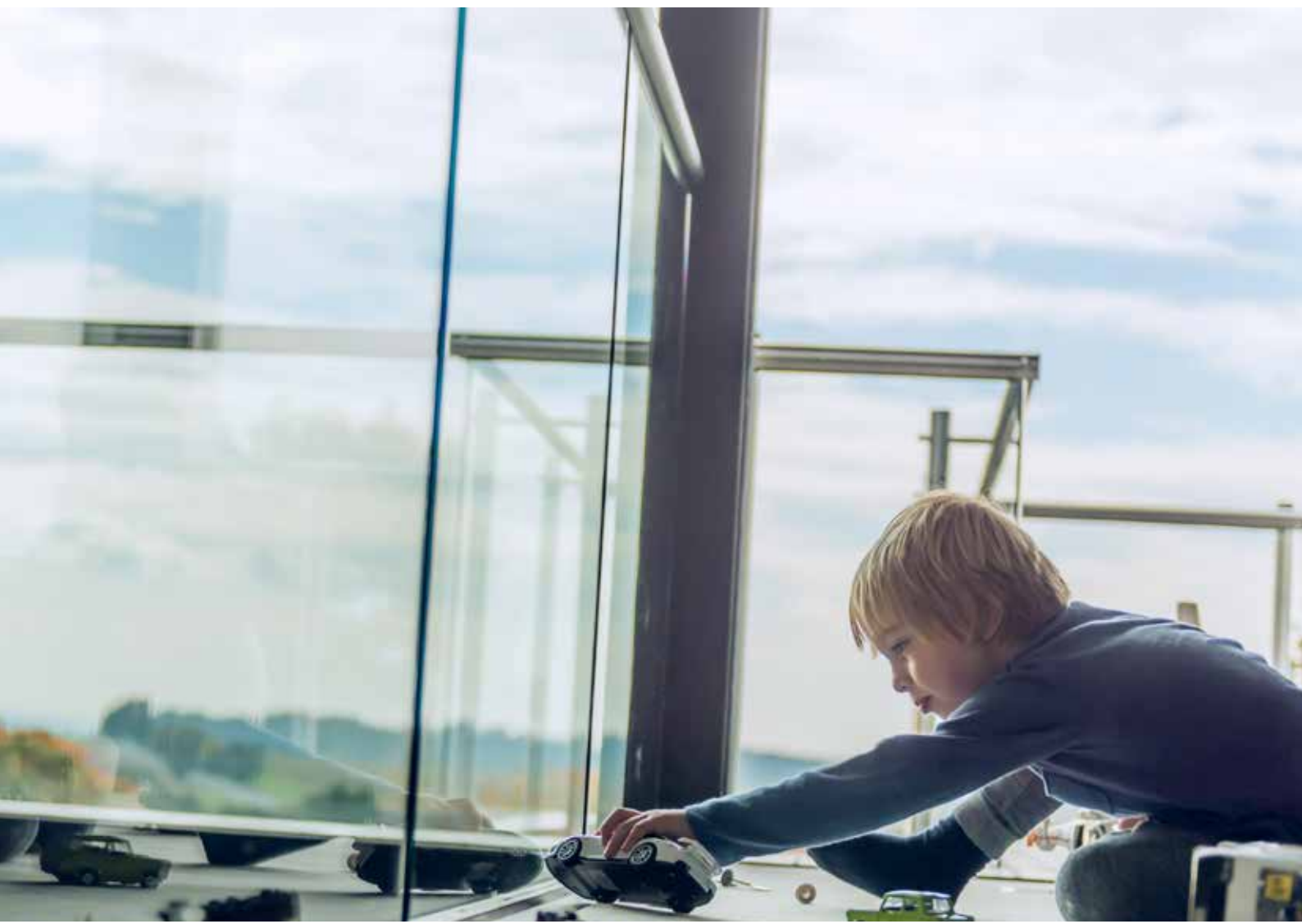


UNIGLAS® | **SAFE**  
S a f e t y g l a s s



THE FUTURE WITH GLASS



## SAFETY WITH GLASS

### SAFETY WITH GLASS

Large-scale glazing units are not just a design feature for modern urban architecture. They also create airy rooms flooded with light, ensuring excellent quality of life.

However, this sophisticated material is also used for all-glass doors, stair treads and stringers, right through to fully glazed lift systems and glass furniture. In fully glazed façades, glass also takes on the role of fall protection.

Even if it appears fragile at first glance, UNIGLAS® | **SAFE Safety Glass** fulfils the highest safety standards thanks to state-of-the-art finishing processes.

### SAFETY CATEGORIES

**1. Active safety:** UNIGLAS® | **SAFE Safety Glass** has special properties such as burglar resistance. For example: from impact and anti-vandalism to bullet resistance providing property protection or explosion resistance.

**2. Passive safety:** The breakage characteristics of UNIGLAS® | **SAFE Safety Glass** offers enhanced protection from serious injuries. For example: shower screens or interior doors made of toughened safety glass.

**3. Construction safety:** UNIGLAS® | **SAFE Safety Glass** features residual stability and load capacity in the event of damage or breakage. For example: railings, supports or stair treads made of glass.

## UNIGLAS®: GLASS ISN'T JUST GLASS

### NORMALLY COOLED GLASS

Single pane of float or patterned glass. Basic glass for further processing into safety or insulating glass. Thermal shock resistance: 40 K

No safety category: In case of glass breakage, dangerous, sharp-edged pieces of glass may be produced, posing an increased risk of injury.

### TOUGHENED SAFETY GLASS

Toughened safety glass is thermally tempered float or suitable patterned glass. Special properties: Increased impact, shock and flexural strength, resistance to impact. Thermal shock resistance: 200 K

Passive safety category: If toughened safety glass breaks due to excessive mechanical or thermal stressing, it usually shatters into blunt-edged, loosely connected pieces that pose only a minor risk of injury.

### HEAT STRENGTHENED GLASS

Manufacture is similar to toughened safety glass. However, there are lower stresses between the surface and the glass core zone. The physical properties lie between the values of normally cooled glass and toughened safety glass. Thermal shock resistance: 100 K

Active safety category: Heat strengthened glass is characterised by increased impact and shock resistance, flexural strength and thermal shock resistance. It is only classified in further safety categories if it is processed into laminated safety glass.

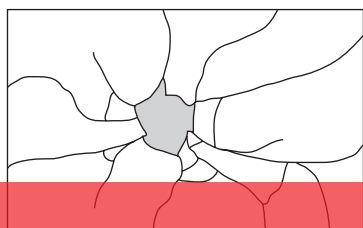
### LAMINATED SAFETY GLASS

Laminated safety glass consists of two or more panes of glass, which are usually connected by tough and flexible, highly tear-resistant, mostly polyvinyl butyral interlayers to form a functional unit. By combining different types of glass (toughened safety glass, heat strengthened glass), glass and interlayer thicknesses, laminated safety glass is provided with additional safety properties.

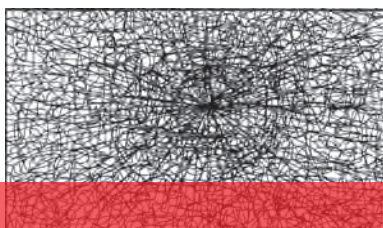
Active safety category: Residual load capacity or stability is achieved when the glass construction supports itself or a defined load over a certain period of time in the event of breakage.

Passive safety category: In the event of mechanical or thermal overload, e.g. through impact or shock, the fragments adhere to the interlayer and reduce the risk of injury.

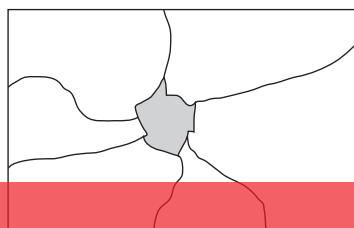
Glass pane of float glass



Toughened safety glass



Heat strengthened glass



Laminated safety glass



## IMPACT BREAKAGE PATTERNS



## PRODUCTION OF TOUGHENED SAFETY GLASS

**Small fragments, big effect: Toughened safety glass is thermally toughened glass with three outstanding properties.**

### TOUGHENED SAFETY GLASS

- 1** Flexural strength is two to three times greater than the initial product. This means that the glass can absorb significantly higher loads with the same thickness, especially even in the event of a blunt impact.
- 2** A toughened safety glass pane offers significantly higher resistance to temperature changes and temperature differences.
- 3** If toughened safety glass breaks during overstressing, blunt-edged fragments are produced which do not usually inflict dangerous cuts.

Toughened safety glass must not be subsequently machined. Cutting, grinding or drilling must be carried out before the tempering process.

#### **Heat soaked thermally toughened safety glass\***

For safety-relevant glazing and glazing that is exposed to high temperature fluctuations, the “heat-soak test” is carried out after producing the toughened safety glass.

In every type of glass, there are unavoidable nickel sulphide inclusions which can trigger “spontaneous failure” in toughened glass without any other external factors involved. An effective measure against unintentional breakage is to treat the toughened safety glass again in a heat-soak test. The panes are heated up to  $290\text{ °C} \pm 10\%$  to deliberately trigger any “spontaneous failure”.



UNIGLAS® | SAFE SAFETY GLASS

## AREAS OF APPLICATION

- All-glass constructions and glass doors
- Horizontal sliding panels and folding sliding panels
- Showcases and shop fronts
- School and play schools, sports and tennis halls
- Escape route glazing
- Fire protection glazing
- Glazing with resistance to impact
- Subsequent processing into insulating glass, laminated safety glass, thermal and solar control glass
- Façades and parapets with heat soaked thermally toughened safety glass

## PROPERTIES

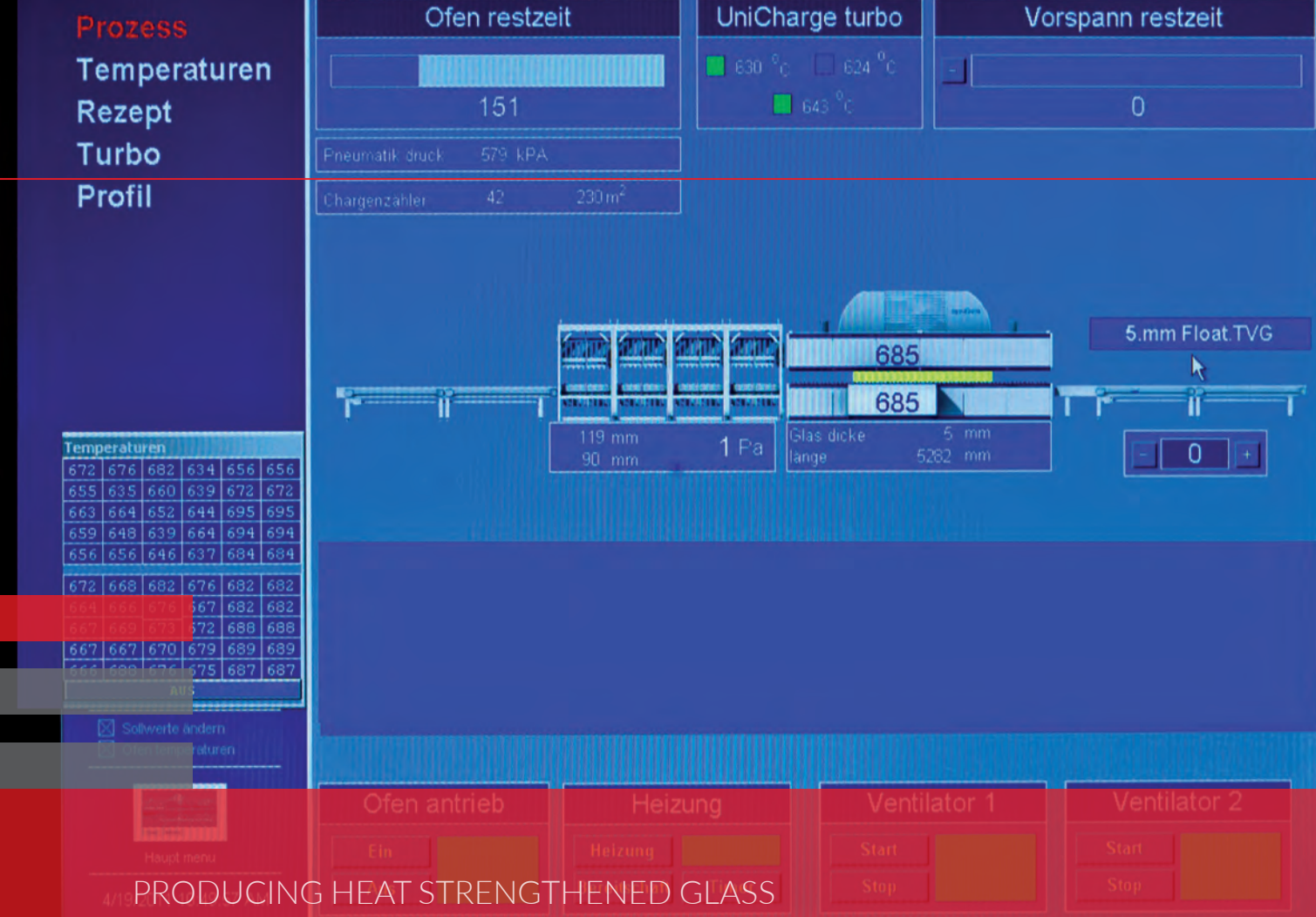
- Approximately two to three times higher tensile strength than normally tempered glass
- High resistance to rapid temperature changes
- Increased resistance to blunt impact and shock loads
- When subjected to excessive stress, toughened safety glass disintegrates into numerous, blunt-edged small fragments

## ADVANTAGE

- Ideal for use in frameless applications
- No severe cuts in the event of glass breakage



\* For Germany, there are regulations that differ from those of other EU countries: According to the Administrative Provisions – Technical Building Rules (MVV TB), externally monitored heat soaked thermally toughened safety glass that achieves reliability class RC 2 according to DIN EN 1990 may be used for glazing where the upper edge is 4 metres above the traffic surface.



The manufacturing process for heat strengthened glass is similar to that for toughened safety glass. The difference is that the glass pane heated to 600 °C is cooled down more slowly afterwards.

## HEAT STRENGTHENED GLASS

Due to the lower tempering degree, the physical properties lie between the values of normally cooled glass and toughened safety glass.

Laminated safety glass made of heat strengthened glass is used when the physical properties of normal float glass are inadequate and the use of toughened safety glass in laminated safety glass is not permissible due to the breakage characteristics or according to the recognised codes of practice. Laminated safety glass made of toughened safety glass does not usually meet the required residual creep resistance.



Heat strengthened glass is not safety glass. It only becomes safety glass if it is further processed to become laminated safety glass.



## POINT-FIXED LAMINATED SAFETY GLASS WITH COLOURED INTERLAYERS

### AREAS OF APPLICATION

As an integral part of laminated safety glass:

- Canopies and overhead glazing
- Partition walls
- Spandrels and railings
- Point-fixed glazing

### PROPERTIES

- Greater tensile strength than float glass
- Active, passive and constructional safety as an integral part of laminated safety glass
- Higher resistance to temperature differences than float glass

### ADVANTAGE

- As an integral part of laminated safety glass, heat strengthened glass is a safety glass that optimally combines active, passive and constructional safety properties.

Find technical data here:

UNI GLAS® | COLLEGE  
Technical Compendium

UNI GLAS® | COLLEGE  
Product overview



## PRODUCTION OF LAMINATED SAFETY GLASS

### **Laminated safety glass**

Stability provided by highly tear-resistant film:  
Laminated safety glass is composed of two or more float or patterned glass panes that are permanently bonded together by highly tear-resistant, special interlayers. Depending on the function, layers of different thickness are arranged between the individual glass panes.

## LAMINATED SAFETY GLASS

### **Laminated safety glass made from heat strengthened glass or toughened safety glass**

Laminated safety glass may be made of either heat strengthened glass or toughened safety

glass, used as single panes or further processed to make insulating glass. In addition to safety properties, it can also be combined with sound insulation properties.

### **Walk-on laminated safety glass**

Walk-on glazing, with or without anti-slip coating, consists of at least three single panes (country-specific) bonded by highly tear-resistant intermediate layers. Screen-printed, deep-etched glass as well as glass that has been textured using certain laser processes can be used. Depending on the application, the single panes of laminated safety glass are produced from toughened safety glass, heat strengthened glass, float or a combination of these.



Laminated safety glass can be manufactured from different types of glass:  
Toughened safety glass, heat strengthened glass or float.



## Areas of application



- Railings and balustrades
- Safety barrier glazing
- Overhead glazing, luminous ceilings
- Walk-on and accessible glazing, glass stairs
- Glazing that is resistant to impact, penetration, bullets and explosions

UNIGLAS® | **SAFE**  
Safety Glass

## Properties

- In the event of overload, the glass breaks but the fragments adhere to the interlayer (splinter protection).
- Great residual stability and load capacity can be achieved.

## Advantages

- Low risk of injury The hole in the glass remains closed.



UNIGLAS® | **COLLEGE**  
Technical Compendium

UNIGLAS® | **COLLEGE**  
Product overview

Find technical data here:



## UNIGLAS® | SAFE SAFETY GLASS

The safety-certified laminated safety glass is capable of many things. The neighbour's children's football bounces off laminated safety glass as thin as 8 mm without incident, much to the relief of the parents.

### SAFETY IN A CLASS OF ITS OWN

What is known as "anti-vandal glazing", which professionals refer to as resistance classes P1A to P5A, can even withstand attempted break-ins with paving stones.

If a burglar tries to break through the glass with cutting tools, for example with an axe, it would be very difficult to make a significant opening with glazing in resistance category P6B to P8B.

Classes BR1 to SG2 can even protect against projectiles. The glass can be constructed to ensure that no shards break loose.

UNIGLAS® | **SAFE Safety Glass** is tested to relevant standards.

#### Resistance categories:

- Anti-vandal glazing: **P-A**
- Penetration-resistant glazing: **P-B**
- Bullet-resistant glazing: **BR**
- Explosion-resistant glazing **ER**



## ANTI-VANDAL GLAZING

This safety glass offers protection against break-in, vandalism and “spontaneous attack”.

### P-A: ANTI-VANDAL GLAZING

The P-A categories for impact-resistant glazing defined in EN 356 are classified into five groups with increasing protective effect.

**Test procedure according to EN356: manual attack**

Anti-vandal glass is tested by means of a steel ball weighing 4.0–4.17 kg with a diameter of 98 to 102 mm. Depending on the classification, the ball free-falls onto the test pane from different heights. The ball must not be able to penetrate the glass.

Resistance category	Standard	Application examples
P1A	EN356	Simplest measure to inhibit burglary
P2A	EN356	Detached houses and blocks of flats in housing estates
P3A	EN356	Secluded houses
P4A	EN356	Houses with high-end fixtures and fittings From RC2 also recognised as burglary protection by insurance companies
P5A	EN356	Houses with particularly valuable content (RC 3)



## PENETRATION-RESISTANT GLAZING

Burglar-resistant glazing in resistance category P-B is used in the case of increased security requirements and within the scope of insurance policies. These are classified into three groups with increasing protective effect.

### P-B: PENETRATION-RESISTANT GLAZING

**Test procedure according to EN356:  
manual attack**

Penetration-resistant glazing is tested with a mechanical axe. The more blows the glass withstands, the higher the resistance category.

Resistance category	Standard	Application examples
P6B	EN356	Chemists/pharmacies, department stores, specialist shops (RC 4)
P7B	EN356	Museums, galleries, psychiatric clinics (RC 5)
P8B	EN356	Jewellers, correctional facilities, server rooms (RC 6)

Glazing is considered bullet-resistant if it prevents the penetration of bullets and has been officially tested by a firing proof office. This is achieved by combining glass panes of different thicknesses and layers of film, which are shot with different bullets during the test, depending on the category.

### BR: BULLET-RESISTANT GLAZING

**Test procedure according to EN1063:  
resistance to shooting**

Bullet-resistant glazing is fired at with different weapons depending on classification. If the test pane is not penetrated by the shots, the required class is achieved.

Resistance category	Standard	Application examples
BR1-S to BR7-NS	EN1063	Banks, military installations, political, judicial and economic buildings

Explosion-resistant glazing can also withstand explosions, e.g. in the event of a terrorist attack.

## D: EXPLOSION-RESISTANT GLAZING

In the event of an explosion, an enormous pressure wave is released depending on the amount of explosive and the distance to the explosion site, which can exceed planned wind loads many times over. Special, interactive designs allow glazing to be produced in resistance categories ER1 to ER4.

Resistance category	Standard	Application examples
ER 1 to ER 4	EN13541	Airports, power stations, military facilities, government buildings, embassies

### Test procedure according to EN13541:

#### Simulated explosive charge

For explosion-resistant glass, the minimum duration of the pressure phase is specified in addition to the pressure load and the specific impact. The test simulates the effect of a TNT-equivalent explosive charge.



BULLET-RESISTANT GLAZING

Glass type	Thermal shock resistance	Cutting ability	Fracture behaviour	Risk of glass breakage	Risk of injury
Float glass	40 K	Yes	Radial cracks from fracture centre	Great	Great
Toughened safety glass	200 K	No	Countless blunt-edged fragments	Low	Low
Heat strengthened glass	100 K	No	Radial cracks from fracture centre	Low	Great
Laminated safety glass/float	40 K	Yes	Radial cracks, shards held by bonding	Great	Low
Laminated safety glass/toughened safety glass	> 40 K	No	Fragments held by bonding	Low	Low
Laminated safety glass/heat strengthened glass	> 40 K	No	Radial cracks, fragments held by bonding	Low	Low

## THE DIFFERENCES BETWEEN INDIVIDUAL GLASS TYPES AT A GLANCE

### FREQUENTLY ASKED QUESTIONS

- 1. What are the differences between float glass, toughened safety glass, heat strengthened glass and laminated safety glass?**

There are many ways of manufacturing glass. The table above shows you the different glass types, which differ in their individual parameters of thermal shock resistance, cutting ability, breakage behaviour, glass breakage as well as risk of injury.

- 2. What is the special feature of toughened safety glass and heat soaked thermally toughened safety glass?**

The thermal treatment of toughened safety glass increases safety. Heat-soaked thermally toughened safety glass is a special toughened

safety glass. It is heated in a controlled manner after the tempering process in the “heat-soak test” to deliberately cause spontaneous failure caused by unavoidable nickel sulphide inclusions.

In Germany, for glazing where the upper edge is more than 4 metres above the traffic surface, verification is required that the toughened safety glass to be used complies with reliability class RC 2 according to DIN EN 1990. This verification can be provided by external monitoring of the production.

- 3. What are the uses for the different types of safety glass?**

We have provided some examples of applications for toughened safety glass, heat strengthened



## TEST PROCEDURE ACCORDING TO EN356: BALL DROP

glass (in combination with laminated safety glass) and laminated safety glass on pages 5, 7, 9 and 11.

#### 4. Which safety glass do I need to use in schools or childcare facilities?

Laminated safety glass, toughened safety glass or heat soaked thermally toughened safety glass.

#### 5. What is bullet-proof glass?

Bullet-proof glass is a colloquial term for special laminated safety glass (LSG) that can withstand impacts, bullets and blasts.

#### 6. Is safety glass generally marked (ESG stamp)? If so, how?

The marking of toughened safety glass and heat soaked thermally toughened safety glass

by means of a stamp is mandatory. Laminated safety glass is not marked separately.

#### 7. According to which criteria are the individual resistance categories tested?

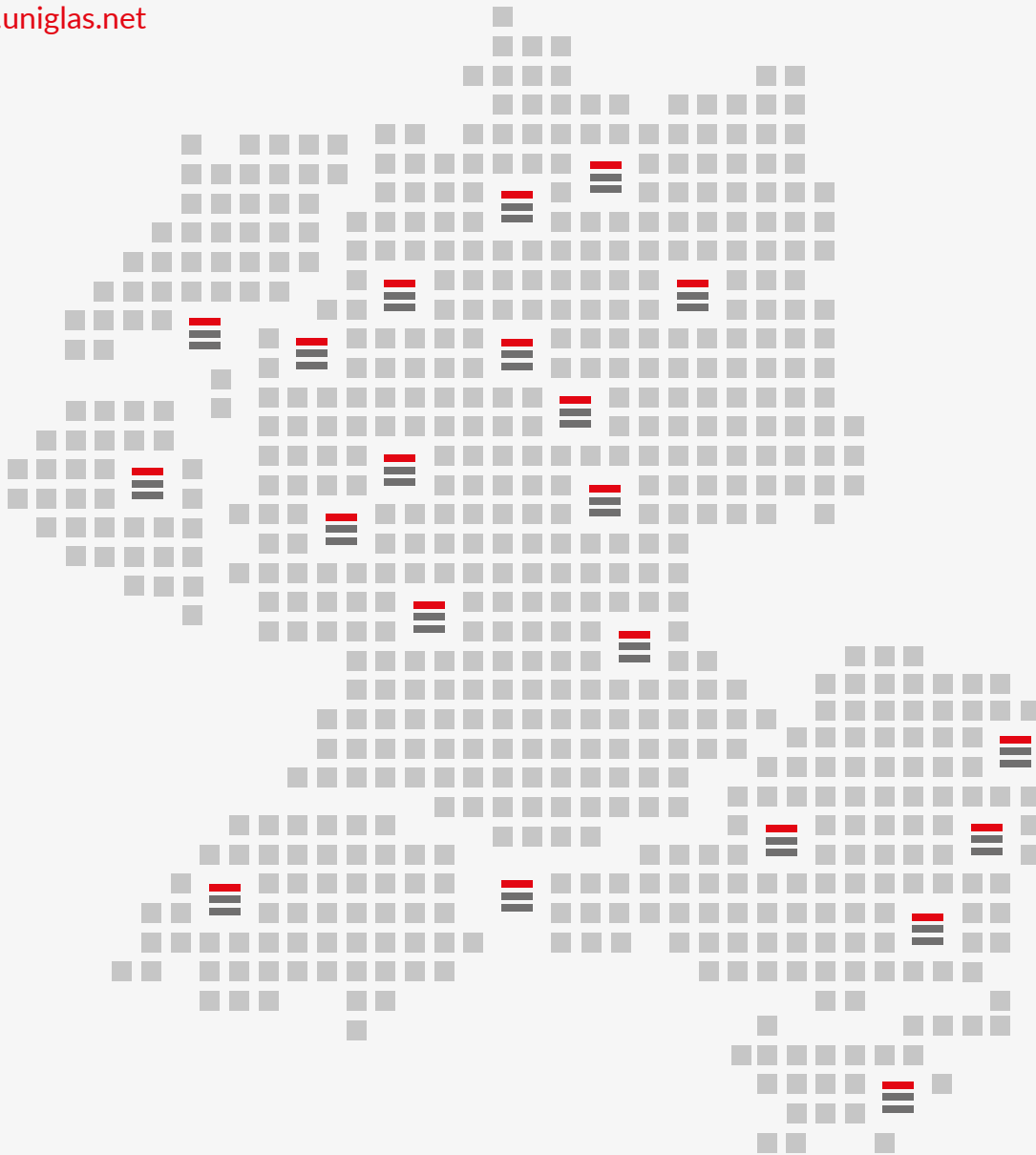
A brief description can be found on pages 13–15.

#### 8. What is meant by impact-resistant glass?

Impact resistance is tested according to DIN 18032-3 by hitting the pane with a handball 54 times and a hockey ball 12 times.

The test is passed if the glass does not show any significant damage.

[www.uniglas.net](http://www.uniglas.net)



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