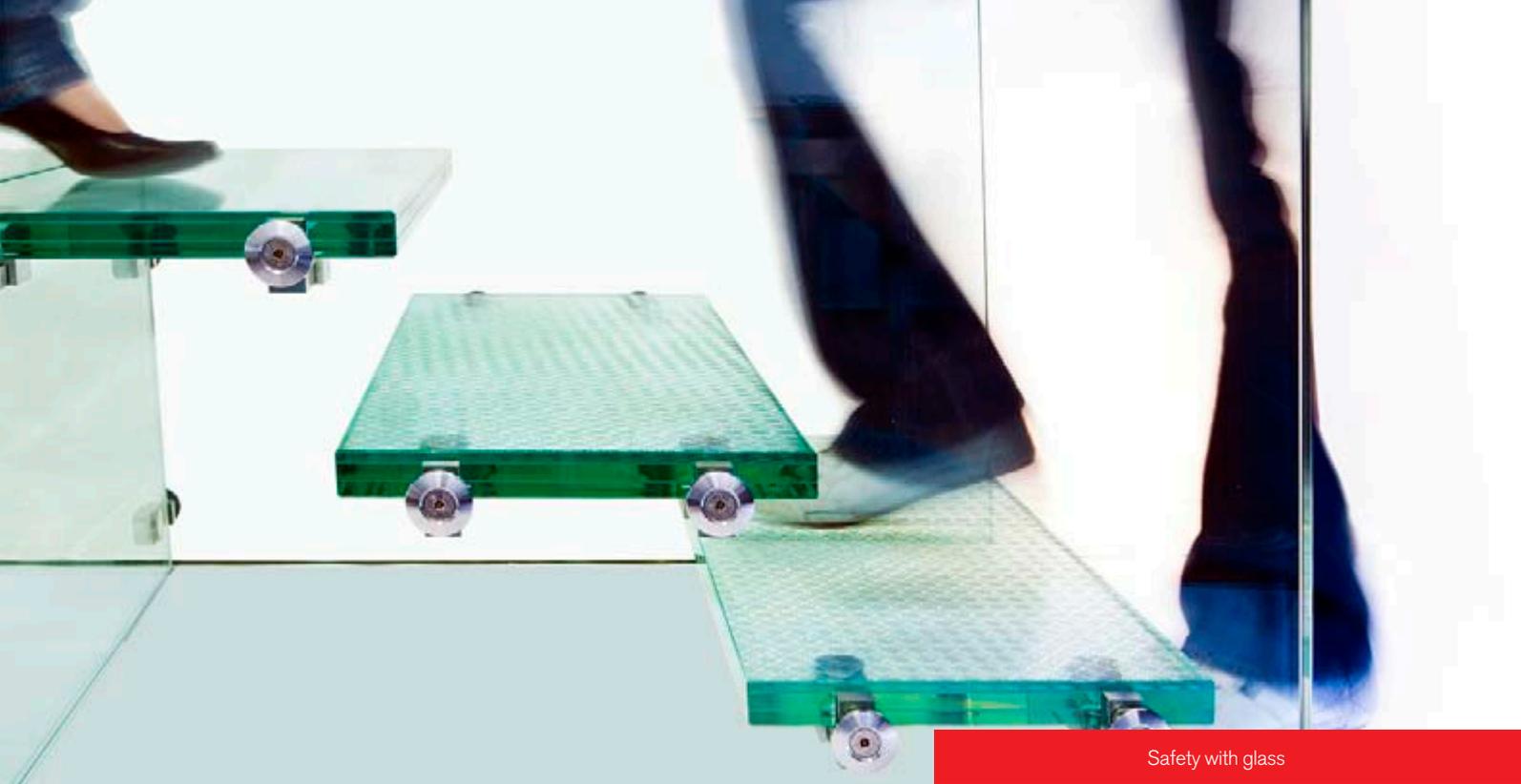


UNIGLAS®
IT'S CLEAR

UNIGLAS® | **SAFE**
Safety glass





Safety with glass

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S a f e t y g l a s s

Safety with glass

Large-scale glazed areas are not just design elements for modern urban architecture, they also create bright rooms flooded with light and thus an exceptionally high quality of life.

However, this sophisticated material is also used with all-glass doors, steps and stair stringers as well as fully glazed lifts and glass furniture. In all-glass façades the glass also takes on a safety barrier function.

Even if it appears fragile at first glance, UNIGLAS® | **SAFE safety glass** meets maximum safety requirements thanks to state of the art finishing processes.

Safety categories

1. Active safety: UNIGLAS® | **SAFE safety glass** has special features such as burglary-resistance, fall protection and fire protection.

Example: from impact-resistance to bullet-resistance as property protection, or explosion-resistance.

2. Passive safety: The fracture pattern of UNIGLAS® | **SAFE safety glass** offers improved protection from serious injuries.

Example: shower partition walls or internal room doors made of single-pane safety glass.

3. Construction safety: UNIGLAS® | **SAFE safety glass** has remaining stability and structural capacity in case of damage or breakage.

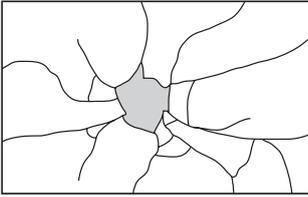
Example: railings, supports or steps made of glass.



All UNIGLAS® | **SAFE safety glass** is tested and certified.
We know what is important. Safety comes first.

UNIGLAS® : Not all glass is the same

The safety requirements for glass are very diverse. Your UNIGLAS® partner will be happy to advise you with the selection of suitable safety glass for your application.



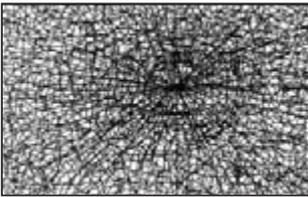
Glass pane made from float glass.
Fracture image: thrown stone

Normal cooled glass:

Single-pane made of float glass or ornamental glass. This glass is the basis for further processing into safety glass or insulating glass.

No safety category: dangerous, sharp-edged pieces of glass may result in case of breakage, which pose an increased risk of injury.

Thermal shock resistance: 40 K



Single-pane safety glass
Fracture image: thrown stone

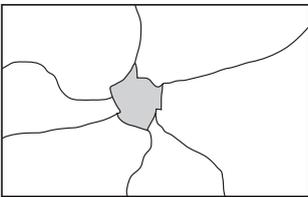
Single-pane safety glass – ESG:

ESG is thermally prestressed float or suitable ornamental glass. The glass is heated to over 600°C and then rapidly cooled down. In the process, the outer zone of the pane cools down quicker than the core. Compressive stress is generated in the surface while tensile stress is generated in the core, which leads to the achievement of passive safety and increased strength.

Passive safety category: If ESG breaks as a result of excess mechanical or thermal load, it usually shatters into blunt-edged, loosely connected fragments. These pose a much lower risk of injury.

Special features: Increased shock and impact resistance, tensile bending strength, temperature shock resistance and ball impact protection.

Temperature shock resistance: 200 K



Partially-tempered glass
Fracture image: thrown stone

Partially-tempered glass – TVG:

Production is similar to that of ESG. The difference is that the glass pane is cooled down slower after being heated at more than 600°C, resulting in less tension between the surface and glass core. The physical properties lie between the values of normal cooled glass and ESG.

Active, passive or construction safety category only if TVG is made into VSG: remaining stability and structural capacity exists if TVG is made into VSG, as the glass element made from VSG withstands stress over a certain period of time in case of breakage.

Active safety category: TVG is distinguished by its increased shock and impact resistance, tensile bending strength and temperature shock resistance.

Temperature shock resistance: 100 K



Laminated safety glass
Fracture image: thrown stone

Laminated safety glass – VSG:

VSG consists of two or more panes of glass that are combined to form a laminated product by means of tough, highly tear-resistant polyvinyl butyral foils. By combining different types of glass (ESG, TVG) the glass and foil thicknesses will lend the VSG additional safety features.

Active safety category: remaining stability and structural capacity exists if the glass construction is able to bear its own or a defined load beyond a certain period of time.

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

Temperature shock resistance of glass: VSG/float 40 K, VSG/ESG 200 K, VSG/TVG 100 K



Production of single-pane safety glass

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Single-pane safety glass, ESG

Small fragments, huge effect: ESG stands for thermally prestressed glass with three superb features:

- 1** Its tensile bending strength is two to three times higher than the original glass. Consequently the same thickness glass can bear much higher tensile or blunt impact stress.
- 2** An ESG pane offers significantly higher resistance towards temperature change and temperature differences.
- 3** If ESG breaks as a result of excess load, it usually shatters into a network of blunt-edged, loosely connected fragments that generally do not lead to dangerous cuts.

ESG cannot be machined retrospectively. Cutting, grinding or drilling must be carried out before the prestressing process.

Heat-soak ESG and ESH-H*

For safety-relevant glazing and glazing that is exposed to high temperature changes, the so-called “heat-soak test” has to be performed after the production of ESG. In every type of glass there are inevitable nickel sulphide crystal inclusions that may lead to spontaneous breakage with prestressed glass. An effective measure against unintentional breakage is another heat treatment of the ESG in a “heat-soak test”. The panes are heated up in a heating chamber to $290^{\circ}\text{C} \pm 10\%$, thereby triggering a possible “spontaneous breakage” in controlled way. This significantly increases the component’s reliability so it exceeds general building inspection specifications.



*** There are different regulations for Germany to the other EU countries: according to the Building Rules List only ESG-H, which is subject to specific provisions, may be used in public safety-relevant areas.**



UNIGLAS® | SAFE safety glass

Applications

- All-glass structures and glass doors
- Horizontal sliding panels (HSW) and folding sliding panels (FSW)
- Glass display cases and shop front designs
- School and kindergartens, sports and tennis facilities
- Escape route glazing
- Fire protection glazing
- Glazing with ball impact protection
- Can be made into insulating glass, VSG, thermal and solar protection glass
- Façades and balustrades with ESG-H

Features

- Roughly two to three times higher tensile bending strength than prestressed float glass
- High resistance towards rapid temperature change
- Increased shock and impact strength against blunt impacts
- With excess load the ESG breaks into lots of little blunt-edged fragments

Benefits

- Ideal for use in frameless applications
- No serious cuts in the event of the glass breaking

You can find the technical data here:

UNIGLAS® | COLLEGE
Technical compendium

UNIGLAS® | COLLEGE
Product overview



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Single-pane safety glass, ESG Alarm

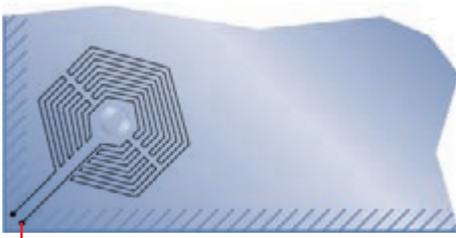
Active protection: ESG can be made into alarm glass with an alarm function and be an important integral part of a building's safety concept. The alarm loop or electrically conductive layer act as the alarm sensor. If the pane shatters due to forceful impact the electric current is interrupted and the alarm is triggered.

The three different alarm loops:

- 1** Printed and baked on alarm loop in the **visible** area. Advantage: its visibility deters potential burglars.
- 2** Printed and baked on alarm loop in the **non-visible** marginal area of the pane. Burglars are not „prewarned“.
- 3** A pane coating can be used and invisible resistors can be placed around the edge in particular with insulating glass with low g-values. The electrical resistance of the coating is monitored by an evaluation unit. There is no cut-out in the coating in the area of the alarm web.



In all three cases the ESG panes are equipped with connection cables of 30 cm length, which must be professionally laid in the rebate area and connected to an alarm unit.



1 Conventional alarm web in the visible area



2 Conventional alarm web in the non-visible area



3 Insulating glass: coating acts as an invisible alarm loop and is monitored by an evaluation unit

Different alarm loops

Applications

- Windows in upmarket properties
- Glazing of shops, banks and business premises
- Terraces and balcony doors
- Museums, galleries and art dealers

With alarm loops 2 and 3

- No visible web
- No cut-out in the coating of the external pane

With alarm loop 3

- Ideal for small panes
- Up to three elements can be connected per evaluation unit

Features

- Alarm already integrated into glass based on the closed circuit principle. Glass breakage detectors installed retrospectively can be unsightly and obstructive when opening and cleaning the window and susceptible to false alarms.

Benefit

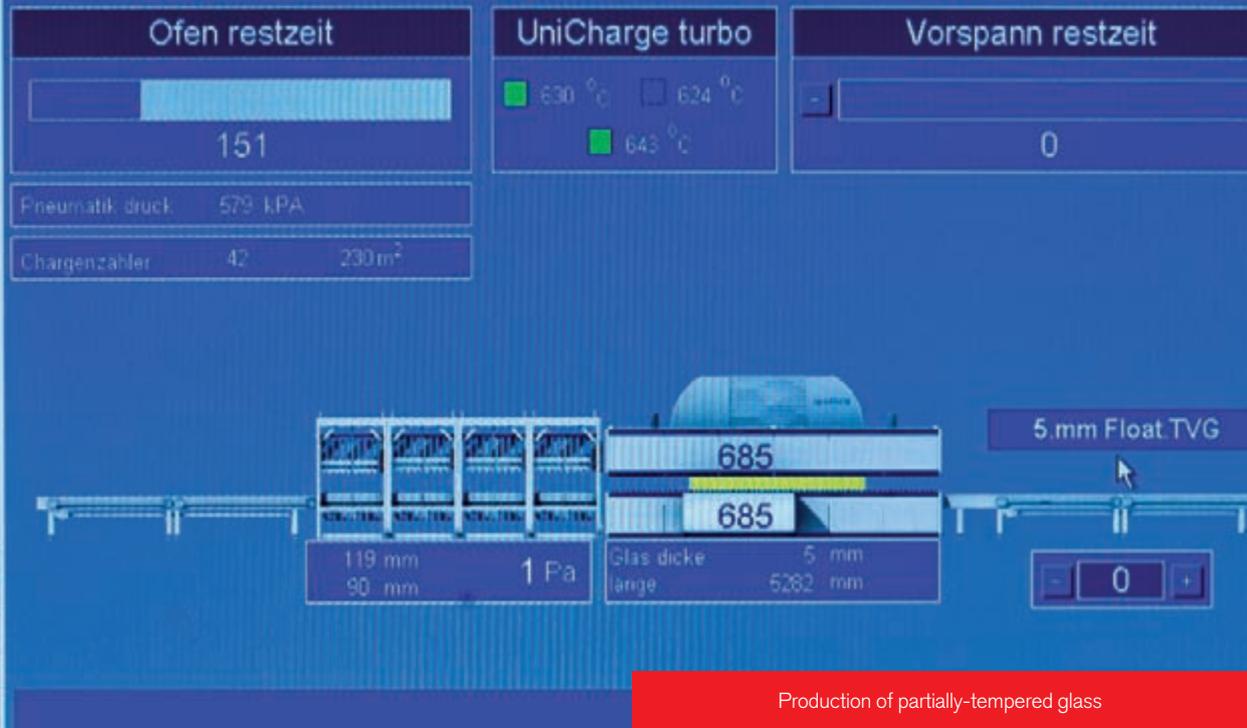
- Effective protection device. Recognised by the Association of Property Insurers (**VdS in Germany**).

You can find the technical data here:

UNI GLAS® | COLLEGE Technical compendium UNI GLAS® | COLLEGE Product overview

Prozess
Temperaturen
Rezept
Turbo
Profil

Temperaturen						
672	676	682	634	656	656	
655	635	660	639	672	672	
663	664	652	644	695	695	
659	648	639	669	694	694	
656	656	646	637	684	684	



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Partially-tempered glass, TVG

The production process for TVG is similar to that of ESG. The difference is that the glass pane heated up to 600 °C is then cooled down somewhat slower. The physical properties lie between the values of normal cooled glass and ESG as a result of the lower degree of prestressing.

VSG made of TVG is used if the physical properties of normal float glass are not sufficient and the use of VSG made of ESG is not reliable as a result of its breakage pattern or according to standard recognised technology regulations. VSG made of ESG usually does not meet the remaining stability requirements.

Like ESG, TVG may not be machined retrospectively.



TVG is not a safety glass. TVG only becomes safety glass if it is made into VSG.



Applications

As a rule combined with VSG:

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

Features

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

Benefit

- As an integral part of VSG, TVG is a safety glass that ideally combines construction, active and passive safety features.

You can find the technical data here:

UNIGLAS® | COLLEGE
Technical compendium

UNIGLAS® | COLLEGE
Product overview



Production of laminated safety glass

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Laminated safety glass, VSG

Laminated safety glass: VSG

Stability thanks to highly tear-resistant foil: VSG is composed of two or more float or ornamental glass panes, which are bonded together permanently using special highly tear-resistant intermediate layers. Layers of different thickness are arranged between the individual panes of glass depending on the function.

Laminated safety glass: VSG made of TVG or ESG

VSG can also be made of TVG or ESG, used as a single-pane or made into insulating glass. Besides the safety features it can also be combined with noise protection features.

Laminated safety glass: VSG, walk-on glass

Walk-on glass, with or without anti-slip coating, consists of at least three single-panes (depending on country), which are bonded using highly tear-resistant intermediate layers. Screen-printed and acid etched glass as well as glass structured using certain laser processes can be used. Depending on application, the single-panes of the VSG are produced from ESG, TVG, float glass or in combination with ESG, TVG and float glass.



**VSG can be produced from different glass:
ESG, TVG or float.**



UNIGLAS® | SAFE safety glass

Applications

- Railings and parapets
- Safety barrier glazing
- Overhead glazing, luminous ceilings
- Walk-on glazing, glass stairs
- Impact, burglary, bullet and explosion resistant glazing

Features

- In the event of overloading the glass breaks but the fragments adhere to the intermediate layer (splinter protection).
- High remaining stability and structural capacity are achievable.

Benefit

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

You can find the technical data here:

UNIGLAS® | COLLEGE
Technical compendium

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Product overview



UNIGLAS® | SAFE safety glass

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A whole other class of safety

The certified safety of VSG is a real all-rounder. With VSG of 8 mm thickness upwards the neighbour's children's football can bounce back without any further consequences to the relief of the parents.

So-called „impact-resistant glazing“, professionals speak here of resistance classes P1A to P5A, can even withstand burglary attempts using paving stones.

If a burglar attempts to break in using cutting tools, for example an axe, they will have great difficulty producing a significant opening with glazing in resistance class P6B to P8B.

Classes BR1 to SG2 can even protect against shots. The glass can also be structured so that there are no splinters.

UNIGLAS® | **SAFE safety glass** is tested according to relevant standards.

Resistance classes:

- Impact-resistant glazing: **P-A**
- Burglary-resistant glazing: **P-B**
- Bullet-resistant glazing: **BR**
- Explosion-resistant glazing: **ER**



P-A: impact-resistant glazing

This safety glass protects against burglary, vandalism and defends against so-called spontaneous attack. The P-A classes defined in EN 356 for impact-resistant glazing are broken down into five groups with increasing protection.

Resistance class	Standard	Application examples
P1A	EN356	Simplest measure for holding up a burglary
P2A	EN356	Detached houses and apartment buildings on housing estates
P3A	EN356	Houses off the beaten track
P4A	EN356	Houses with upmarket fixtures and fittings. From this class upwards also recognised as burglary protection Risk Class 1 (RC1) by insurance companies.
P5A	EN356	Houses with particularly valuable possessions (RC 2)

Testing procedure in accordance with EN356: manual attack

Impact-resistant glass is tested using a steel ball weighing 4.0 - 4.17 kg with a diameter of 98 to 102 mm. Depending on classification, the ball is dropped from different heights in free fall onto the test pane. The ball may not break through the glass.

You can find the technical data here: [UNI GLAS® COLLEGE Technical compendium](#) | [UNI GLAS® COLLEGE Product overview](#)



Burglary-resistant glazing

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P-B: burglary-resistant glazing

Burglary-resistant glazing with resistance class P-B is used in case of increased safety requirements and if designated by insurance companies. This is broken down into three groups with increasing protection.

Testing process in accordance with EN356: manual attack

Burglary-resistant glass is tested using a mechanical axe. The more blows the glass withstands, the higher the resistance class.

Resistance class	Standard	Application examples
P6B	EN356	Chemists, department stores, specialist retailers (RC 3)
P7B	EN356	Museums, galleries, psychiatric clinics (RC 4)
P8B	EN356	Jewellers, prisons, server rooms (RC 5 and 6)

BR: bullet-resistant glazing

Glazing is considered to be bullet-resistant if it prevents the penetration of shots and was officially tested by a Proof House. It is produced by combining glass panes of different thicknesses and foil layers, which are shot with different projectiles during testing, depending on the class.

Testing procedure in accordance with EN1063: resistance against gunfire

Bullet-resistant glass is shot at using different weapons, depending on classification. If the test pane is not penetrated by the shots, the required class is achieved.

Resistance class	Standard	Application examples
BR1-S to BR7-NS	EN1063	Banks, military facilities, political, judiciary and financial buildings



Bullet-resistant glazing

ER: Explosion-resistant glazing

Explosion-resistant glazing also withstand explosions, e.g. in the event of a terrorist attack. In the event of an explosion an enormous pressure wave is released, depending on the amount of explosives and distance from the explosion site, which can exceed the planned effect of wind loads several times over. Glazing in resistance classes ER1 to ER4 can be realised using specific, interactive constructions.

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

Testing procedure in accordance with EN13541: simulated explosion

For explosion-resistant glass the minimum duration of the pressure phase is established as well as the pressure load. The test simulates the effect of a TNT equivalent explosion.

You can find the technical data here:

UNI GLAS® | COLLEGE
Technical compendium

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Product overview



Point-fixed VSG with coloured foils

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Practice report

Our children are our future. It is therefore important that we set the benchmark high when designing their surroundings and at the same time naturally apply maximum safety standards.

A successful example of this is the all-day school Borchshöhe in Bremen, a project by the company FRERICHS GLAS GMBH from Verden.

In this property all the design features of glass were realised in an exemplary way taking into account all safety aspects that are important in childcare.

The building's façade was fitted with both clear VSG and VSG with colourful film as insulating glass in the corridors and dining hall to create and open bright atmosphere flooded with light. Interesting light effects were achieved by the colourful elements in the vertical glazing.

The canopy glazing consists of point-fixed VSG made of 2 x TVG with coloured foils. Special attention was paid to the design of the canopies. They are to symbolise trees and thus integrate perfectly into the surrounding nature. The coloured foils used in the warm colours red and yellow provide a child-friendly and cheerful atmosphere.

The photos on Pages 9, 16 and 17 were supplied by the architect BDA Johannes Schneider and photographer Joachim Fliegner.



Safety glass in the all-day school Borchshöhe

Ideal combinations

With UNIGLAS® | **SAFE safety glass** we offer you an exciting product range and various combination options, such as thermal insulation glass, noise protection glass and solar protection glass.

Your customised safety concept is coordinated to you and your property depending on the safety category and requirements. Your UNIGLAS® partner will be happy to advise you with the selection of the right glass.

You can find the technical data here:

UNIGLAS® | **COLLEGE**
Technical compendium

UNIGLAS® | **COLLEGE**
Product overview

Type of glass	Temperature shock resistance	Cutting ability	Fracture pattern	Risk of glass breakage	Risk of injury
Float glass	40 K	Yes	Radial cracks from fracture centre	Great	Great
ESG	200 K	No	Countless blunt-edged fragments	Low	Low
TVG	100 K	No	Radial cracks from fracture centre	Low	Great
VSG/Float	40 K	Yes	Radial cracks, splinters adhere to bonding	Great	Low
VSG/ESG	200 K	No	Fragments adhere to bonding	Low	Low
VSG/TVG	100 K	No	Radial cracks, fracture pieces adhere to bonding	Low	Low

Summary of differences in individual types of glass



Frequently asked questions

1. What are the differences between float glass, ESG, TVG and VSG?

There are different options for producing glass. The table above shows you the different types of glass that differ in their individual parameters due to temperature shock resistance, cutting ability, fracture pattern, risk of glass breakage and risk of injury.

2. What is special about ESG and ESG-H?

Safety is enhanced thanks to the thermal treatment of the ESG. ESG-H is a special ESG, which is heated up again in a controlled manner in a so-called „heat-soak test“ to intentionally cause spontaneous breakages due to inevitably present nickel sulphide inclusions.

ESG-H is a building product regulated in Germany, which can be used in individual cases without consent. In other European Union countries the heat-soak test is required in accordance with EN14179, which corresponds to the German safety level.

3. What are the various options for using different types of safety glass?

We have listed some example applications for ESG, TVG (in combination with VSG) and VSG for you on Pages 5, 7, 9 and 11.

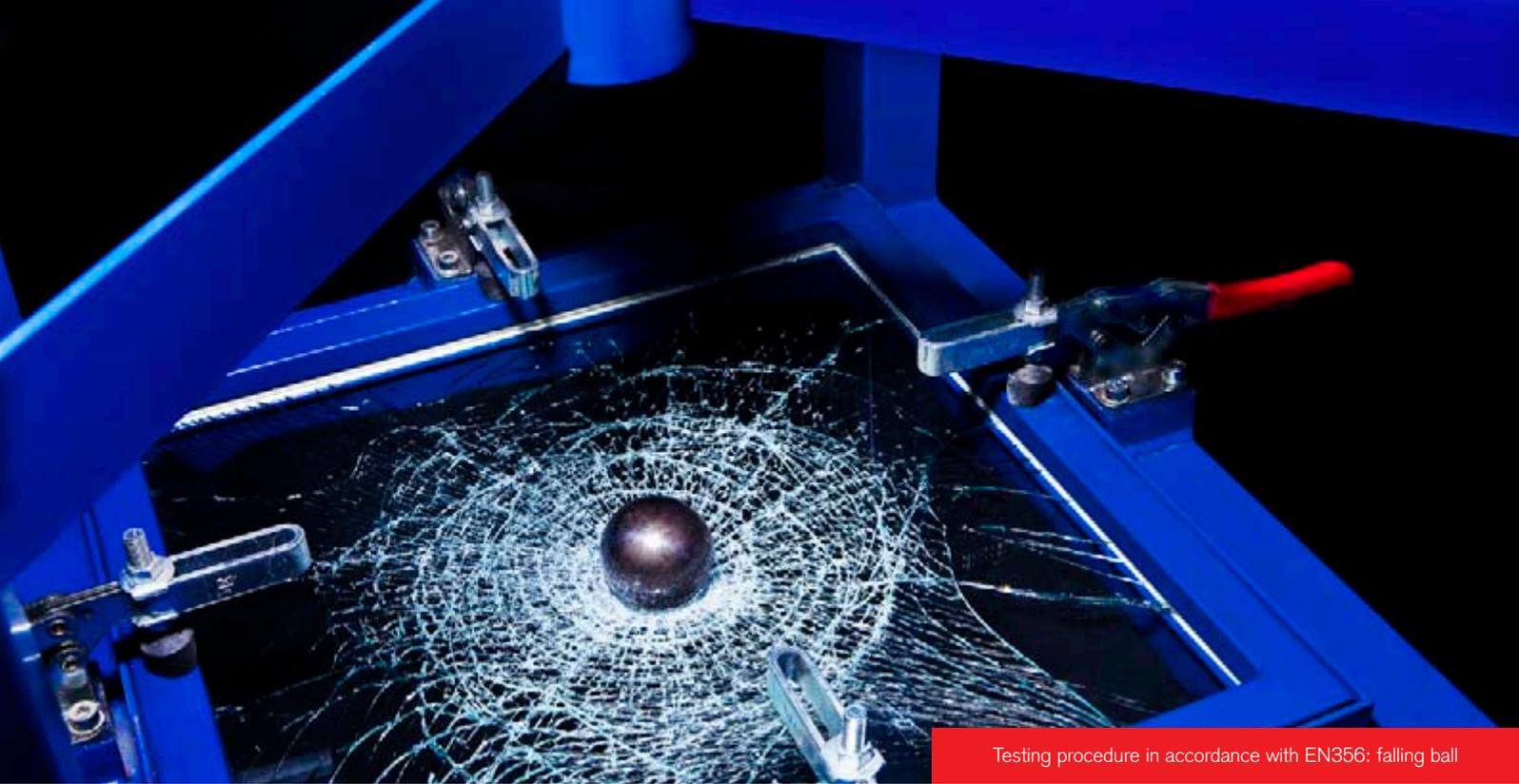
4. Which safety glass do I have to use in schools or kindergartens?

VSG or ESG bzw. ESG-H.

5. What is understood by bulletproof glass?

Bulletproof glass is a word for special laminated safety glass (VSG) that can withstand the effects of blows, shots and explosions.

VSG is used to protect property and people, for example at bank counters, in shop display windows and to armour special vehicles.



Testing procedure in accordance with EN356: falling ball

6. Is safety glass generally marked (ESG stamp)?

If yes, how?

It is compulsory to mark ESG and ESG-H using a stamp. VSG is not marked as such.

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

You can find a brief description on Pages 13 - 15.

8. What is understood by ball impact-resistant glass?

Ball impact-resistance is tested in accordance with DIN 18032-3 by shooting a handball at the pane 54 times and a hockey ball at it 12 times. It passes the test if the glass does not have any significant damage.

9. What does TRAV mean?

Technical rules for safety barrier glazing: TRAV

These include provisions for planning, building, installing and testing glass structures, for example for railings, balustrades or room-height glazing. Different designs were defined by the German Institute for Building Engineering (DIBt) in the TRAV.

The TRAV gives examples for glazing, where compliance with the usually prescribed component testing may be waived.

Constructions and glazing, which deviate from the TRAV specifications require in each individual case consent or general building inspection approval.



Our proximity: your advantage

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