**[®])

EI = integrity and insulation (Pilkington **Pyrostop**[®])

Combinations

Pilkington **Pyrostop**[®] and Pilkington **Pyrodur**[®] are designed to be combined with the full range of Pilkington glasses in either insulating glass units or as monolithic glazing for all glazing applications. This gives full scope to design glazing with thermal insulation, solar control, acoustic insulation, safety and security properties – all with built-in high performance fire protection.



How to specify fire resistant glass?

Subject to confirmation of: fire tested assembly/safety requirement/thermal stress check/wind loading check (façades). Please verify compliance with local regulations.

It is the installer's responsibility to ensure that the glasses are installed in a fully tested and certified glazing system, and that the assemblies meet local regulatory requirements.

All Pilkington **Pyrostop**[®] and Pilkington **Pyrodur**[®] products should have permanent marking on glass surface.



Laminated fire protection glass for integrity only

Description

Pilkington **Pyrodur**® is a clear laminated fire-resistant and safety glass (in thickness from 9 mm) designed to provide integrity-only fire protection, but also offering a level of insulation against radiant heat transfer.

Applications

Suitable for internal and external applications where fire-resistant glasses are required to provide a prescribed level of integrity only, Pilkington **Pyrodur**® is available in single and double-glazed form, for use with steel, aluminium, softwood and hardwood timber frames. It can be combined with functional glasses to produce a wide range of products for numerous applications. Pilkington **Pyrodur**® is particularly suited to use in doors, screens and partitions where lightweight, narrow profiles are important and ease of glazing is a priority. Other applications include insulating glass units in façades and roof glazing.




Features and benefits

- Provides proven integrity for up to 60 minutes when used in a suitable, tested glazing system, restricting the spread of flames, smoke and hot gases.
- Special clear intumescent interlayers, reacting to form a rigid, opaque, visual barrier to flames, helping to reduce panic and fear during evacuation of the building.
- Added benefit of reducing the transmission of conductive and radiant heat from the fire.
- Lightweight.
- Totally clear, unobstructed vision.
- Can be used for internal or external applications.
- Provides effective noise control.
- Can provide impact safety performance, dependent upon thickness.
- Can be combined with other functional glasses for greater flexibility in applications.
- Available in monolithic or insulating glass unit form.



Pilkington Pyrodu® for internal use (class E)

 PILKINGTON <small>NSG Group Flat Glass Business</small>	Pilkington Pyrodu® for internal use (class E)							
Glass type	Class	Thickness [mm]	Thickness tolerance [mm]	Light trans. LT [%]	Weight [kg/m ²]	Rw -value [dB]	U -value [W/m ² K]	Maximum tested size [mm]
Pilkington Pyrodu® 30-10 (integrity 30 min)	E 30	7	±1	89	17	34	5,6	1200 x 2300
Pilkington Pyrodu® 30-103 (integrity 30 min)	E 30	9	±1	88	22	35	5,5	1200 x 2400
Pilkington Pyrodu® 60-10 (integrity 60 min)	E 60	10	±1	87	24	35	5,4	1200 x 2000
Pilkington Pyrodu® 30-500 (integrity 30 min) inclined glazing	E 30	23	±2	83	53	40	4,9	1050 x 2000

Notes:
Size tolerance ± 1 mm/m length of edge.



Pilkington Pyrodur® for external use (class E)

Glass type	Class	Thickness [mm]	Thickness tolerance [mm]	Light transm. LT [%]	Weight [kg/m ²]	Rw -value [dB]	U -value [W/m ² K]	Maximum tested size [mm]
Pilkington Pyrodur® 30-201 (integrity 30 min)	E 30	10	±1	87	24	36	5,4	1400 x 2600
Pilkington Pyrodur® 30-251 IGU with 6 mm Pilkington Optifloat™ (integrity 30 min)	E 30	24 to 32	±2	78	40	38	3,0	1400 x 2300
Pilkington Pyrodur® 30-351 IGU with coated glass (integrity 30 min)	E 30	24 to 32	±2	depends on coating*	40	38	down to 1,1	1400 x 2300
Pilkington Pyrodur® 60-20 (integrity 60 min)	E 60	13	±1	85	31	38	5,3	1200 x 2000
Pilkington Pyrodur® 60-35 IGU with coated glass (integrity 60 min)	E 60	25 to 29	±2	depends on coating*	46	38	down to 1,3	1200 x 2000
Pilkington Pyrodur® 30-401 (integrity 30 min) inclined glazing	E 30	40	±2	depends on coating*	67	40	down to 1,3	1050 x 2000

Notes:

Size tolerance ± 1 mm/m length of edge.

* Insulating glass units may include various types of coatings e.g. low-emissivity or Pilkington Suncool™. They can provide additional functions such like thermal insulation (U-value) solar control (g-value), or change colour and reflection of the product.



Wired fire protection glass

Description

Pilkington **Pyroshield™ 2** is a fire resistant wired glass which, in the event of fire, provides an effective barrier to flame, smoke and hot gases. Available in Texture version, offering privacy,

Pilkington **Pyroshield™ 2** can be used where there is a specific requirement for integrity-only fire protection.

Pilkington **Pyroshield™ 2 Safety** is a monolithic safety wired glass for use where there is a specific requirement for both integrity-only fire protection and impact safety to class 3(B)3 according to EN 12600. Available in clear version, Pilkington **Pyroshield™ 2 Safety** is a unique fire and impact resistant glass, combining a fire resistance rating of up to 30 minutes integrity with a consistent level of impact safety.

Applications

Suitable for use with steel and timber frames, internally or externally, Pilkington **Pyroshield™ 2** is ideal for use in screens, partitions, doors, windows, fanlights and overhead glazing. Where there is also a requirement for safety, Pilkington **Pyroshield™ 2 Safety** should be specified.


Features and benefits

- The most widely tested wired fire protection product in the world.
- Visually identifiable as fire resistant glass.
- Provides proven integrity for up to 30 minutes when used in a suitable, tested glazing system, restricting the spread of flames, smoke and hot gases.
- Maintains integrity even when fractured or sprayed with water.
- Pilkington **Pyroshield™ 2 Safety** offers impact safety performance to class 3(B)3 according to EN 12600.
- Pilkington **Pyroshield™ 2 Safety Clear**, in nominal 6 mm, offers distortion-free vision, and remain transparent throughout the fire period.



- Pilkington **Pyroshield™ 2** Texture, in nominal 7 mm, offers a degree of obscuration when privacy is required.
- Easily cut to size locally from stock sizes.
- Extremely cost-effective compared with other integrity fire protection glasses.




 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Pyroshield™ 2 Texture				
		glass	performance code	light	energy	S, UV
7 mm	I	W/m ² K U U value % LT light % g energy	% LT transmittance % LRo reflectance outside % LRI reflectance inside - Ra colour rendering index	% ET direct transmittance % ER reflectance % EA absorptance % TET total transmittance - SSC shortwave shading coeff. - LSC longwave shading coeff. - TSC total shading coefficient	- s selectivity index % UV UV transmittance	78 81 5,7 ⇄ Texture 73 8 19 78 0,84 0,06 0,90 1,04 49
		monolithic glass				

Notes:

Maximum size: 3353 mm x 1829 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Pyroshield™ 2 Safety Clear																																						
		glass	performance code		light			energy				S, UV																												
6 mm	Clear ⇄	U	W/m ² K	LT	%	LT	%	LRo	%	LRI	%	Ra	-	ET	%	direct transmittance	ER	%	reflectance	EA	%	absorptance	TET	%	total transmittance	SSC	%	shortwave shading coeff.	LSC	%	longwave shading coeff.	TSC	%	total shading coefficient	S	-	s selectivity index	UV	%	UV transmittance
		5,7		81		81		9		9		98		73			8		19		19		77		0,84		0,05		0,89		1,05		49							



Notes:
Maximum size: 3300 mm x 1980 mm.



Laminated fire protection glass for integrity and insulation

Description

A clear, laminated fully insulating fire-resistant and safety glass that offers the highest levels of fire protection, limiting the transmission of conductive and radiant heat, while maximising the available levels of natural light and visibility.

Applications

Designed for interior and exterior use where thermal protection is officially required in the case of fire. Available for use with steel, aluminium and timber frames, and in single or double-glazed form, Pilkington **Pyrostop®** is ideal for use in transparent fire walls, windows, doors, screens, partitions, façades, roof glazing (special type) and horizontal glazing (special type).



Features and benefits

- Extensively tested clear fire protection.
- Provides proven integrity and insulation for up to 120 minutes when used in a suitable, tested glazing system, restricting the spread of flames, smoke and hot gases and limiting the transmission of conductive and radiant heat from the fire.
- Special clear intumescent interlayers, reacting to form a rigid, opaque, visual barrier to flames, helping to reduce panic and fear during evacuation of the building.
- Maximum light transmission for thicker versions that use Pilkington **Optiwhite™** low iron glass.
- Totally clear, unobstructed vision.
- Impact safety.
- Provides effective noise control.
- Can be combined with other functional glasses for greater flexibility in applications.
- Available in different types for internal or external use.
- Available in monolithic or insulating glass unit form.



Pilkington Pyrostop® for internal use (class EI)




Class	Thickness [mm]	Thickness tolerance [mm]	Light transm. LT [%]	Weight [kg/m ²]	Rw -value [dB]	U -value [W/m ² K]	Maximum tested size [mm]
Pilkington Pyrostop® 30-10 (insulation 30 min, integrity 30 min)	EI 30 15	±1	86	35	38	5,1	1400 x 2400
Pilkington Pyrostop® 60-101 (insulation 60 min, integrity 60 min)	EI 60 23	±2	87	55	41	4,8	1400 x 2400
Pilkington Pyrostop® 90-102 (insulation 90 min, integrity 90 min)	EI 90 37	±2	84	86	44	4,2	1400 x 2300
Pilkington Pyrostop® 120-10 (insulation 120 min, integrity 120 min)	EI 120 56	±3	74	117	43	2,5	1150 x 2200
Pilkington Pyrostop® 120-106 (insulation 120 min, integrity 120 min)	EI 120 54	±3	75	112	43	2,6	1220 x 2420
Pilkington Pyrostop® 30-500 (insulation 30 min, integrity 30 min) inclined glazing	EI 30 27	±2	81	63	41	4,8	1050 x 2000
Pilkington Pyrostop® 60-50 (insulation 60 min, integrity 60 min) inclined glazing	EI 60 33	±3	85	75	41	4,5	1050 x 2000

Notes:

Size tolerance ± 1 mm/m length of edge.



Pilkington Pyrostop® for external use (class EI)

 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Pyrostop® for external use (class EI)									
Class	Thickness [mm]	Thickness tolerance [mm]	Light transm. LT [%]	Weight [kg/m ²]	Rw -value [dB]	U -value [W/m ² K]	Maximum tested size [mm]				
EI 30	18	±1	85	42	38	5,0	1400 x 3000				
EI 30	32 to 36	±2	76	58	39 to 40	2,9 to 2,7	1400 x 2400				
EI 30	32 to 36	±2	depends on coating*	58	39 to 40	down to 1,3	1400 x 2400				
EI 60	27	±2	86	63	41	4,7	1400 x 2400				
EI 60	41 to 45	±2	77	77	41	2,7	1400 x 2400				
EI 60	41 to 45	±2	depends on coating*	77	41	down to 1,3	1400 x 2400				
EI 90	40	±2	83	93	44	4,1	1400 x 2000				
EI 120	64	±2	depends on coating*	120	46	2,3	1150 x 2200				
EI 30	44	±2	depends on coating*	77	40	down to 1,3	1050 x 2000				

Notes:

Size tolerance ± 1 mm/m length of edge.

* Insulating glass units may include various types of coatings e.g. low-emissivity or Pilkington **Suncool**™. They can provide additional functions such like thermal insulation (U-value), solar control (g-value), or change colour and reflection of the product.



4.0 Noise Control



Introduction

It could be a Sunday afternoon when you are indoors reading a good book, you could be tucked up in bed at night or seated at work trying to concentrate when you are disturbed by noisy neighbours, traffic or a variety of other unwanted noise. We all suffer from the intrusion of noise at some time or another.

With an increasing population density, factory production and transport, the noise seems to get worse with fewer opportunities to escape. Along with the increase in noise is a growing awareness of the effect on health due to the stress caused by everyday sounds intruding into once quiet environments. The trend for the future suggests that traffic and noise in general is going to get worse as living space declines. There is an increasing interest in ways to protect people from noise to avoid the considerable stress that it causes and in some cases serious illness.

A considerable amount of work has been done to control noise intrusion into a building and between adjoining areas, and whilst this is valuable we want to concentrate on the contribution that the careful selection of glass has to offer in managing the problem.



Figure 1: Sound spreads out in a similar manner to waves in water.



What is sound?

From a physical point of view, sound belongs in the field of wave physics / mechanical oscillations. Even 2000 years ago, a Roman architect engaged in the construction of amphitheatres used waves in water to improve his design.

For example, if we strike a tuning fork, we can hear the oscillations, but we cannot see them. These oscillations of the tuning fork are transmitted to air molecules, which then pass on their oscillations to other air molecules. This behaviour can be demonstrated in water. These oscillations are comparable to a wave in water, with the height of the wave being a measure of the volume of sound and the number of waves in time is the frequency of the sound i.e. the more waves, the higher the frequency. Frequency is defined as cycles per second or Hertz. Hertz is the correct way to describe the frequency or pitch of the sounds and is abbreviated to Hz.

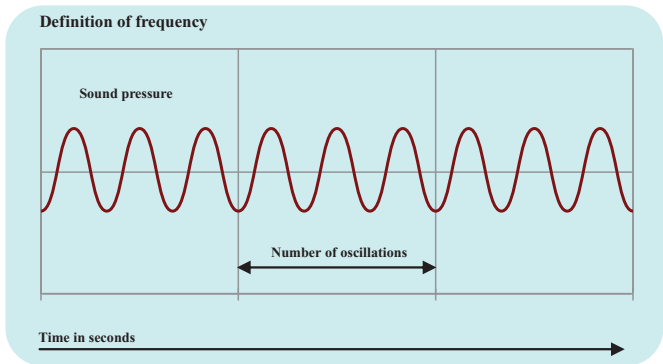


Figure 2: Definition of frequency.

In music, the note A (nearest A above middle C) has a frequency of 440 Hz or oscillations per second in concert tuning. If the frequency is doubled to 880 Hz, the note increases by an octave for equal tempered tuning.

The human ear of a young person can detect frequencies of 20 Hz up to 20,000 Hz and is capable of detecting sound pressures, or to be more precise pressure fluctuations, of between 10^{-5} Pascals (Pa) = 0,00001 (lower limit of hearing) and 10^2 Pa = 100 Pa (pain threshold)



by passing these on to the brain as a sensation of volume. With increased age the range of audible frequency diminishes from both ends of the scale naturally or from hearing damage.

The relationship between the quietest and the loudest noise is a ratio of 1 to 10 million. Since this is very unwieldy, in practice the sound-pressure level, or sound level L for short, is expressed as a logarithmic scale which represents a conversion of the sound pressure into a more convenient measure known as the decibel scale (dB). The normal range extends from 0 dB (hearing threshold) to around 130 dB (pain threshold). Figure 3 shows a few examples.

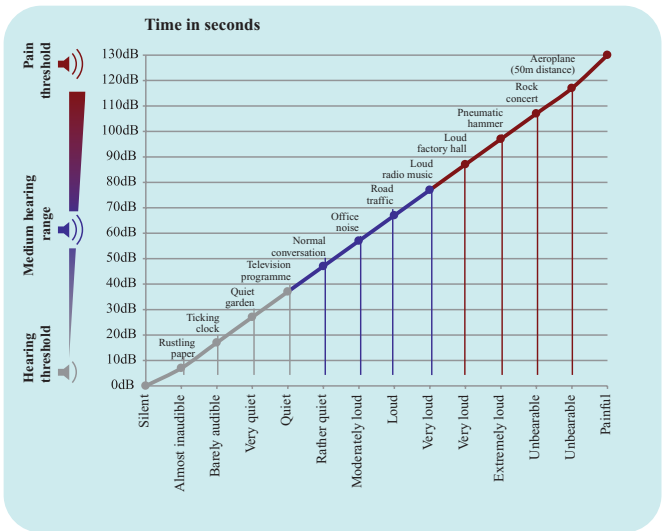


Figure 3: Noise source and perception (source: Kuraray, Troisdorf).

There are a variety of ways of creating noise and each noise can produce different volumes of sound at different frequencies. If we use aircraft as an example there is a clear difference in the sound made by propeller driven aircraft, modern fan jets and military aircraft. If the volume by frequency is plotted as a graph they would look distinctly different. When trying to defeat noise these variations can be taken into account and different glass types also work better at some frequencies than others. By matching the performance of the glass to the noise we can selectively reduce the most annoying



sounds to get the maximum benefit. Anyone living next to a private airstrip with light aircraft has a very different problem to a neighbour of a military base. The solution to the noise problem will be to use a different glass configuration.

Determining the noise level can be done in a number of ways. For large or difficult projects a site noise survey can be commissioned using acoustic consultants who use sensitive equipment to measure and average noise levels by frequency over a period. These surveys give precise data on the volume of noise at each frequency that needs to be attenuated. The information is often provided in reports that break the noise down into a table showing octave frequencies, e.g.:

Frequency [Hz]	125	250	500	1000	2000	4000
Sound pressure [dB]	30	36	42	44	48	50

The sound can be measured at the site, close to the noise source or a distance in between. Where site data is not provided an adjustment can be made to the sound to allow for distance. The further you are away from the source the less impact it has.

Example: Decay of noise with distance.

Road traffic noise decreases by approximately 3 dB with doubling of distance at right angles to the road. If, for example, L is the dB noise level at 5 meters, then the decay follows the pattern:

5 m	L	dB
10 m	(L-3)	dB
20 m	(L-6)	dB
40 m	(L-9)	dB
80 m	(L-12)	dB
160 m	(L-15)	dB

The noise level is often measured over a period and averaged to remove the disproportionate effect of isolated loud noise that is exceptional like a car horn sounding. A level of noise energy can be determined that is an A weighted long term average called the day-evening-night level (L_{den}). It is the L_{den} noise level that should be the basis of the design rather than isolated peaks in sound. Therefore



the aim of the design should be to control the general noise rather than exceptions otherwise the noise reduction criteria would become extreme. For some applications it may be appropriate to use only part of the three periods or a supplementary noise indicator for noise that only occurs for a short period of time.

There is sometimes an option with noise measuring equipment to record the data with an A weighting. Where interior noise limits are set they are often expressed in dB (A) L_{Aeq} . The A weighting is an adjustment to the noise at each frequency that follows a standardised curve. The A weighting is a recognition that the human ear does not react to the same volume at each frequency equally i.e. some frequencies seem louder than others even though they are being delivered with the same energy. It is important that the human reaction to noise is considered rather than making decisions based upon the sensitive instruments that measure sound in an absolute way.

Where a survey is not carried out then there are examples of previous surveys that allow designers to assume typical noise levels from common sources of noise e.g. road traffic, music, speech, trains, aircraft etc.

Where third octave or octave band information is not provided there are a range of shorthand expressions used for the noise, typically the R_w and R_{tra} figures may be used to abbreviate the information. For glass performance the abbreviations are determined by taking plots on a graph of the sound attenuation by frequency and mathematically comparing standard curves to then until they are a good fit. The noise reduction at a fixed frequency on the standard curves provides the R_w and R_{tra} figures.

When the noise level is known the performance of the glass can be matched to get the required level of residual noise. It is important that the indices of measurement are matched or in the same scale to ensure that the calculation is correct.

For those who like to dig a little deeper

The measured values for 10 mm Pilkington **Optifloat**[™] – 16 mm air space – 9,1 mm Pilkington **Optiphon**[™]* are shown in blue. The

* previously known as Pilkington **Optilam**[™] Phon



reference curve specified in EN 717 Section 4 is shown in red. This reference curve is now moved downwards in whole dB increments, until the sum of the deviations of the measured values from the shifted reference curve is maximised and less than 32 dB. Only those measured values that are less than the reference values are taken into account. The y-value of this shifted reference curve (green curve in Fig. 4) at a frequency of 500 Hz is the sought R_w -value, in this example 45 dB. Unfortunately, the above-mentioned relationship between the sound-pressure amplitude and the perceived volume is not as simple as scientists would like it to be because nature has made our hearing more sensitive to certain ranges than to others. This means that we perceive a thousand Hz tone as louder than a hundred Hz tone, even though the volume is the same. This property of the human ear is taken into account in the shape of the reference curve.

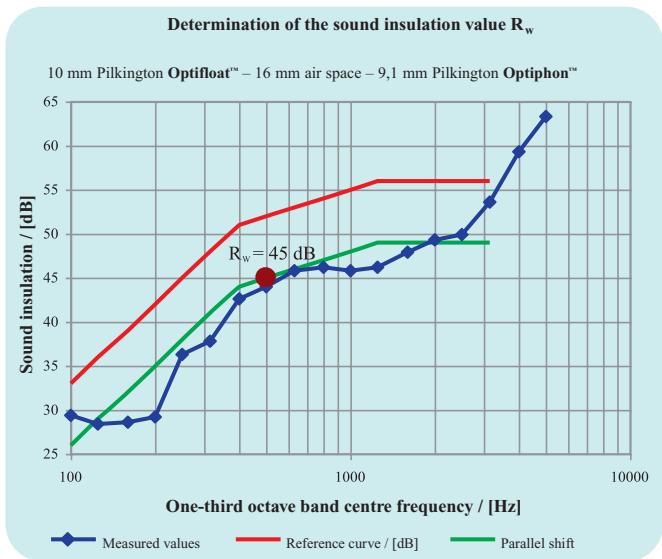


Figure 4: Determining the sound insulation.

Determining the sound insulation of types of glass

Since it would be time consuming and costly to measure every system on site, all sound insulation spectra are recorded under



standardised conditions. As we see, sound insulation is very frequency-dependent. To avoid having to work with the complete data set this diagram can be reduced to a single value. The standardised procedure is described in the box below. The result is a single number – in this case $R_w = 45$ dB – which can be used in further calculations.

The disadvantage of such a single-value specification is that we can arrive at the same result with completely different curve shapes, as shown in Figure 5.

We achieve more expressive single-value specifications if we use “custom-made” reference curves for specific requirements.

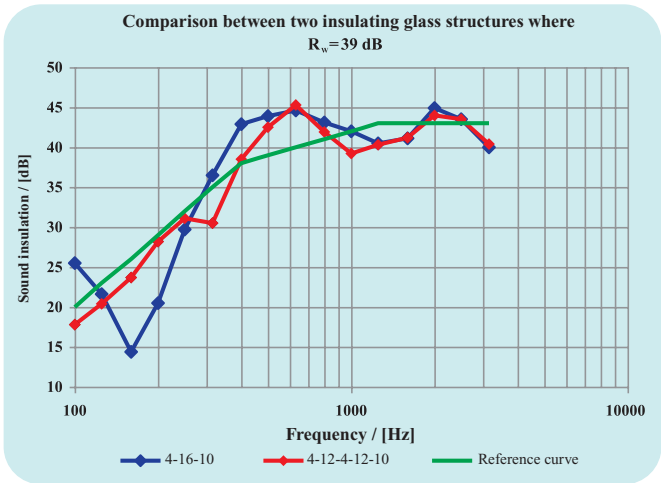


Figure 5: Comparison between two insulating glass structures.

Such “special cases” are C and C_{tr} . They take into account the different frequency spectra of residential and traffic noises and thus make it possible to find adequate solutions to the problems in question in a simple manner.

The C -value takes into account the noise sources:

- residential activities (talking, music, radio, TV),
- children playing,
- rail traffic at average and high speed,



- motorway traffic > 80 km/h (50 mph),
- jet aeroplanes a short distance away,
- businesses that emit primarily medium- and high-frequency noise.

The C_{tr} -value takes into account noise sources such as:

- urban road traffic,
- low speed rail traffic,
- propeller aeroplanes,
- jet aeroplanes a long distance away,
- disco music,
- businesses that emit primarily low- and medium-frequency noise.

Thus, if the planned building is located in a city, right by a main road, the C_{tr} value is the most suitable. If a building is planned right next to a motorway, the C value is more appropriate.

Calculation rules

Although the use of the dB scale facilitates nice convenient numbers, it also gives rise to somewhat unusual “calculation rules”. If a noise source is duplicated then the overall dB value rises by only 3 dB. A ten-fold increase i.e. ten electric fans instead of one, leads to an increase of only twice as much noise i.e. 10 dB.

To complete the explanation, we should also mention that a halving of the noise level at the ear is not recognised as a halving of the volume. In general it is true that:

- a difference of 1 dB is not practically noticeable,
- a difference of 3 dB is just perceptible,
- a difference of 5 dB represents a clear difference,
- a difference of 10 dB halves / doubles the noise.

The different types of sound insulation

Mass

As mentioned above, sound spreads in waves by exciting the molecules of the medium in question so that they oscillate. Due to this means of transmission, the noise is subject to a natural damping – depending upon the mass in question. Expressed



simply: the more mass put between transmitter and receiver, the greater the damping.

The simplest way of increasing the sound insulation of glass is therefore to use a lot of glass. Thus a 12 mm single pane has an R_w value of 34 dB, whereas the corresponding value for a 4 mm pane is only 29 dB.

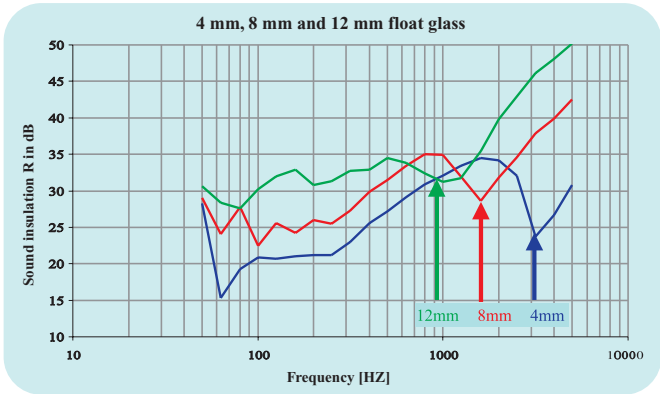


Figure 6: Influence of the pane thickness on the coincidence frequency.

Coincident frequency and asymmetry

If we compare the spectra of 4 mm, 8 mm and 12 mm float glass, we see that each of these spectra has a downturn in the right-hand section.

This fall off in performance at certain frequencies or coincident frequencies occurs at the frequency that matches the natural resonant frequency for the product. The so-called coincident frequency f_g is material specific and dependent upon thickness for glass. As a rule of thumb:

$$f_g = \frac{12000 \text{ Hz}}{d}$$

(where d = thickness of material)



According to this formula, f_g is 3000 Hz for 4 mm float glass, 1500 Hz for 8 mm float glass and 1000 Hz for 12 mm float glass, which corresponds very well with the spectra in Figure 6.

To overcome this we can mix the thicknesses of glass panes in an insulating unit structure so that when one pane is at its coincident frequency the other is not and continues to defeat the sound. Such asymmetric structures can thus significantly reduce the downturn in the coincidence range, as shown in Figure 7. A 30% difference in thickness is desirable. Not only does this reduce the dip but it also shifts it up the scale which is beneficial as the higher the frequency, the more effective the glass becomes at reducing the overall noise level.

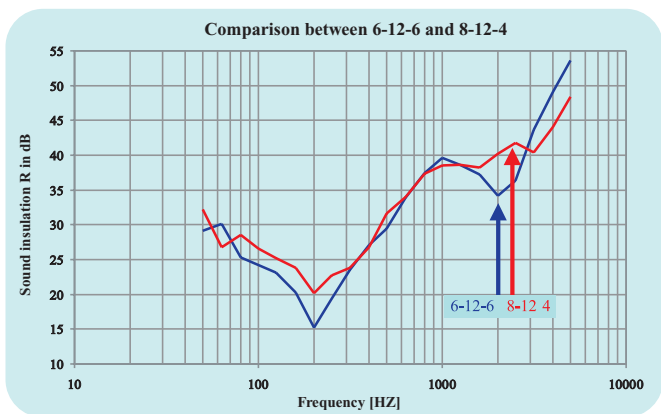


Figure 7: Asymmetric glass structure to reduce coincidence.

Gap between panes / gas fillings

Another method for controlling the transmission of noise is to vary the distance between the panes of glass. With conventional insulating glass units the gap between the panes is limited to maintain the optimal thermal performance and the size of the gap is not large enough to significantly improve the acoustic performance. With secondary glazing there is an opportunity to have relatively large gaps and an airspace of over 60 mm starts to provide real improvements in performance. The space between the panes can also be lined with acoustic tiles to enhance the benefit.



Gas filling the space between panes of an IGU has a marginal effect and there is no practical improvement in using argon gas. Due to the density of krypton a small benefit can be gained in acoustic performance of up to 1 dB. Sulphur hexafluoride (SF_6) could be used for sound insulation simply because it is so heavy, however, this gas has two disadvantages. Firstly it worsens the thermal insulation value and secondly this gas has a CO_2 equivalent of 22.800 and thus makes an extremely large contribution to the greenhouse effect. For these two reasons, the use of SF_6 gas is banned throughout large parts of Europe.

Decoupling / damping

We have said that the thickness of glass helps and varying the glass thicknesses in an insulating unit is a useful method of improving noise reduction. Adding mass to the product or having large air gaps may also be undesirable for reasons of weight and space. Fortunately there are ways of improving the noise reduction of relatively thin panes of glass by introducing a damping effect within the glass. By laminating the glass with ordinary PVB interlayer we can reduce the fall off in performance due to the coincident frequency and shift the frequency at which the downturn occurs. Adding a Pilkington **Optilam**[™] product to the construction can have a marked improvement particularly where the noise level would be high at the coincident frequency for a monolithic glass. Insulating glass units can provide very good results with a mixture of monolithic (Pilkington **Optifloat**[™]) and Pilkington **Optilam**[™] glass types.

For higher specification requirements there is Pilkington **Optiphon**[™]. These products use special interlayers in a laminate that further decouple the two panes of glass whilst still providing the impact safety of laminated glass. If you look at the curve profile for Pilkington **Optiphon**[™] you will see that the fall off in performance at what would have been a coincident frequency is almost eliminated. The correct grade of product can be chosen to match the sound profile to allow superior performance without dramatically increasing the glass thickness. This allows for greater flexibility in design without compromising other glazing functions.

In the left-hand part of the spectra (Fig. 7) we see a further downturn. This is the so-called resonant frequency. This is the



frequency at which the component as a whole oscillates in resonance and thus transports the sound oscillations particularly well and insulates poorly.

The sound insulation can be improved by moving the resonant frequency of the component to another frequency (away from the nuisance frequency or to where the human ear can hear less well). This is achieved by “decoupling” the insulating glass unit, by making a pane of glass at the same time dense and soft. This can be achieved by joining two panes of glass either with special (soft) cast-in-place resins or with modern PVB interlayers developed specially for this application.

Important reminder

The object of selecting the right acoustic product is to make the internal environment comfortable and free from the stress associated with noise intrusion. The level of residual noise is not the same for all locations and national guidelines are produced for most environments. For instance, the background noise in a library should be around 30 dB. Zero noise is undesirable and tends only to be found in an echoic chambers usually reserved for testing. Zero noise can be an eerie experience as the ear tunes to other sounds that become distracting.

The equation as a first guide becomes:

$$\text{Noise Source} - \text{building attenuation} = \text{residual noise}$$

Note that the whole building needs to work and that glass alone will not solve all acoustic problems. Sound only needs a small entry way to get into a building unlike heat loss or gain, which tends to be proportional to the surface area. For a noise reduction of up to 35 dB provided by the glass the window frame without a ventilator should provide similar performance. Above this level, windows developed for noise reduction need to keep pace with the glass performance to ensure the combined product is functioning.



To sum up

There are five factors that can be combined, which can positively influence the sound insulation of an insulating glass unit.

1. Glass mass.
2. Asymmetric structure.
3. Large gap between panes.
4. Use of alternative gases.
5. Use of Pilkington **Optiphon™** special laminated safety glasses or Cast In Place (CIP) products.

For the higher sound insulation requirements, modern sound insulating laminated safety glass products such as Pilkington **Optiphon™**, are becoming increasingly prevalent in comparison to the cast-in-place resin products because R_w values of even more than 50 dB can be achieved and they can be supplied in large sizes. The compatibility of PVB with other materials is well understood and safety benefits such as impact protection / safer overhead glazing can also be achieved.

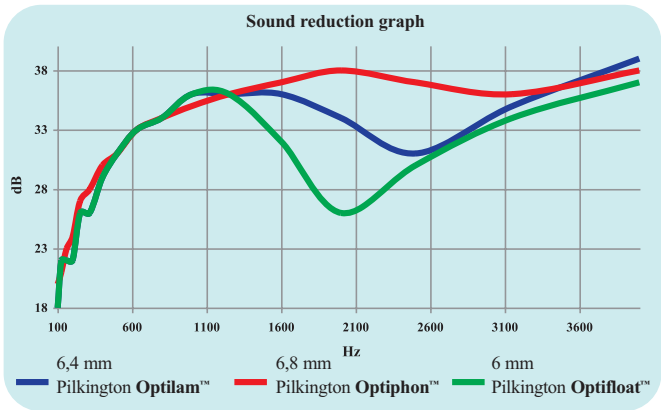


Figure 8: Sound reduction illustration.

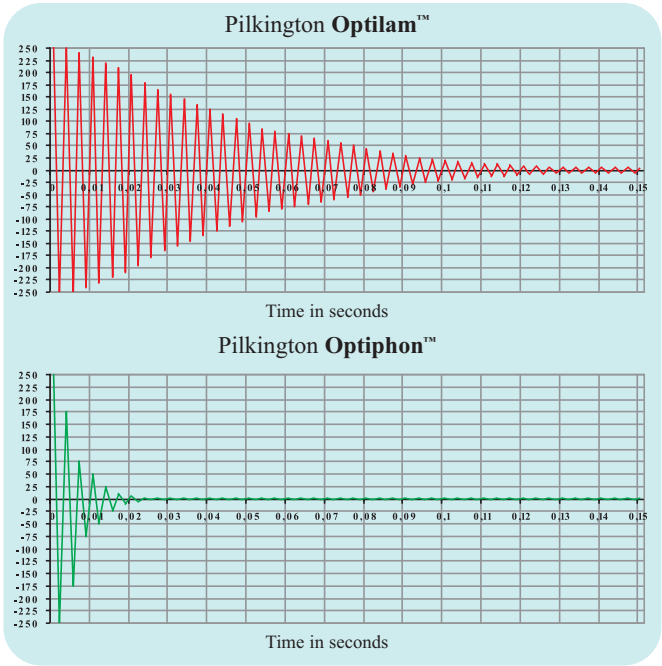


Figure 9: The illustration shows the impressive damping differences between Pilkington **Optilam™** and Pilkington **Optiphon™** from the sound engineering point of view.

4



Insulating glass units with improved sound insulation

With increasing traffic on the road, rail and in the air, noise insulation has become a very important topic. It is not a question of it being a luxury anymore it is essential that noise reduction is considered in the specification of the glazing.

Pilkington **Insulight™** Phon is a proven and tested solution to the problem of noise control.

The enhanced sound insulation of Pilkington **Insulight™** Phon insulating glass units is made possible through the use of:

- panes of varied thickness – a 30 percent difference in thickness is recommended, e.g. 6 mm and 10 mm;
- Pilkington **Optilam™**, laminated glass, which is produced by combining two or more glass sheets with one or more PVB interlayers;
- Pilkington **Optiphon™** glass: laminated, sound absorbing glass with high acoustic insulation, which uses special foil to yield excellent noise attenuation parameters.

All above mentioned products can be combined with other functional products such as low-emissivity glass for improved thermal insulation or solar control glass for better solar control performance.



Pilkington **Insulight™** Phon

type	acoustic performance data						light			energy			
	R _w (dB)	C (dB)	C _{tr} (dB)	C 100-5000 (dB)	C _{tr} 100-5000 (dB)	LT %	LR ₀ %	LR ₁ %	g %	ET %	ER %	EA %	TSC
	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN 410	EN 410	EN 410	EN 410	EN 410	EN 410	EN 410	= g/87
4-16ar-4*	31	-2	-5	-1	-5	80	13	14	61	54	26	20	0,70
6-16ar-4*	34	-2	-5	-2	-5	79	13	14	59	52	23	25	0,68
6-16kr-4*	37	-2	-6	-1	-6	79	13	14	59	52	23	25	0,68
8-12kr-4*	37	-3	-6	-2	-6	78	12	14	57	50	21	29	0,66
8-16ar-4*	37	-2	-5	-1	-5	78	12	14	57	50	21	29	0,66
8-16ar-6*	36	-2	-6	-1	-6	77	12	14	57	49	21	30	0,66
8-20ar-4*	37	-2	-6	-1	-6	78	12	14	57	50	21	29	0,66
10-16ar-4*	38	-2	-6	-1	-6	77	12	14	56	48	19	33	0,64
10-16kr-4*	40	-4	-9	-3	-9	77	12	14	56	48	19	33	0,64
10-20ar-4*	39	-4	-8	-3	-8	77	12	14	56	48	19	33	0,64
10-16ar-6*	40	-2	-5	-1	-5	76	12	14	56	47	19	34	0,64

Notes: The performance data for insulating glass units have been determined with Pilkington **Optitherm™** S3 coating on glass marked with* and with argon (90%) or krypton (90%) gas filling.



Pilkington Insulight™ Phon		acoustic performance data						light			energy			
type	PILKINGTON NSG Group PVT Glass Business	R _w	C	C _{tr}	C	C _{tr}	LT	LR ₀	LR ₁	g	ET	ER	EA	TSC
		(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(%)	(%)	(%)	(%)
		EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN 410	EN 410	EN 410	EN 410	EN 410
4*-16ar-8,8L		38	-2	-6	-1	-6	78	14	12	58	48	28	24	0,67
6*-14ar-8,8L		39	-2	-6	-1	-6	77	14	12	56	47	26	27	0,64
4*-16ar-9,5L		38	-2	-6	-1	-6	77	14	12	58	48	28	24	0,67
4*-16ar-10,8L		38	-2	-6	-1	-6	77	14	12	57	47	28	25	0,66
6*-16ar-10,8L		40	-2	-6	-1	-6	76	14	12	56	46	26	28	0,64
8,4L-16ar-6*		37	-3	-7	-2	-7	77	12	14	55	47	19	34	0,63
8,8L-16ar-8*		37	-3	-7	-2	-7	76	12	14	55	46	18	36	0,63
12,8L-16ar-6*		41	-2	-5	-1	-5	75	12	14	51	44	15	41	0,59
12,8L-16ar-8*		41	-2	-5	-1	-5	75	12	14	51	43	15	42	0,59
16,8L-16ar-8*		41	-1	-4	0	-4	73	12	13	49	41	13	46	0,56
4*-8kr-4-8kr-4*		31	-1	-4	0	-4	71	18	18	50	41	33	26	0,57

Notes: The performance data for insulating glass units have been determined with Pilkington **Optitherm™** S3 coating on glass marked with* and with argon (90%) or krypton (90%) gas filling. Letter L means that ordinary laminated glass Pilkington **Optilam™** has been used.



Pilkington Insulight™ Phon													
type	acoustic performance data						light			energy			
	R _w (dB)	C (dB)	C _{tr} (dB)	C 100-5000 (dB)	C _{tr} 100-5000 (dB)	LT %	LR ₀ %	LR ₁ %	g %	ET %	ER %	EA %	TSC
	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN 410	EN 410	EN 410	EN 410	EN 410	EN 410	EN 410	= g/87
4*-10kr-4-10kr-4*	32	-1	-5	0	-5	71	18	18	50	41	33	26	0,57
4*-12ar-4-12ar-4*	32	-1	-5	0	-5	71	18	18	50	41	33	26	0,57
4*-12kr-4-12kr-4*	33	-1	-5	0	-5	71	18	18	50	41	33	26	0,57
4*-14kr-4-14kr-4*	32	-1	-4	0	-4	71	18	18	50	41	33	26	0,57
4*-16kr-4-16kr-4*	32	-1	-5	0	-5	71	18	18	50	41	33	26	0,57
6*-10kr-4-10kr-4*	36	-1	-5	0	-5	70	18	18	49	41	30	29	0,56
6*-12ar-4-12ar-4*	36	-2	-6	-1	-6	70	18	18	49	41	30	29	0,56
6*-12kr-4-12kr-4*	38	-2	-6	-1	-6	70	18	18	49	41	30	29	0,56
8*-12ar-4-12ar-4*	37	-2	-7	-1	-7	70	17	18	48	40	28	32	0,55
8*-12ar-4-12ar-6*	39	-2	-5	-1	-5	69	17	18	48	39	28	33	0,55
8*-12kr-4-12kr-6*	39	-1	-5	0	-5	69	17	18	48	39	28	33	0,55
8*-12ar-6-12ar-6*	38	-2	-6	-1	-6	69	17	17	47	38	28	34	0,54

Notes: The performance data for insulating glass units have been determined with Pilkington **Optitherm™** S3 coating on glass marked with* and with argon (90%) or krypton (90%) gas filling. Letter L means that ordinary laminated glass Pilkington **Optilam™** has been used.





Laminated glass with high sound insulation

Description

By using a special PVB (polyvinylbutyral) interlayer, Pilkington **Optiphon™** is a high quality acoustic laminated glass that offers excellent noise reduction without compromising on light transmittance or impact performance.

The desired acoustic performance can be achieved through combining various thicknesses of glass with a PVB interlayer. With a large variety of product combinations, Pilkington **Optiphon™** offers the opportunity to achieve specific noise reduction requirements.

Pilkington **Optiphon™** can be combined with other Pilkington products for a multi-functional noise-reduction monolithic glass or a multi-functional noise-reduction insulating glass unit providing additional benefits, such as thermal insulation, solar control or self-cleaning.

Applications

Pilkington **Optiphon™** is the ideal choice of glass in situations where there is excess noise from road, rail or air traffic, or other sources such as factories or nightclubs.

Benefits

- Provide a range of noise control levels.
- A thin and lightweight solution to noise problems.
- Achieve safety class 1(B)1 (EN 12600) and are available to meet security glass classifications in accordance with EN 356.
- In case of breakage remains intact, minimising the risk of injury.
- Widely tested.
- Easy to process, and can be incorporated into insulating glass units.
- Can be single, double or triple glazed.
- Can be combined with other Pilkington products for a multi-functional noise-reduction monolithic glass or a multi-functional noise-reduction insulating glass unit providing additional benefits, such as thermal insulation, solar control, or self-cleaning.
- Standard available sizes: 6000 x 3210 mm, 3210 x 2550 mm.
- Available thicknesses: 6,8; 8,8; 9,1; 10,8; 12,8; 13,1 mm.



Pilkington Optiphon™

type	acoustic performance data						light				energy			
	R _w (dB)	C (dB)	C _{tr} (dB)	C 100-5000 (dB)	C _{tr} 100-5000 (dB)	LT %	LR ₀ %	LR _r %	g %	ET %	ER %	EA %	TSC	
	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN 410	EN 410	EN 410	EN 410	EN 410	EN 410	= g/87	
8,8	37	-1	-4	0	-4	87	8	8	76	70	7	23	0,87	
9,1	37	-1	-3	0	-3	87	8	8	76	69	7	24	0,87	
10,8	38	-1	-2	0	-2	86	8	8	74	67	7	26	0,85	
12,8	39	0	-2	1	-2	85	8	8	72	65	6	29	0,83	
13,1	40	0	-2	0	-2	85	8	8	71	64	6	30	0,82	
4*-16-8,8	39	-1	-5	0	-5	78	14	12	58	48	28	24	0,67	
5*-16-8,8	40	-3	-7	2	-7	77	13	14	60	46	24	30	0,69	
6*-16-8,8	41	-3	-7	9	-7	77	14	12	56	47	26	27	0,64	
6*-16-9,1	41	-2	-6	-1	-6	77	14	12	56	47	26	27	0,64	
6*-16-10,8	42	-3	-7	-2	-7	76	14	12	56	46	26	28	0,64	
6*-16-12,8	42	-3	-8	-2	-8	75	14	12	56	44	26	30	0,64	
6*-16-13,1	43	-1	-5	0	-5	75	14	12	56	44	26	30	0,64	
8*-16-8,8	42	-3	-7	2	-7	76	14	12	55	46	24	30	0,63	

Notes: The performance data for insulating glass units have been determined with Pilkington **Optitherm™** S3 coating on glass marked with* and with argon (90%) gas filling.



Pilkington Optiphon™													
type	acoustic performance data						light			energy			
	R _w (dB)	C (dB)	C _{tr} (dB)	C 100-5000 (dB)	C _{tr} 100-5000 (dB)	LT %	LR ₆ %	LR _i %	g %	ET %	ER %	EA %	TSC = g/87
	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN 410	EN 410	EN 410	EN 410	EN 410	EN 410	
8*-16-9,1	43	-3	-7	9	-7	76	14	12	55	46	24	30	0,63
8*-16-10,8	43	-2	-6	-1	-6	76	14	12	55	45	24	31	0,63
8*-16-12,8	43	-2	-7	-1	-7	75	14	12	55	43	24	33	0,63
10*-16-8,8	44	-2	-6	-1	-6	76	14	12	54	45	23	32	0,62
10*-16-9,1	45	-2	-5	-1	-5	76	14	12	54	45	23	32	0,62
10*-16-10,8	44	-1	-5	0	-5	75	14	12	54	44	23	33	0,62
10*-16-12,8	45	-2	-6	-1	-6	74	13	12	54	42	23	35	0,62
6,5-16-4*	36	-1	-5	0	-5	78	13	14	57	50	20	30	0,66
6,5-16-6*	39	-1	-5	0	-5	78	12	14	57	49	20	31	0,66
8,5-16-4*	38	-1	-5	0	-5	78	12	14	55	48	18	34	0,63
8,5-16-6*	41	-2	-6	-1	-6	77	12	14	55	47	18	35	0,63
8,5-16-8*	42	-2	-6	-1	-6	76	12	14	55	46	18	36	0,63
8,5-16-10*	45	-2	-6	-1	-6	76	12	14	55	45	18	37	0,63

Notes: The performance data for insulating glass units have been determined with Pilkington Optitherm™ S3 coating on glass marked with* and with argon (90%) gas filling.



Pilkington **Optiphon™**

type	acoustic performance data						light				energy				
	R _w (dB)	C (dB)	C _{tr} (dB)	C 100-5000 (dB)	C _{tr} 100-5000 (dB)	C _{tr} 100-5000 (dB)	LT %	LR ₀ %	LR _i %	g %	ET %	ER %	EA %	TSC = g/87	
	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN ISO 717-1	EN 410	EN 410	EN 410	EN 410	EN 410	EN 410	EN 410		
8,5* -16-12,5	49	-3	-8	-2	-8	-8	74	13	12	12	51	41	19	40	0,59
8,5* -20-12,5	50	-3	-8	-2	-8	-8	74	13	12	12	51	41	19	40	0,59
8,8* -16-12,8	47	-2	-7	-1	-7	-7	74	13	12	12	51	41	19	40	0,59
9,1* -16-13,1	49	-3	-8	-2	-8	-8	74	13	12	12	51	41	18	41	0,59
9,1* -20-13,1	50	-3	-8	-2	-8	-8	74	13	12	12	51	41	18	41	0,59
10,5* -16-8*	43	-2	-6	-1	-6	-6	76	12	14	14	53	45	17	38	0,61
10,5* -16-10*	45	-1	-5	0	-5	-5	75	12	14	14	53	44	17	39	0,61
12,5 -16-8*	43	-1	-5	0	-5	-5	75	12	14	14	52	43	15	42	0,60
12,5 -16-10*	45	-1	-5	0	-5	-5	74	12	13	13	52	42	15	43	0,60
6*-12-4-12-9,1*	41	-2	-7	-1	-7	-7	68	17	17	17	48	37	30	33	0,55
13,1*-12-6-12-9,1*	49	-1	-6	0	-6	-6	65	16	17	17	42	32	18	50	0,48
13,1*-12kr6-12kr9,1*	50	-2	-7	-2	-7	-7	65	16	17	17	41	32	18	50	0,47

Notes: The performance data for insulating glass units have been determined with Pilkington **Optitherm™** S3 coating on glass marked with* and with argon (90%) gas filling.



5.0 Safety / Security

5



Demanding safety legislation has highlighted the critical areas where modern safety glazing must comply with the relevant safety requirements. Innovations in the development of Safety/Security glass has opened up new avenues of design, which allows people to be protected from personal injury and, in the most extreme cases, protect 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 design criteria of natural light and visibility. We are always at the forefront in further developing the products and the industry standards, so that personal accident and serious injuries resulting from glass impact are further prevented or minimized.

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 physical, armed or blast.

Using only the right type of glass is not enough to secure the necessary resistance to the severe loads. The glass, once impacted, behaves differently in different framing systems, it is therefore imperative to combine high performance glazing with high performance framing systems.



The standards

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

The pendulum impact test is the standard for classifying flat glass products by performance under impact and by mode of breakage. Similar in principle to previously used swing bag tests, EN 12600 utilises a dual rubber tyre impactor to strike the glass at three drop heights.

The classifications are summarised below.

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

The classification has three components:

- The first is the class (i.e. 1, 2 or 3) at which the glass has either not broken or broken safely.
- The second 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 safety 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 (i.e. 1, 2 or 3) at which the product did not break (e.g. for toughened glass) or where it broke, but no shear or opening bigger than 76 mm in diameter appeared.



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 hard body impactor of mass 4,11 kg for classes P1A to P5A and an axe for classes P6B to P8B.

These classes of resistance are summarised below.

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

The test consists of 3 shots fired on the vertices of a 100 mm equilateral triangle glass sample with a weapon corresponding to the required class.

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).

These classes of resistance are summarised below.

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 x 19	8,0	400	5
BR3-S BR3-NS	0,357 Magnum	10,25	430	5
BR4-S BR4-NS	0,44 Magnum	15,55	440	5
BR5-S BR5-NS	5,56 x 45	4,0	950	10
BR6-S BR6-NS	7,62 x 51	9,45	830	10
BR7-S BR7-NS	7,62 x 51	9,72	820	10



Class of resistance	Calibre	Bullet mass [g]	Bullet velocity [m/s]	Test range [m]
SG1-S SG1-NS	0,22 LR	2,6	360	10
SG2-S SG2-NS	9 mm x 19	8,0	400	5



Description

Pilkington **Optilam**[™] – is a laminated safety glass which consists of two or more panes of glass bonded together by heat and pressure with one or more sheets of flexible PVB (polyvinylbutyral) interlayer, sandwiched permanently between the glasses. The interlayers ensure the integrity of the glass, by holding the broken pieces in place should damage occur. In fact, glass fragments adhere strongly to the interlayer, while the resistant cushioning effect dissipates the energy. The performance of Pilkington **Optilam**[™] 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.

Applications

Pilkington **Optilam**[™] offers the specifier a wide choice of products fulfilling a multitude of functional requirements. For a given application, Pilkington **Optilam**[™] can be specified to offer one or more of the following attributes: safety, security, noise control, solar control, bullet resistance, blast resistance, UV screening, privacy or decoration. The manufacturing method allows a wide variety of styles, shapes, colours and glass types to be incorporated.

Pilkington **Optilam**[™] can be used wherever safety or security is important, in commercial, public and domestic applications. Recommended applications are skylights, full height windows, balustrades, low level glazing, tables and counter tops. It is particularly suited for use in hazardous situations, such as doors, partitions, balconies, sloped glazing and other overhead glass applications.

When there is a risk of thermal stress, Pilkington **Optilam**[™] glass can be manufactured with heat strengthened or toughened glass.



Features and benefits

- Class 2(B)2 performance to EN 12600 achieved through Pilkington **Optilam**[™] 6,4, which is the most widely used thickness for protecting people against risk of accidental injury. Can achieve up to Class 1(B)1, dependent upon thickness.
- Available incorporating Pilkington **Optifloat**[™] Tint and Pilkington **Suncool**[™] range of glasses, or a tinted PVB interlayer (Pilkington **Optilam**[™] I) to provide both safety and solar control properties.
- Can be used with textured glass and polished wired glass.
- Available in combination with Pilkington **K Glass**[™] or Pilkington **Optitherm**[™] to enhance thermal insulation whilst providing safety.
- Reduced light transmission when made with a matt obscure interlayer.
- May be single glazed or incorporated in an insulating glass unit.
- Available in a wide range of thicknesses.



Description

Pilkington **Optilam**[™] (security glass) is produced by combining layers of glass with PVB interlayers to form sandwiches of material with specific design properties ensuring security in addition to its safety properties.

Applications

Pilkington **Optilam**[™] (security glass) offers the specifier a wide choice of products fulfilling a multitude of functional requirements in applications such as buildings or shops which display valuable goods, banks, building societies, museums, as well as in hospitals and prisons. For a given application, Pilkington **Optilam**[™] can be specified to offer one or more of the following attributes: safety, security, noise control, solar control, bullet resistance, blast resistance, UV screening, privacy or decoration

Features and benefits

- Conforms to security glazing standards (e.g. 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, protecting from vandalism, burglary or ballistic attack.
- Able to withstand repeated blows from heavy objects such as bricks, hammers or crowbars.
- Provides UV protection, which may help to reduce fading.



Description

Pilkington Toughened Safety 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 glass strength.

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

Most Pilkington glass is available in toughened form.

Applications

Pilkington Toughened Safety Glass provides an economical and proven solution in any areas of particular hazard where national standards or Codes of Practice specifically require the use of safety glazing material.

Pilkington Toughened Safety Glass can be used, for example, along passageways and areas of high pedestrian traffic, in doors and adjacent panels, shower and bath enclosures, balconies, barriers, staircases and other structural glazing applications. It can be used to provide uninterrupted single or double glazed cladding for the whole building. Other applications include frameless shop fronts and entrances, internal partitions, furniture, canopies, gymnasiums and sports arenas.

Features and benefits

- Achieves up to Class 1(C)1 according to EN 12600, dependent upon glass type and thickness.
- Up to 3-4 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.
- When broken, it shatters into small, relatively harmless pieces, reducing the risk of personal injury.
- Reduces the risk of thermal stress breakage of glass exposed to solar radiation.
- Conforms to all the requirements of EN 12150-1 and is CE marked in accordance with EN 12150-2.
- Available in a wide range of sizes and thicknesses.



Glass sizes

Thickness [mm]	Maximum size [mm]	Minimum size [mm]
4	1500 x 2500	200 x 350
5	2000 x 3000	200 x 350
6-19	2800 x 6000	200 x 350

Technical data

hardness	6 on Mohs Scale according to EN 572-1:1999
density	2500 kg/m ³ according to EN 572-1
resistance to temperature	ΔT 200 K according to EN 12150-1
U-value	5,7-5,8 W/m ² K according to EN 673
bending strength	120 N/mm ² according to EN 12150-1

All types of Pilkington Toughened Safety Glass will be readily identified by the simple use of 'T' following the product brand name.

To distinguish heat soaked toughened glass from standard toughened glass, the word 'Plus' is used at the end of product name. Examples are given below.

Pilkington Optifloat™ T	toughened Pilkington Optifloat™
Pilkington Optiwhite™ T	toughened Pilkington Optiwhite™
Pilkington K Glass™ T	toughened Pilkington K Glass™
Pilkington Activ™ T	toughened Pilkington Activ™
Pilkington Optifloat™ Grey T	toughened Pilkington Optifloat™ Grey
Pilkington Suncool™ 70/40 T	toughened Pilkington Suncool™ 70/40
Pilkington Optitherm™ S3 T	toughened Pilkington Optitherm™ S3
Pilkington Optifloat™ T Plus	heat soaked toughened Pilkington Optifloat™



6.0 Self-cleaning



Pilkington made a significant step in the glass industry with the development of Pilkington **Activ™** the first dual-action self-cleaning glass. The unique dual-action of the Pilkington **Activ™** coating uses the forces of nature to help keep the glass free from dirt, giving not only the practical benefit of less cleaning, but also clearer, better-looking windows. The Pilkington **Activ™** coating, located on surface #1 of the glass, works in two stages. Firstly, it reacts with natural daylight to break down and loosen organic dirt. Secondly, when it rains, instead of forming droplets, the water spreads evenly over the surface of the glass, forming a thin film and helping to wash any dirt away, preventing the formation of drying spots and streaks, and helping the glass to dry very quickly. In installations where condensation is a problem, it reduces its visibility and helps it to evaporate more quickly.

The Pilkington **Activ™** coating works also on cloudy days and during the night. During dry spells the glass can be cleaned by simply hosing it down.

Glass used today in commercial buildings and offices, has to provide multiple functions. A technical profile of large glazed areas must meet requirements related to solar control, thermal insulation and noise control, as well as strict safety regulations. These requirements can now be combined with self-cleaning properties. Availability of dual coated products and laminating possibilities allow the manufacture of the glass products that ensure aesthetics, safety, comfort and cost-effective operation of modern buildings, allowing best cost effective management of buildings.

Dual coating technology is used to combine self-cleaning and solar control properties in one product, ensuring a highly cost effective glass combination. Pilkington **Activ Suncool™** is manufactured with a Pilkington **Activ™** coating on the outside (i.e. on surface 1) and a Pilkington **Suncool™** coating on the inside (i.e. coating on surface 2). It is used in insulating glass units to enable cost effective building management literally from both sides.



In the commercial sector the glass often needs to provide additional protection features. To meet these requirements, Pilkington offers two product lines of laminated safety glass. Using laminated Pilkington **Activ**™ glass for façade elements and on glazed roof and sloping areas which are difficult to access, both safety and self-cleaning can be assured.

The same applies to the combination of the self-cleaning properties with noise control of the façade. Functional glass, such as Pilkington **Activ Optiphon**™ allows a significant decrease in costs of window cleaning, and at the same time, it has an increased sound reduction index (R_w).

Pilkington **Optitherm**™ S3 low-emissivity coating, usually used on surface #3 in insulating glass units, is sometimes difficult or impossible to apply on some glass types. However, dual coated Pilkington **Activ Optitherm**™ S3 provides self-cleaning and good thermal insulation for insulating glass units with thick bullet-resistant or textured glass.

Function	Product and combination
Self-cleaning	Pilkington Activ ™ monolithic, single-coated, used as single or in insulating glass units.
Plus solar control	Pilkington Activ Suncool ™ monolithic, dual-coated, used in insulating glass units.
Plus safety	Pilkington Activ Optilam ™ laminated safety glass, coated, used as single or in insulating glass units.
Plus noise control	Pilkington Activ Optiphon ™ sound insulating laminated safety glass, coated, used as single or in insulating glass units.
Plus thermal insulation	Pilkington Activ Optitherm ™ S3 monolithic, dual-coated, used in insulating glass units.

Apart from the above-mentioned combinations, other configurations are possible (e.g. Pilkington **Activ Suncool Optilam**™).



Self-cleaning solar control glass

Description

Pilkington **Activ™** Blue is a pyrolytic on-line coated body-tinted, self-cleaning and medium performance solar control glass, with an attractive blue colour. Its surface #1 self-cleaning coating has photocatalytic and hydrophilic properties. The unique blue colour helps to keep internal temperatures cool whilst still maintaining excellent light transmittance, low light reflection and high energy absorption. For optimum self-cleaning and thermal performance, Pilkington **Activ™** Blue can be combined with Pilkington **K Glass™** or Pilkington **Optitherm™** in an insulating glass unit.

Applications

Specially designed for the optimum roof unit, Pilkington **Activ™** Blue is perfect for use in conservatories and winter gardens. Its self-cleaning properties make it ideal for use in hard to reach places that are difficult to clean.


Pilkington **Activ™** Blue must always be processed, installed and maintained in accordance with our specialist Handling and Processing instructions for Pilkington **Activ™**.



Features and benefits

- Self-cleaning properties reduce the need for manual cleaning, saving water and eliminating potentially harmful run-off from expensive detergents, also increasing personal safety.
- Additional medium performance solar control properties, reducing solar heat entering the building, enhancing comfort and reducing the need for cooling the building.
- Attractive blue colour of the glass is perfect for roof glazing, enhancing the view from inside to outside.
- Good light transmission.
- Low exterior reflection, improving aesthetics of the building.
- Works even on cloudy days and during the night.
- Highly durable pyrolytic on-line coating that lasts the lifetime of the glass, easy to handle and process.
- Can be laminated, toughened, bent and enamelled using standard techniques.
- Can be used in its monolithic form or incorporated into insulating glass units (coating on surface #1), and has an unlimited shelf-life.
- Can be combined in an insulating glass unit with low-emissivity glass such as Pilkington **K Glass™** or Pilkington **Optitherm™** for additional thermal insulation properties.
- Available in a range of different sizes and thicknesses (4, 6 and 10 mm).




 PILKINGTON NSG Group Flat Glass Business		Pilkington Activ™ Blue																		
		glass	performance code	light	energy	S, UV														
I monolithic glass #1	W/m ² K	U	LT	g	energy	LT	g	LT	g	energy	ER	EA	TET	SSC	LSC	TSC	S	UV		
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	
4	mm	↔	5,8	59	55	59	15	11	89	44	13	43	55	0,51	0,12	0,63	1,07	15		
6	mm	↔	5,7	49	47	49	14	9	82	33	13	54	47	0,38	0,16	0,54	1,04	11		
10	mm	↔	5,6	35	38	35	13	7	70	21	12	67	38	0,24	0,20	0,44	0,92	6		

Notes:

Maximum size: 6000 mm x 3210 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Activ™ Blue																	
		glass configuration		performance code		light			energy				S, UV						
		W/m ² K	%	%	LT	g	LT	LRo	LRI	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
II	II	2,6	44	36	g	energy	44	16	15	80	28	13	59	36	0,32	0,09	0,41	1,22	9
	II	1,5	40	32	LT	light	40	17	17	82	24	14	62	32	0,28	0,09	0,37	1,25	7
	II	1,0	38	24	U	U value	38	18	23	80	19	17	64	25	0,22	0,06	0,28	1,58	6
	II	1,1	43	29			43	16	15	81	23	15	62	29	0,26	0,07	0,33	1,48	6
	II																		
	II																		
	II																		

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.



Self-cleaning glass

Description

An pyrolytic on-line coated self-cleaning glass with photo-catalytic and hydrophilic properties.

Applications


Pilkington **Activ™** Clear is the perfect choice for situations where cleaning is difficult or costly, such as high-rise buildings, glass roof structures or conservatories and atria, or in housing for use by elderly residents. It is also ideal where good visibility is important, for example, in sports stadiums, commentary boxes, airports and external walkways.

Pilkington **Activ™** Clear must always be processed, installed and maintained in accordance with our specialist Handling and Processing instructions for Pilkington **Activ™**.

Features and benefits

- Self-cleaning properties reduce the need for manual cleaning, saving water and eliminating potentially harmful run-off from expensive detergents, also increasing personal safety.
- Works even on cloudy days and during the night.
- Highly durable pyrolytic on-line coating that lasts the lifetime of the glass, easy to handle and process.
- Can be laminated, toughened, bent and enamelled using standard techniques.
- Can be used in its monolithic form or incorporated in insulating glass units (coating on surface #1), and has an unlimited shelf-life.
- Available in combination with Pilkington **Optilam™** for impact resistance or increased security, Pilkington **Optiphon™** for improved noise reduction, Pilkington **Optitherm™** S3 for additional thermal insulation properties.
- Can be combined in an insulating glass unit with a low-emissivity glass such as Pilkington **K Glass™** or Pilkington **Optitherm™** for additional thermal insulation properties.
- Available in a range of different sizes and thicknesses (4, 6, 8 and 10 mm).




 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Activ™ Clear																
		glass	performance code		light			energy				S, UV						
	I	W/m ² K	U	LT	g	LT	LRo	LRI	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	%
	monolithic glass #1		U value	light	energy	transmittance	reflectance outside	reflectance inside	colour rendering index	direct transmittance	reflectance	absorptance	total transmittance	shortwave shading coeff.	longwave shading coeff.	total shading coefficient	selectivity index	UV transmittance
4	mm	5,8	84	81	81	84	14	14	98	79	13	8	81	0,91	0,02	0,93	1,04	40
6	mm	5,7	83	79	79	83	14	14	99	76	13	11	79	0,87	0,04	0,91	1,05	36
8	mm	5,7	82	76	76	82	14	14	99	72	13	15	76	0,83	0,04	0,87	1,08	33
10	mm	5,6	81	74	74	81	14	14	98	69	13	18	74	0,79	0,06	0,85	1,09	31

Notes:

Maximum size: 6000 mm x 3210 mm.



Pilkington Activ™ Clear		S, UV		energy		light		performance code		glass configuration
		-	%	-	%	-	%	-	%	
 PILKINGTON NSG Group Flat Glass Business	II	UV	UV transmittance	UV	UV transmittance	1,06	31			
		S	s selectivity index	S	s selectivity index	1,06	31			
		TSC	total shading coefficient	TSC	total shading coefficient	0,83				
		LSC	longwave shading coeff.	LSC	longwave shading coeff.	0,79				
		SSC	shortwave shading coeff.	SSC	shortwave shading coeff.	0,53				
		TET	total transmittance	TET	total transmittance	72	72	69	46	58
		EA	absorptance	EA	absorptance	15	21	17	18	19
		ER	reflectance	ER	reflectance	18	21	43	31	19
		ET	direct transmittance	ET	direct transmittance	67	58	40	51	67
		Ra	colour rendering index	Ra	colour rendering index	98	98	97	98	98
		LRI	reflectance inside	LRI	reflectance inside	20	21	27	19	19
		LRO	reflectance outside	LRO	reflectance outside	20	23	26	18	19
		LT	transmittance	LT	transmittance	76	70	66	75	75
		g	energy	g	energy	72	69	46	58	58
		LT	light	LT	light	76	70	66	75	75
		U	U value	U	U value	2,6	1,5	1,0	1,1	1,1
	II	insulating glass unit, Pilkington Optitherm™ S3 #3								↕
	II	insulating glass unit, Pilkington Optitherm™ S1 #3								↕
	II	insulating glass unit, Pilkington K Glass™ #3								↕
	II	insulating glass unit, primary product outside #1								↕

Notes:

1. Based on 4 mm glass thickness.
2. Based on 16 mm argon filled (90%) cavities.



Neutral self-cleaning solar control glass

Description

A self-cleaning and medium performance solar control dual coated glass with a neutral colour:

- surface #1 self-cleaning on-line coating with photo-catalytic and hydrophilic properties,
- surface #2 off-line solar control coating, with medium light transmittance and high light reflectance.

Its unique solar control coating also helps keep internal temperatures cool whilst still maintaining excellent, neutral light transmittance.

Applications

Specially designed for conservatories and large glazed areas, Pilkington **Activ**[™] Neutral is perfect for use in both the roof and verticals for domestic or commercial applications.

Pilkington **Activ**[™] Neutral must always be processed, installed and maintained in accordance with our specialist Handling and Processing instructions for Pilkington **Activ**[™].


Features and benefits

- Self-cleaning properties reduce the need for manual cleaning, saving water and eliminating potentially harmful run-off from expensive detergents, also increasing personal safety.
- Additional medium solar control performance properties, reducing solar heat entering the building, enhancing comfort and reducing the need for cooling the building.
- Works even on cloudy days and during the night.
- Neutral appearance in transmission and reflection, offering attractive aesthetics and making it ideal for use in roof or vertical glazing applications.
- Good light transmission.
- Durable dual coatings coating that last the lifetime of the glass, easy to handle and process.
- Can be laminated, toughened, and bent using standard techniques.
- Has to be incorporated into insulating glass units (self-cleaning coating on surface #1 / solar control coating on surface #2).




- Can be combined in an insulating glass unit with a low-emissivity glass such as Pilkington **K Glass**[™] or Pilkington **Optitherm**[™] for additional thermal insulation properties.
- Available in a range of different sizes and thicknesses (4, 6 and 8 mm).



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Activ™ Neutral																	
		glass	performance code		light			energy				S, UV							
	I	W/m ² K	U	LT	g	LT	LRo	LRI	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	%	%
	monolithic glass #1		U value	light	energy	transmittance	reflectance outside	reflectance inside	colour rendering index	direct transmittance	reflectance	absorptance	total transmittance	shortwave shading coeff.	longwave shading coeff.	total shading coefficient	selectivity index	UV transmittance	
4	mm	5,6	50	50	55	50	28	19	99	47	22	31	55	0,54	0,09	0,63	0,91	25	
6	mm	5,6	48	48	53	48	27	19	99	45	21	34	53	0,52	0,09	0,61	0,91	23	
8	mm	5,5	48	48	52	48	26	19	98	43	20	37	52	0,49	0,11	0,60	0,92	21	

Notes:
Maximum size: 6000 mm x 3210 mm.



 PILKINGTON NSG Group Flat Glass Business		Pilkington Activ™ Neutral																
		glass configuration		performance code		light		energy				S, UV						
		W/m ² K	%	%	g	LT	U	%	ET	ER	EA	TET	SSC	LSC	TSC	-	%	UV
	II	2,5	44	44	g	44	2,5	36	22	42	44	44	0,41	0,10	0,51	1,00	17	UV transmittance
	II	1,5	40	41	energy	40	1,5	31	23	46	41	41	0,36	0,11	0,47	0,98	13	S selectivity index
	II	1,0	38	28	light	38	1,0	23	30	47	47	28	0,26	0,06	0,32	1,36	12	total shading coefficient
	II	1,1	43	35	U value	43	1,1	29	27	44	44	35	0,33	0,07	0,40	1,23	11	longwave shading coeff.
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	shortwave shading coeff.
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	total transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	absorptance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	reflectance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	direct transmittance
					U value			40	30	23	46	41	0,36	0,11	0,47	0,98	13	colour rendering index
					energy			38	31	29	46	41	0,36	0,11	0,47	0,98	13	reflectance inside
					light			43	28	22	46	41	0,36	0,11	0,47	0,98	13	reflectance outside
					U value			44	29	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	transmittance
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	transmittance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	transmittance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	transmittance
					U value			40	30	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			38	31	29	46	41	0,36	0,11	0,47	0,98	13	transmittance
					light			43	28	22	46	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			44	29	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	transmittance
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	transmittance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	transmittance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	transmittance
					U value			40	30	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			38	31	29	46	41	0,36	0,11	0,47	0,98	13	transmittance
					light			43	28	22	46	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			44	29	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	transmittance
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	transmittance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	transmittance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	transmittance
					U value			40	30	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			38	31	29	46	41	0,36	0,11	0,47	0,98	13	transmittance
					light			43	28	22	46	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			44	29	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	transmittance
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	transmittance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	transmittance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	transmittance
					U value			40	30	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			38	31	29	46	41	0,36	0,11	0,47	0,98	13	transmittance
					light			43	28	22	46	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			44	29	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	transmittance
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	transmittance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	transmittance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	transmittance
					U value			40	30	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			38	31	29	46	41	0,36	0,11	0,47	0,98	13	transmittance
					light			43	28	22	46	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			44	29	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	transmittance
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	transmittance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	transmittance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	transmittance
					U value			40	30	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			38	31	29	46	41	0,36	0,11	0,47	0,98	13	transmittance
					light			43	28	22	46	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			44	29	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	transmittance
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	transmittance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	transmittance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	transmittance
					U value			40	30	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			38	31	29	46	41	0,36	0,11	0,47	0,98	13	transmittance
					light			43	28	22	46	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			44	29	23	46	41	0,36	0,11	0,47	0,98	13	transmittance
					energy			36	22	42	44	44	0,41	0,10	0,51	1,00	17	transmittance
					light			31	23	46	41	41	0,36	0,11	0,47	0,98	13	transmittance
					U value			23	30	47	47	28	0,26	0,06	0,32	1,36	12	transmittance
					energy			29	27	44	44	35	0,33	0,07	0,40	1,23	11	transmittance
					light			44	29	23	44	44	0,41	0,10	0,51	1,00	17	transmittance



Self-cleaning high performance solar control and low-emissivity glass

Description

A range of self-cleaning, superior solar control and thermal insulation performance dual coated glass:

- surface #1 self-cleaning on-line coating with photo-catalytic and hydrophilic properties;
- surface #2 superior off-line solar control and low-emissivity coating, with high light transmittance, low, medium or high light reflectance and outstanding U-value (down to 1,0 W/m²K) in an double insulating glass unit.

Pilkington **Activ Suncool™** is available in a wide range of clear or neutral appearances and in two distinctive colours: blue and silver.

The appearance of the Pilkington **Activ Suncool™** range

Product	Appearance in reflection (external view)	Level of reflection†	Appearance in transmission (internal view)
Insulating glass unit construction (6 mm external pane – 16 mm – 4 mm Pilkington Optifloat™ Clear)			
Pilkington Activ Suncool™ 70/40	neutral	medium	neutral
Pilkington Activ Suncool™ 70/35	neutral/ blue	medium	neutral
Pilkington Activ Suncool™ 66/33	neutral/ blue	medium	neutral
Pilkington Activ Suncool™ 50/25	neutral/ blue	medium	neutral
Pilkington Activ Suncool™ Blue 50/27	blue	medium	neutral
Pilkington Activ Suncool™ Silver 50/30	silver	high	neutral
Pilkington Activ Suncool™ 40/22	neutral/ blue	medium	neutral
Pilkington Activ Suncool™ 30/17	neutral/ blue	high	neutral

† Level of reflection: low < 15%, medium 15-25%, high > 25%.



Pilkington **Activ Suncool™** is a range of dual coated products incorporating self-cleaning, solar control and thermal insulation properties. The external self-cleaning coating breaks down the organic dirt, and rain water washes any loosened dirt away. The internal solar control and low-emissivity coating reflects short wavelength solar radiation out of the building, as well as long wavelength heat radiation (generated by heating systems, lighting and building's occupants) back into the building.

Pilkington **Activ Suncool™** effectively reduces solar heat gain, at the same time providing high level of light transmittance and aesthetic appearance.

We have developed a range of Pilkington Spandrel Glass products for use with Pilkington **Activ Suncool™** solar control glass to ensure continuity in the aesthetic design of façades. Pilkington Spandrel Glass Coated is available in thicknesses 6 mm, 8 mm and 10 mm in toughened form. Maximum size of such spandrels is 2500 x 4500 mm.

The Pilkington Spandrel Glass Coated product range and appearance

Product	Appearance in reflection	Level of reflection †	Light reflection [%]
Pilkington Spandrel Glass Coated A200	neutral/blue	medium	24
Pilkington Spandrel Glass Coated A140	neutral/blue	high	29
Pilkington Spandrel Glass Coated A120	silver	high	37

† Level of reflection: low < 15%, medium 15-25%, high > 25%.



The full Pilkington **Activ Suncool™** range and recommended off-line coated spandrels are shown below.

Product	Spandrel offering
Pilkington Activ Suncool™ 70/40	*
Pilkington Activ Suncool™ 70/35	(A200)**
Pilkington Activ Suncool™ 66/33	(A200)**
Pilkington Activ Suncool™ 50/25	A200
Pilkington Activ Suncool™ Blue 50/27	–
Pilkington Activ Suncool™ Silver 50/30	A120
Pilkington Activ Suncool™ 40/22	(A140)***
Pilkington Activ Suncool™ 30/17	A140

* Due to its low reflection, the appearance of Pilkington **Activ Suncool™** 70/40 is dominated by the transmission. However Pilkington Spandrel Glass Coated A200 can be offered as a spandrel solution for Pilkington **Activ Suncool™** 70/40 when the colour match is not expected to be perfect.

** Pilkington Spandrel Glass Coated A200 is the recommended solution for Pilkington **Activ Suncool™** 70/35 and Pilkington **Activ Suncool™** 66/33. Whilst not a perfect colour match this is the most harmonising offering in comparison to an enamelled spandrel solution.

*** Pilkington Spandrel Glass Coated A140 is the recommended solution for Pilkington **Activ Suncool™** 40/22. Whilst not a perfect colour match this is the most harmonising offering in comparison to an enamelled spandrel solution.

As with all spandrel constructions, it is strongly advised that the customer conducts a visual ‘mock-up’ test to ensure an acceptable match.



Applications


Pilkington **Activ Suncool™** can only be used in insulating glass units. Designed to achieve optimum performance in large glazed areas, Pilkington **Activ Suncool™** is suitable for commercial and residential applications that demand high light transmission properties.

Where a safety glass is required, Pilkington **Activ Suncool™** can be specified as toughened or laminated glass. Toughened or heat strengthened glass should also be specified in applications where Pilkington **Activ Suncool™** may be at risk of thermal breakage.

Features and benefits

- Self-cleaning properties reduce the need for manual cleaning, saving water and eliminating potentially harmful run-off from expensive detergents, also increasing personal safety.
- Additional superior solar control property, reducing the need for cooling the inside of the building.
- Range of light transmission and reflection, reducing the need for lighting the inside of the building.
- Wide range of appearance and performance options, providing a solution for the most demanding designs.
- Superior low-emissivity, with U-values down to 1,0 W/m²K in 6-16-4 standard constructions with argon (90%), making the products highly energy efficient, through reduced need for heating.
- Works even on cloudy days and during the night.
- Highly durable self-cleaning coating lasts the lifetime of the glass.
- Can only be used in insulating glass units (self-cleaning coating on surface #1 / solar control coating on surface #2), with argon gas for even better thermal insulation.
- Available in combination with Pilkington **Optilam™**, for impact resistance or increased security, or Pilkington **Optiphon™**, for improved noise reduction.
- Available in annealed, toughened and laminated forms.
- Selection of harmonising spandrel panels available, allowing freedom in design of complete glass façades.
- Available in a range of different sizes and thicknesses (generally available in 6 and 8 mm; 4 mm is available in some products, 10 mm is available on special request).



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Activ Suncool™ 70/40											
		glass configuration		performance code		light		energy			S, UV		
II	II	U	LT	g	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
	III	1,1	66	40	35	33	32	40	0,40	0,06	0,46	1,65	13
	II												
	II												
	III												
	III												
	III												

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm (double glazed units) and 12 mm (triple glazed units) argon filled (90%) cavities.
3. The primary product shall only be used in insulating glass units.
4. Maximum size of primary monolithic product is 6000 mm x 3210 mm.




Pilkington Activ Suncool™ 66/33		S, UV		energy		light		performance code		glass configuration		
		%	UV	%		%		%		W/m ² K		
		1,79	S selectivity index	0,39	TSC total shading coefficient	95	Ra colour rendering index	34	g energy	III	triple insulating glass unit, Pilkington Optitherm™ S3 #5	↑
				0,05	LSC longwave shading coeff.	21	LRI reflectance inside		LT light	II	insulating glass unit, Pilkington Optitherm™ S3 #3	↑
				0,34	SSC shortwave shading coeff.	21	LRO reflectance outside		U U value	II	insulating glass unit, Pilkington K Glass™ #3	↑
		34	TET total transmittance		ET direct transmittance	61	LT transmittance			II	insulating glass unit, primary product outside #1+2	↑
		30	EA absorptance									
		40	ER reflectance									


Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm (double glazed units) and 12 mm (triple glazed units) argon filled (90%) cavities.
3. The primary product shall only be used in insulating glass units.
4. Maximum size of primary monolithic product is 6000 mm x 3210 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Activ Suncool™ 50/25									
		glass configuration		performance code		light		energy		S, UV	
II		II		II		LT		EA		S	
insulating glass unit, primary product outside #1+2		insulating glass unit, Pilkington K Glass™ #3		insulating glass unit, Pilkington Optitherm™ S3 #3		triple insulating glass unit, Pilkington Optitherm™ S3 #5		absorptance		selectivity index	
↑		↑		↑		47		40		1,81	
↑		↑		↑		23		0,05		5	
↑		↑		↑		21		0,25			
↑		↑		↑		93		0,30			
↑		↑		↑		26		0,30			
↑		↑		↑		26		0,05			
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↑		↑		↑		26					




 PILKINGTON <small>NSG Group Flat Glass Business</small>	Pilkington Activ Suncool™ Silver 50/30		S, UV		%	UV	UV transmittance	12	-	-	-
					-	S	S selectivity index	1,57	-	-	-
			energy		-	TSC	total shading coefficient	0,34	-	-	-
					-	LSC	longwave shading coeff.	0,04	-	-	-
					-	SSC	shortwave shading coeff.	0,3	-	-	-
					%	TET	total transmittance	30	-	-	-
					%	EA	absorptance	28	-	-	-
					%	ER	reflectance	46	-	-	-
					%	ET	direct transmittance	26	-	-	-
			light		-	Ra	colour rendering index	94	-	-	-
%	LRI	reflectance inside			34	-	-	-			
%	LRo	reflectance outside			42	-	-	-			
%	LT	transmittance			47	-	-	-			
performance code		%	g	energy	30	-	-	-			
		%	LT	light	47	-	-	-			
		W/m ² K	U	U value	1,0	-	-	-			
glass configuration		III	triple insulating glass unit, Pilkington Optitherm™ S3 #5					↑			
		II	insulating glass unit, Pilkington Optitherm™ S3 #3					↑			
		II	insulating glass unit, Pilkington K Glass™ #3					↑			
		II	insulating glass unit, primary product outside #1+2					↑			

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm (double glazed units) and 12 mm (triple glazed units) argon filled (90%) cavities.
3. The primary product shall only be used in insulating glass units.
4. Maximum size of primary monolithic product is 6000 mm x 3210 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Activ Suncool™ 30/17											
		S, UV		%		UV		UV transmittance		5			
				-		S		selectivity index		1,56			
		energy		-		TSC		total shading coefficient		0,21			
				-		LSC		longwave shading coeff.		0,04			
				-		SSC		shortwave shading coeff.		0,17			
				%		TET		total transmittance		18			
				%		EA		absorptance		45			
				%		ER		reflectance		40			
				%		ET		direct transmittance		15			
		light		-		Ra		colour rendering index		88			
				%		LRI		reflectance inside		17			
				%		LRo		reflectance outside		30			
				%		LT		transmittance		28			
		performance code		%		g		energy		18			
				%		LT		light		28			
				W/m ² K		U		U value		1,1			
		glass configuration		III				triple insulating glass unit, Pilkington Optitherm™ S3 #5				↑	
				II				insulating glass unit, Pilkington Optitherm™ S3 #3				↑	
				II				insulating glass unit, Pilkington K Glass™ #3				↑	
				II				insulating glass unit, primary product outside #1+2				↑	

Notes:

1. Based on 6 mm glass thickness.
2. Based on 16 mm (double glazed units) and 12 mm (triple glazed units) argon filled (90%) cavities.
3. The primary product shall only be used in insulating glass units.
4. Maximum size of primary monolithic product is 6000 mm x 3210 mm.



7.0 Decoration



Our decoration glass is very versatile; it allows total freedom in design and can be customised to fulfil any requirements. Various technologies can be used to create the finished products, whether it is patterned or colour glass. We can also influence the glass surface's transparency as well as its light transmittance of (i.e. be translucent).

Our range of decorative products comprises transparent or translucent glass such as screen printed glass, laminated glass with tinted or white translucent interlayer, sand blasted or acid etched glass, texture glass, or fully opaque products such like enamelled glass, mirrors, and reflective spandrel panels.

Using decorative glass you can create surroundings with a strong individual identity. In this section you will find our most popular decorative products. However, additional decorative glass can be manufactured on request to meet individual requirements of architects and specifiers.



The translucent glass

Description

An acid-etched glass suitable for internal or external use, Pilkington **Optifloat™** Opal creates an attractive finish for windows, partition walls, glass doors, furniture, shelving, wall cladding and many more applications. Whilst they can look stunning and create a beautiful effect, many of the semi-opaque glasses on the market have proved difficult to stock, handle and process – until now.

Pilkington **Optifloat™** Opal offers all the diffused natural light of a translucent glass, but with none of the drawbacks. The real beauty is that it can be stored and processed in the same way as standard float glass, is readily available from stock in a range of sizes and thicknesses and can be easily toughened, laminated or screen-printed – making Pilkington **Optifloat™** Opal the ideal choice.

Applications

Because it is versatile and easy to handle and processed, Pilkington **Optifloat™** Opal can be used in any internal or external applications for decoration purposes such as windows, partition walls, glass doors and furniture (including shelves, cabinets and display cases), working surfaces, wall cladding and balustrades.



Features and benefits

- High light transmittance (of typically 87% in 4 mm), allowing privacy and uniform, natural design whilst still diffusing light.
- ‘Velvet smooth’ and durable surface; high perceived value in any application.
- Can be used internally and externally, highly resistant even by challenging weather conditions.
- Anti-reflectivity of the etched surface.
- Available from stock.
- Can be stored and processed as ordinary float glass.
- Can be toughened, laminated and screen-printed using standard techniques.
- Available in a wide range of sizes and thicknesses (4, 6, 8 and 10 mm).



Description

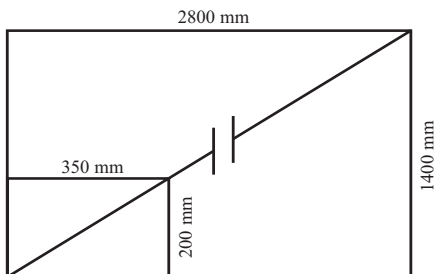
A clear or tinted float glass, which has been printed with ceramic ink designs and subsequently toughened. Pilkington Screen Printed Glass is available in wide range of colours and designs that fully or partially cover the surface of the glass. Pilkington Screen Printed Glass gives strength, safety, privacy, decoration and solar control in one product. Ceramic coverage on the screen printed glass helps to control heat and light transmission. The shading coefficient of clear and body-tinted glass is reduced, thus allowing greater flexibility of choice and design.

Applications

Pilkington Screen Printed Glass can be used in wide variety of applications including doors, bus shelters, telephone kiosks, display signs etc., in addition to the more traditional glazing of partitions, windows and façades.

Features and benefits

- Available in a wide range of designs.
- Meets the requirements for toughened safety glass.
- High durability of ceramic ink.
- No colour fading.
- Can be single or double glazed.
- Can be subjected to additional heat soak treatment, where required.
- Available in a wide range of sizes and thicknesses.

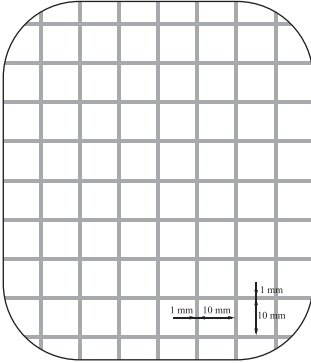


Pilkington Screen Printed Glass.

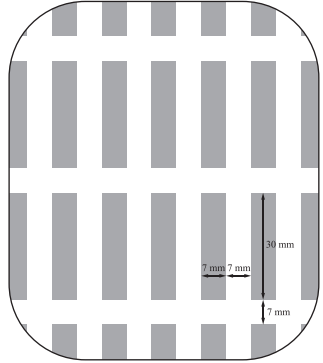
Minimum and maximum size of glass subjected to screen printing.



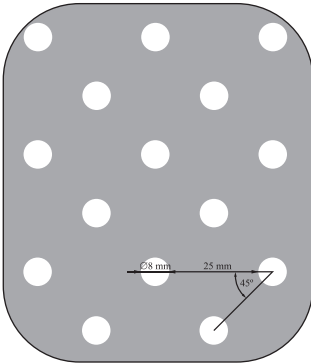
Pilkington Screen Printed Glass Standard designs



QR10-1

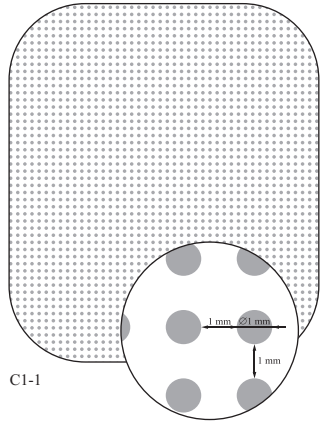


R7-30-7V



45CR8-25

 Ceramic enamel



C1-1



Description

A range of toughened safety glass mostly used in non-vision area of the façade, it includes Pilkington Spandrel Glass Enamelled, Pilkington Spandrel Glass Silicon and Pilkington Spandrel Glass Coated.

Pilkington Spandrel Glass Enamelled

Pilkington Spandrel Glass Enamelled is produced by depositing special ceramic paint on the glass, and subsequently being toughened, a process which also fires ceramic paint into the glass surface.

Pilkington Spandrel Glass Enamelled is offered in 10 standard colours: white RAL 9016, light grey RAL 7046, grey RAL 7012, dark grey RAL 7021, bronze RAL 8017, green RAL 6032, dark green RAL 6012, blue RAL 5024, dark blue RAL 5010 i black RAL 9011. A wider range of RAL colours is available upon request, but minimum quantity ordered should be 200 m².

Maximum size: 1800 x 4500 mm.

Pilkington Spandrel Glass Silicon

Pilkington Spandrel Glass Silicon is a toughened glass covered with silicon coating, which makes the glass non-transparent. Pilkington Spandrel Glass Silicon, in standard offer, is available in Blue Grey tint. On special request, the glass is also offered in following tints: Warsaw Grey, Traffic Grey, Primary White and Harmony Blue.

Maximum size: 1800 x 4500 mm.

Pilkington Spandrel Glass Coated

Pilkington Spandrel Glass Coated is a toughened glass, coated with special metallic coating, developed for Pilkington **Suncool™** glass range (type E200, E120, E140) and Pilkington **Activ Suncool™** (type A200, A120, A140).

Maximum size: 2500 x 4500 mm.



Our wide range of Pilkington Spandrel Glass offers a number of options for use with curtain wall applications allowing the entire building exterior to be fully glazed. Its primary function is to cover the construction elements in non-vision areas, such as hung ceilings or the edges of floor slabs. Spandrel glass can be incorporated into insulating glass units, and when used in combination with the same adjacent vision glass, it can either complement or contrast depending on the coating or colour of the external glass. Spandrel glass can be insulated with a variety of materials to meet even the most exacting of standards.

Applications

Pilkington Spandrel Glass is used for curtain wall applications, either to match the non-vision spandrel panels to the vision area of glazing or to provide a contrast to the vision area glazing.

Pilkington Spandrel Glass Enamelled is also used for interior design and furniture.

Features and benefits

- Meets the requirements for toughened safety glass.
- No colour fading.
- Wide range of colours of enamelled glass, allowing a wide range of visual effects.
- Provides uniformity of curtain walling appearance, and total concealment of internal structure or services.
- Can be subjected to additional heat soak treatment, where required.
- Available in a wide range of sizes and thicknesses.



Description

A rolled patterned glass, one surface of which has a specific pattern or design impressed into the surface, Pilkington Texture Glass provides obscuration and decoration. The patterned glass allows the passage of light but depending on the depth and configuration of the pattern, varying degrees of obscuration are obtained. All patterns are classified according to their obscuration in relation to each other, the gradation being from 1 (least obscuring) to 5 (most obscuring).

Applications


The designs give scope for combining functional suitability with decorative effect, whilst emphasising the natural light-enhancing properties of glass. The glasses can be supplied in toughened or laminated form for safety and incorporated into insulating glass units for thermal insulation or noise control.

Pilkington Texture Glass is translucent, with diffused light transmitted but privacy maintained. It offers a wide selection of alternatives, meeting both functional and aesthetic requirements and may be used for privacy in commercial, industrial and residential buildings. It may also be used for decorative purposes in applications such as doors, partitions and balustrades.

Features and benefits

- Provide different degrees of obscuration for privacy of decoration purposes.
- Extensive range of designs and finishes.
- Available with wired glass, and therefore suitable for glazing resistant to fire.
- Available in toughened and laminated forms (depending on design) for safety and security performance.
- Can be single glazed or incorporated in an insulating glass unit for additional properties.
- Available in a wide range of sizes and thicknesses (3, 4, 6, 8 and 10 mm) depending on design.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Texture Glass																			
												glass	performance code	light	energy	S, UV					
	I	W/m ² K	U	LT	g	LT	energy	LT	LR ^o	LR ⁱ	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV	
	monolithic glass																				
3	mm	↕	5,8	89	85	89	88	86	88	88	88	83	7	10	85	0,94	0,04	0,98	1,05	59	
4	mm	↕	5,8	88	82	88	88	86	88	88	98	78	7	15	82	0,90	0,04	0,94	1,07	55	
6	mm	↕	5,7	86	78	86	86	86	86	86	97	73	7	20	78	0,84	0,06	0,90	1,1	48	
10	mm	↕	5,6	84	74	84	84	84	84	84	95	67	7	26	74	0,77	0,08	0,85	1,14	41	

Notes:

Maximum size: 2140 mm x 1320 mm (except for rough cast available in 2700 mm x 1320 mm).



8.0 Glass Systems



Glass can be used to create building interiors which connect occupants with the external environment, combining unbroken views of the surrounding nature and high level of natural light with the comfort and safety of the internal environment.

This section present two of our attractive and practical glass systems, which will allow you, for example, to transform yards into cosy interiors, enclose private and public outdoor areas under glass roofs and build stunning glass façades.

Our two major glass systems, Pilkington **Planar**[™] and Pilkington **Profilit**[™] are developed for use in glass façades, walls or roofs, and also for internal glazing applications.

Our Pilkington specialists and accredited installers can provide all the support that architects and designers require during their planning and design process.



The ultimate structural glazing system

Description

A structural glazing system that provides a flush glass surface, by utilising stainless steel fittings housed in countersunk holes to fix the glass façade back to the structure, instead of using the more conventional framed systems. The result is a fully engineered system with the minimum of structure and the maximum visual clarity. The exterior glass used in all Pilkington **Planar**[™] systems is normally 10, 12, 15 or 19 mm thick Pilkington **Optifloat**[™] heat soaked toughened glass. A silicone seal between adjacent panels provides weatherproofing. Pilkington has been at the forefront of structural glass testing and design for over 40 years. The fixture holes are a critical feature, subject to constant investigation and testing because of the stresses induced locally by wind or snow loading, or by the weight of the façade. Positive and negative wind loads as well as snow loads must be resisted by the system and transferred through the fixing locations. The system uses a combination of thickness of glass, panel size and number of fixings to accommodate for a variety of loads. Pilkington **Planar**[™] system has given architects the freedom to create the stunning glass buildings and canopies that are such a feature of modern cityscapes.

Glass types used within Pilkington **Planar**[™] systems:

- Single glass – flat and curved.
- Single laminated safety glass.
- Pilkington **Planar**[™] Integral.
- Insulating glass units.
- Laminated insulating glass units.
- Triple insulating glass units – Pilkington **Planar**[™] Triple.

Please note that Pilkington **Planar**[™] can incorporate most Pilkington glass types, including our the range of solar control, low-emissivity, screen printed glass as well as our Pilkington **Activ**[™] self-cleaning glass.



Various forms of steel structures can be used to support a Pilkington **Planar**[™] façade. The versatility of Pilkington **Planar**[™] connections enables almost any type of structure to be used.

The compatible support systems are:

- Steel structures: basic mullions, trusses, tension structures.
- Aluminium purlins.
- Glass mullions systems.

Applications

The Pilkington **Planar**[™] system covers the full range of applications – from the small and technically simple through to major packages for total building cladding. Past work includes curtain walls, complex three dimensional façades and roofs, opening lights and curved glasses.

Features and benefits

- Offers maximum freedom in design.
- Flush external surface.
- Engineered to permit glazing in any plane: vertical, horizontal or sloping.
- High quality and appearance of materials.
- Most widely tested structural glazing system.
- 12 years warranty.
- Can incorporate most Pilkington glass types, including solar control, low-emissivity and screen printed glass, as well as Pilkington **Activ**[™] self-cleaning glass.



Description

Pilkington **Profilit**[™] is an alkali cast glass in U-shape, which is produced according to EN 572, Part 7, using the machine rolling process. It is translucent, but not transparent, with a patterned surface on the outside (pattern 504) and has the quality features of cast glass.

Range of products overview

- Pilkington **Profilit**[™] (standard) – with ornament 504 and uncoated
- Pilkington **Profilit**[™] Wired – with longitudinal wire inlays
- Pilkington **Profilit**[™] Amethyst – blue
- Pilkington **Profilit**[™] Clear – without ornament 504
- Pilkington **Profilit**[™] Antisol – solar control
- Pilkington **Profilit**[™] Plus 1,7 – thermal insulation
- Pilkington **Profilit**[™] T – thermally toughened
- Pilkington **Profilit**[™] T Color – thermally toughened and coloured enamelled

Thermal insulation

Pilkington **Profilit**[™] Plus 1,7 is a low-e coated glass with a U-value of 1,8 W/m²K when double glazed. Please note that Pilkington **Profilit**[™] Plus has to be assembled according to our guidelines. For more information, please contact your local sales representative.

Solar control

Pilkington **Profilit**[™] Antisol reduces the total solar energy transmittance (g-value) of the glazing.

Although the Pilkington **Profilit**[™] Antisol coating is bronze in colour, high visible light transmittance can be maintained.

Safety

Thermally toughened profiled glass Pilkington **Profilit**[™] T is specially designed to satisfy increased safety requirements within common areas of public buildings. This product variant provides greater mechanical strength compared to its annealed version, allowing the creation of large surfaces that are bright whilst also meeting all safety requirements. In addition it allows for longer installation lengths in comparison with standard Pilkington **Profilit**[™]. Heat soaked thermally toughened glass is available upon request.



Decoration

Thermally toughened and colour coated Pilkington **Profilit**[™] T Color is a profiled enamelled glass available in a wide range of colours, that gives architects new design possibilities. As the glass is toughened, it also meets higher safety requirements.

Noise control

Noise ranks among the most unpleasant emissions. The psychological and physical strain resulting from noise is a continuous hazard to human health.

The use of Pilkington **Profilit**[™] glass reduces the level of external noise to a level that is safe for the human ear. A double glazed installation with the padding profiles no. 165 and 166 achieves a sound reduction of 38 - 41 dB. Triple glazing can be used to achieve a sound reduction of 55 dB.

Applications

Pilkington **Profilit**[™] can be used in interior or exterior applications. The "U-shaped" channels can be installed either vertically or horizontally. The glass is available in a variety of colours and textures with varying translucency, allowing for the passage of natural light without the loss of privacy. Pilkington **Profilit**[™] is energy efficient, provides excellent sound reduction and is one of the most cost-efficient glass wall systems available. It can be single glazed for interior use or dual glazed for exterior applications.

Sports centre applications:

For sports centre glazing subject to ball impact, a double skin special profile Pilkington **Profilit**[™] K22/60/7, K25/60/7 or K32/60/7 construction should be selected, as permitted for ball impact glazing in accordance with DIN 18032, Part 3. The profile should be used without wires. Please consider special application requirements.



Pilkington Profilit™



Pilkington Profilit™ glass types	K 22(*)	K 25	K 32	K 50	K 22/60/7	K 25/60/7	K 32/60/7
Width	w [mm]	232	262	331	498	232	331
Flange height	h [mm]	41	41	41	41	60	60
Weight (single glazing)	t [mm]	6	6	6	6	7	7
Weight (single glazing)	[kg/m ²]	19,5	19,0	18,2	17,0	25,5	22,5
Max. length supplied (not max. installation length)		6000	6000	6000	5000	7000	7000
Number of longitudinal wires		7(*)	8	10	16(*)	7	8
With 16 longitudinal wires (meshing function)		-	16	-	-	-	16
For façades**		-	-	-	-	-	8+2*
Pilkington Profilit™ Plus 1,7		-	S	S	S	S	S
Pilkington Profilit™ Plus 1,7 wired		-	S	S	-	-	S
Pilkington Profilit™ Antisol		-	S	S	S	S	S
Pilkington Profilit™ Antisol wired		-	S	S	-	-	S
Pilkington Profilit™ Amethyst (blue)		-	S	S	-	-	S
Pilkington Profilit™ Amethyst wired		-	S	-	-	-	S
Pilkington Profilit™ Clear (without ornamentation)		-	S(*)	-	S(*)	-	S(*)
Pilkington Profilit™ Clear wired (without ornamentation)		-	S	-	-	-	-
Light transmittance (mean value)		single glazing: 86%		double glazing: 75%			
Thermal transmittance	U [W/m ² K]	SG: 5,6	DG: 2,8	DG: 2,8	SG: 5,52	DG: 2,7	
Sound insulation value (in range 100-3200 Hz)	R _w [dB]	SG: 22	DG: 38***	DG: 38***	SG: 25	DG: 41***	
Pilkington Profilit™ T and Pilkington Profilit™ T Color thermally toughened profiled glass can be heat soaked upon request. The supply lengths and maximum installation lengths provided in this document do not apply for Pilkington Profilit™ T and Pilkington Profilit™ T Color.							

* – One wire per flange.
 ** – For Pilkington **Profilit™** façades, please consult our technical advisory service prior to use.
 *** – Glass installation using Pilkington **Profilit™** gaskets nos. 165 and 166.
 Notes: R_w value for eg. for K22 = 36 dB without padding, 38 dB with padding.
 SG – single glazing / DG – double glazing
 S = special production – for production-related reasons these products are only manufactured on a per-order basis and are not kept in stock.
 (*) = sale from stock providing there are sufficient stocks available or from next production run.
 We would be pleased to examine the possibility of supplying any product combination not mentioned above upon request.



9.0 Special Applications



Our special applications section includes products with specific properties.

Pilkington **Optiwhite™** – is an extra clear low iron float glass which can be used as a final product, in insulating glass units or as a by-product for manufacture of other special glass products. It is also used in the fast developing solar energy sector.

Pilkington **Mirropane™** is used as a one-way vision mirror for undetected surveillance. This type of glass is used in areas which need to be observed or where people need to be prevented from looking in, for example in police stations, customs halls, hospitals, warehouses, computer installations and banks.

Pilkington **TEC Glass™** is a range of low-emissivity glasses with an electric conductive coating of special qualities. Pilkington **TEC Glass™** is also used in white goods applications such as fridge and oven doors, where high insulation is required. In its toughened version, it is used for direct electrical heating, which uses an electric current passing through the coating. Because the coating conducts electricity, static electricity is conducted from the coated side. We manufacture various types of Pilkington **TEC Glass™** with different resistance levels. The glass is neutral and transparent like conventional float glass and has high light transmission. It can be curved, toughened and screen printed.

If you are interested to know more about these products please contact our Technical Advisor.



High reflective coated glass for one-way vision

Description

An on-line coated glass product developed for use as a one-way mirror where total clear vision is required and specific lighting conditions can be achieved. Under specified lighting conditions it offers an effective means of providing undetected surveillance and high quality one-way vision to achieve complete privacy.

In order to maintain privacy in the observing area, the ratio of illumination levels between public and private side, or observed and observing side, must be 8:1. It is also advisable, if absolute privacy is essential, to have dark furnishings, to wear dark clothing in the area from which observation is taken place, and to ensure the lights on the observed side are not directed at the glass.


Applications

Pilkington **Mirropane™** is the ideal choice for supermarkets, computer rooms, banks or cash offices, where areas need to be kept under observation or hidden from public scrutiny. It is also appropriate for patient monitoring in hospitals or residential care establishments. Pilkington **Mirropane™** is available in 6 mm annealed form.

Pilkington **Mirropane™** is normally only used for internal applications. In such cases, since neither side of the mirror will be exposed to the weather, glazing materials such as adhesive cotton based strips, plastics or rubber channels can be used in a suitable frame. The glass must be installed with the coating on the observer's side. In such situation glass on the observer's side appears like a normal mirror and helps to hide the fact that the glass is used for surveillance purposes. In addition such position of the coating avoids a risk of finger prints, scratches etc. on the higher traffic side of the glass (e.g. in shops). When used within an insulating glass unit, the coating should face the cavity, and the Pilkington **Mirropane™** glass should be on the observer's side.

If you would like to use Pilkington **Mirropane™** in external applications, please contact your local Pilkington representative.



		<p style="text-align: center;">Pilkington Mirropane™ Grey</p>		<p>S, UV</p>		%	UV	UV transmittance	2				
				-	s	selectivity index	0,28						
		<p>energy</p>		-	TSC		total shading coefficient	0,46					
				-	LSC		longwave shading coeff.	0,20					
				-	SSC		shortwave shading coeff.	0,26					
				%	TET		total transmittance	40					
				%	EA		absorptance	66					
				%	ER		reflectance	11					
				%	ET		direct transmittance	23					
				<p>light</p>		-	Ra		colour rendering index	71			
						%	LRI		reflectance inside	70			
						%	LRo		reflectance outside	17			
%	LT		transmittance			11							
<p>performance code</p>		%	g		energy	40							
		%	LT		light	11							
		W/m ² K	U		U value	5,7							
<p>glass configuration</p>		III	triple insulating glass unit, Pilkington Optitherm™ S3 #5					↑					
		II	insulating glass unit, Pilkington Optitherm™ S3 #3					↑					
		II	insulating glass unit, Pilkington K Glass™ #3					↑					
		II	insulating glass unit, primary product outside #2					↑					
		I	primary product, monolithic #2					↑					

Notes:
Maximum size: 5180 mm x 3300 mm.



Extra clear low iron float glass

Description

An extra clear low iron float glass. The glass is practically colourless, and the green cast inherent to ordinary clear float glass, which is particularly noticeable in thicker glasses, is virtually eliminated. Pilkington **Optiwhite™** offers the highest level of light and solar energy transmittance.


Applications

Pilkington **Optiwhite™** is recommended for applications that require high light transmission or for which a glass of neutral colour is desired. These include clear fire protection glazing, laminated security glazing, insulating glass units, photovoltaic modules, solar collectors, projection room windows, shop fronts, demonstration counters, shelving, showcases, table tops and other frameless glazing applications. Pilkington **Optiwhite™** is also ideal for glass which is to be ceramically decorated, as the true colours of the decoration will show through the glass. The colour neutrality of Pilkington **Optiwhite™** is mostly noticeable in applications where the edges of the glass are exposed, for example in shelving or table tops.

Features and benefits

- Practically colourless compared to ordinary clear float glass, ideal for applications where the glass edges are visible or when a neutral colour is desired.
- Highest light transmittance (1% higher than clear float glass in 3 mm thickness – 6% higher in 15 mm thickness), offering outstanding visual clarity when unrestricted view is required.
- High solar heat transmittance (4% higher than clear float glass in 3 mm thickness), allowing more heat through the glass, thus reducing the need for heating the building.
- Available in annealed or toughened form.
- Can be combined with other Pilkington products to offer additional benefits such as solar control, noise reduction or fire protection.
- Available in a wide range of thicknesses, from 2 to 19 mm.



 PILKINGTON <small>NSG Group Flat Glass Business</small>		Pilkington Optiwhite™																
		glass configuration	performance code				light				energy				S, UV			
		W/m ² K	U	LT	g	LT	LRo	LRi	Ra	ET	ER	EA	TET	SSC	LSC	TSC	S	UV
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
	I																	
2 mm	↔	5,9	91	91	91	91	8	8	100	91	8	1	91	1,05	0,00	1,05	1,00	86
3 mm	↔	5,8	91	91	91	91	8	8	100	90	8	2	91	1,03	0,02	1,05	1,00	84
4 mm	↔	5,8	91	91	91	91	8	8	100	90	8	2	91	1,03	0,02	1,05	1,00	83
5 mm	↔	5,8	91	90	90	91	8	8	100	89	8	3	90	1,02	0,01	1,03	1,01	81
6 mm	↔	5,7	91	90	90	91	8	8	100	89	8	3	90	1,02	0,01	1,03	1,01	81
8 mm	↔	5,7	91	89	89	91	8	8	99	88	8	4	89	1,01	0,01	1,02	1,02	78
10 mm	↔	5,6	90	88	88	90	8	8	99	87	8	5	88	1,00	0,01	1,01	1,02	76
12 mm	↔	5,5	90	88	88	90	8	8	99	86	8	6	88	0,99	0,02	1,01	1,02	73
15 mm	↔	5,5	89	87	87	89	8	8	99	85	8	7	87	0,98	0,02	1,00	1,02	71
19 mm	↔	5,3	89	86	86	89	8	8	98	83	8	9	86	0,95	0,04	0,99	1,03	68

Notes:
 Special extra clear low iron float glass.
 Maximum size: 6000 mm x 3210 mm.

Contact list

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Belorussia, Bulgaria, Romania, Lithuania, Moldavia

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For **processed products** (e.g. insulating glass units, toughened glass, enamelled glass, screen printed glass etc.) enquiries:

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