GLAZING GUIDELINES

VERSION 01 – September 2025

Your Dreams, Our Challenge

This version of the *Glazing Guidelines* replaces and cancels all previous versions.
Please check www.agc-yourglass.com regularly for any updates.

CONTENT

1. GENERAL

1.1. Applicability

These glazing guidelines apply to AGC Glass Europe and AGC INTERPANE glass products designed for installation in window frames, facade systems and other reliable glass-retaining systems made of verified materials and profiles normally used in building construction. They supplement or extend the requirements for durability set out in the applicable glass product standards.

Adherence to these AGC Glass Europe and AGC INTERPANE glazing guidelines is compulsory for any claims related to product defects or warranty issues. This is particularly critical for glass panes and edge seals, which must not be altered or damaged during further processing. Specialised products such as alarm glass, fire-resistant glass and decorative glass are subject to additional glazing guidelines. Moreover, when dealing with specific products, adherence to the respective processing guidelines is required. Should a processor transform our glass into other glass-based products, it is their responsibility to establish and enforce their own glazing guidelines.

In the event that the glazing system is subject to supplementary regulations under national codes or due to unique climate challenges not addressed by these guidelines, prior agreement must be sought from and given by AGC Glass Europe and AGC INTERPANE.

1.2. Purpose

Adherence to the AGC Glass Europe and AGC INTERPANE glazing guidelines is essential for ensuring that glazing systems are technically sound and structurally correct. This is a fundamental requirement for maintaining the multifaceted functionality of glass products and for preventing damage to them.

1.3. Quality and durability guarantee

The creation of large bay windows is now achievable without constraints related to climate or the performance demands of the facade. AGC Glass Europe and AGC INTERPANE provide an extensive selection of products tailored to meet various requirements, including thermal insulation, solar control, acoustic insulation and safety measures such as protection against injury, burglary, or fire. These functional properties can be integrated with one another and aligned with aesthetic preferences.

However, it is crucial to note that the performance levels promised by a glazing product can only be achieved when it is properly installed in an environment that supports the unique functions expected of the glass.

These guidelines draw on many years of experience and specify the optimal conditions for using AGC Glass Europe and AGC INTERPANE glazing so as to ensure that it performs well over time. Our guarantee depends on compliance with the guidelines set out in this document.

2. Glazing guidelines

2.1. Scope and target group

This document is intended to serve as a foundational resource, providing essential information and directions for designers, technical planners and architects, as well as for manufacturers and processors of glass products and for those involved in the design of windows, doors and facade systems. It aims to facilitate material-appropriate design, planning and construction with glass. For specific details that fall outside the scope of these guidelines, we recommend consulting the processing and glazing guidelines of the relevant manufacturers or products, as well as the applicable standards and regulations.

This document outlines the requirements for and provides information on the use of single glass and insulating glass units in both the building envelope and the building interior. It is important to note that these guidelines do not encompass alternative glazing systems, such as point-fixed panes.

2.2. Basic requirements

2.2.1 General remarks

The architectural design and detailing of windows, doors and facade systems must guarantee the durability and functionality of glazing under expected design loads throughout their service lifetime.

Design loads and their effects on the glazing system are calculated in the planning phase. These fundamental conditions must be defined by the architect, engineer or designer. It is imperative to conduct a preemptive inspection for defects and to communicate any issues.

Consequently, the design and dimensioning of profiles and glass fittings must ensure sufficient load-bearing capacity. For particular types of glass, such as acoustic control or burglar-resistant glass, it is crucial to adhere to the relevant stipulations outlined in the relevant documents, such as standards, guidelines, or also test reports. The chosen glass products and their installation must satisfy the performance criteria for the entire system, whether it be a window, door or facade. Measures must be in place to guarantee enduring pressure equalisation and moisture drainage. Additionally, any direct contact between metal and glass should be avoided.

Before proceeding with glazing, regardless of the frame material, it is essential to confirm that the structure is dry, free from dust and grease, has been verified for sufficient strength and secure anchorage and has been inspected for suitably sized openings for pressure equalisation. It is also vital to ensure that the selected type of glass is appropriate for its intended application and that the correct fittings are available for the installation of the glass, whether it is a fixed glazing or bonded system. These aspects may be subject to more rigorous requirements where necessary. Achieving these standards requires a collaborative effort among engineers/designers, manufacturers and installers from the initial design and planning stages.

It is essential to comply with European and national building codes, which cover a range of regulations, including but not limited to:

- proper installation;
- the dimensioning of windows and frame systems;
- load assessment;
- other guidelines and standards specifying requirements relating to personal safety, which must also be observed.

If special circumstances arise, it is important to consult AGC Glass Europe and AGC INTERPANE to make sure that all requirements are met and to get expert advice.

2.2.2. Calculation of suitable and/or necessary glass thicknesses

The thickness of the glass units must be determined prior to the execution phase. When dimensioning glass thicknesses, all anticipated design loads relevant to the installation location must be taken into consideration. These include wind loads, live loads and snow loads, as well as negative or positive pressures within the cavity and the dead load of the glass itself.

The process of determining glass thicknesses, which is an integral part of the structural design, is a specialised design task. As such, it should be subject to a separate agreement and service. This ensures that the glass units are not only fit for purpose but also comply with the necessary safety and performance standards.

Particular attention must be paid to the following considerations:

- Compliance with locally applicable standards, rules and regulations is mandatory. This includes adhering to the safety concept, understanding the impacts on the building and its components, selecting the appropriate type of glass, ensuring minimum glass thickness requirements are met and executing a proper glass design.
- All potential impacts on the glazing system must be assessed as accurately as possible in line with national rules and regulations. This includes calculating wind loads that are specific to the glazing's position on the facade, accounting for the superimposition of isochoric pressures and taking into account additional loads, such as snow loads and dead loads that may arise from snow accumulation on horizontal glazing systems.
- Glazing systems that function as safety barriers must undergo structural engineering verification to confirm their integrity and must be accompanied by proof of impact resistance.
- In cases where the chosen glass configurations or types, or the design specifications, do not align with the technical rules or applicable standards, further testing or verifications may be required to ensure compliance and safety.
- The project must take into account the altitude differential between the production site and the installation location, including the entire transport route.

2.2.3. Glazing systems - basic principles

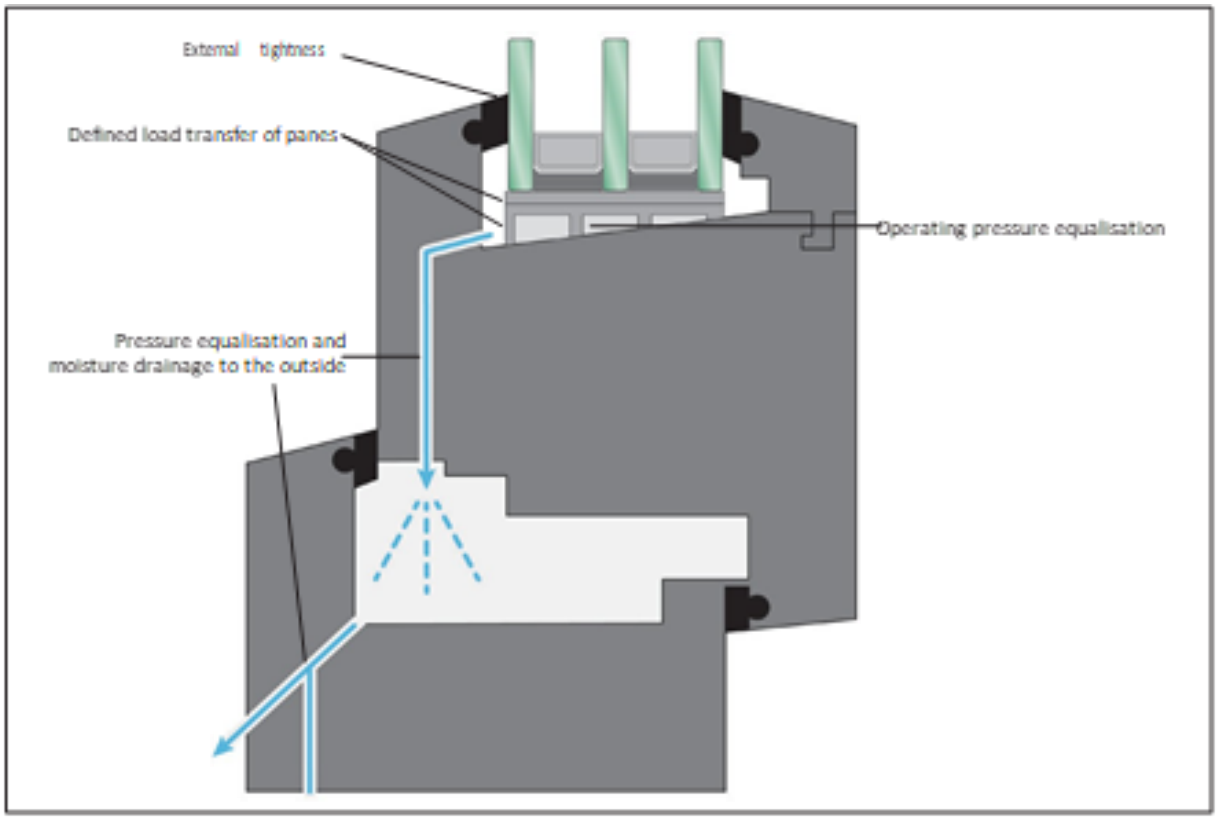
The fundamental requirements for glazing systems are depicted in the schematic illustration provided. These requirements may need to be modified based on the specific use of the building, such as spaces with elevated levels of air humidity, or the climate zone, particularly those with higher air humidity. Adjustments could include, for example, fitting the glazing beads externally rather than internally, or incorporating additional openings for pressure equalisation.

For all glazing systems that do not use sealant in the rebate area, it is crucial to have sufficient openings, both in terms of size and placement, to facilitate the drainage of any moisture that may have penetrated or collected in the rebate area. This ensures that the area dries out promptly. The presence of standing water or persistent moisture on the glass unit should be avoided to prevent damage. Any bespoke designs must be discussed and approved by AGC Glass Europe and AGC INTERPANE to ensure their durability and compatibility.

Proper use, cleaning and maintenance of the glazing are essential to meet all the specifications mentioned above. Additionally, if provided, the processing or fabrication instructions from the system manufacturers should be followed.

It is advisable to avoid completely filling the rebate area with sealant, as applying sealant without entrapping air bubbles is nearly impossible. This can lead to increased moisture exposure and potentially damaging the insulating glass unit or frame over time.

Consequently, the use of systems with a sealant-free rebate area is recommended. In special cases, such as windows and facade systems that require burglar resistance or bonded window systems, agreements must be made with the window/facade producer and the insulating glass manufacturer regarding durability and material compatibility. For these scenarios, the use of proven and tested systems is advised.



General design and structural requirements

2.2.4. Material compatibility

Material compatibility can be defined as the absence of adverse interactions between materials. In the context of glazing systems, compatibility is of particular importance for components that interact with, or come into direct or indirect contact with, the edge seal of the insulating glass unit. These components include, but are not limited to:

- Glazing sealants;
- Cleaning agents;
- Glazing blocks;
- Interlayers in laminated glass units;
- Edge seal systems in insulating glass units;
- Accessories that come into contact with interlayers and edge seal systems;
- Subsidiary building materials, such as chalk powder, films and foils;
- Protective films applied to position 1 of the glass unit to protect it.

While interactions between the wide range of adhesives, sealants and accessories are inevitable, they are deemed acceptable provided they do not impair the functional requirements, durability or aesthetic integrity of the building component.

Typically, the responsibility for verifying material compatibility rests with the manufacturer of the complete window and facade system, as they possess comprehensive knowledge of the materials ultimately used. The methodologies for conducting such compatibility tests or verifications are outlined in ift Guidelines DI 01/1, DI 02/1 and NF DTU 39 P1-2 Annexe A.

2.3. Requirements for the glazing rebate

2.3.1 Detailing and execution

- The materials selected for the frame or glass retention system must be appropriate for the glazing. This ensures that the system can adequately support the glass and maintain its integrity over time.
- The dimensions of the glazing rebate and the glazing beads are critical; they must provide sufficient coverage of the glass edges to safely bear loads and to allow for the permissible tolerances in glass dimensions. It is important to acknowledge that special types of glass, such as toughened glass, laminated glass, laminated safety glass and patterned glass, may exhibit different tolerances and/or dimensions as a result of their manufacturing processes.
- The width of the glazing rebate should be designed to not only accommodate the glass pane but also to ensure there is enough space for the necessary thickness of sealing material on both sides of the glass. Additionally, it must allow for the correct installation of the glazing beads so as to secure the glass in place effectively.

2.3.2. Requirements for the glazing rebate

The requirements for the glazing rebate, bite and sealant selection are specified in various standards, including DIN 18545, EN 15651-2, EN 12488:2016 and NF DTU 39 P1-1.

A schematic illustration of a glazing system and the associated terms is given in the illustration on the next page. This essentially corresponds to the description given in DIN 18545. The requirements set out in DIN 18545 usually apply to glazing systems with gunned sealants (wet glazing) but can in principle also be applied to other glazing systems using different sealing methods in accordance with DIN 18545.

As a rule, the glass bite should be at least 2/3 of the glazing rebate upstand and should not exceed 20 mm in the construction in order to minimise the thermal load on the pane. If the glass bite exceeds 20 mm care must be taken to ensure that the permissible temperature differences within the pane for the glass type used are not exceeded and that there is no risk of glass breakage caused by mechanical loads (see table below).

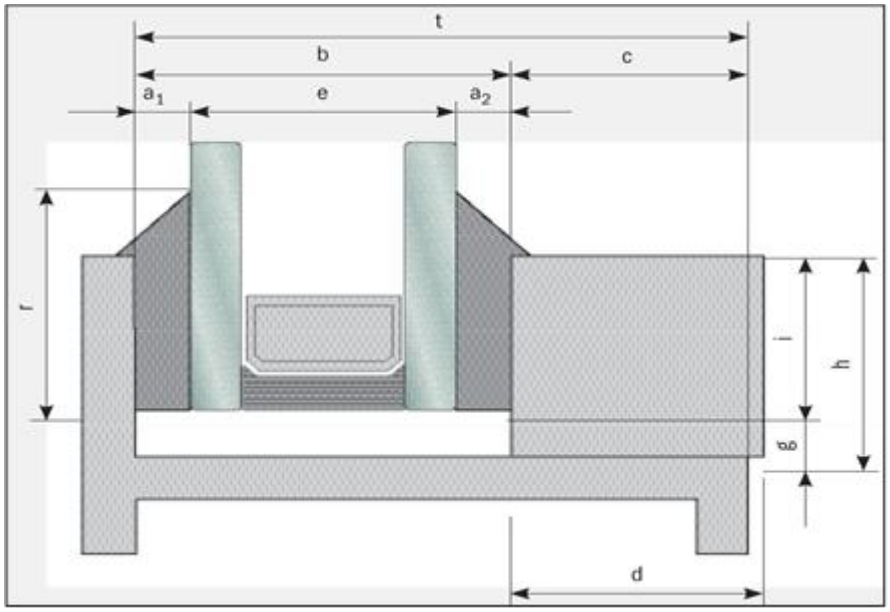


Diagram of glazing rebate based on DIN 18545:2015-07 and DIN 52460:2015-12

a_1 = external sealant thickness/external gasket	e = thickness of glazing unit
a_2 = internal sealant thickness/internal gasket	g = glazing rebate platform
b = glazing rebate width (usually = (2/3) • h ≤ 20 mm)	h = glazing rebate upstand
c = contact width of glazing bead	i = glass bite
d = width of glazing bead	t = total rebate width
r = cover of insulating glass edge seal	

2.4. Requirements for glazing systems

In the glazing industry, we distinguish between wet glazing and dry glazing techniques. Dry glazing involves the use of sealing lips, compression strips or gaskets to create a seal. In contrast, wet glazing typically employs sealants applied with a gun. However, the industry also offers hybrid systems which combine these methods by using gun-applied sealants for external weatherproofing and gaskets for the internal seal.

Glazing systems must be completely watertight, preventing any ingress of water from the exterior to the interior. Conversely, for air permeability, the system should be airtight with the seal preventing air from moving from the interior to the exterior. Vapour tightness is also critical and must be ensured from the interior into the glazing rebate.

Additionally, effective moisture drainage and pressure equalisation mechanisms are essential, operating from the interior to the exterior, in order to ensure the longevity and functionality of the glazing system.

2.4.1. Wet glazing systems using sealants

The necessary face clearance dimension in wet glazing applications is typically achieved through the use of glazing tapes.

2.4.2. Glazing with double-sided glazing tape

This method is prevalent for installing glazing units in timber frames but it is equally applicable to frames constructed from alternative materials. The glass pane is cushioned on both the interior and exterior by a resilient (elastic), double-sided glazing tape, which serves to alleviate stresses induced by the installation process and subsequent operational use. The thickness of the glazing tape is crucial as it dictates the face clearance. The choice of tape thickness should be informed by various factors, including the dimensions of the glass, the composition of the frame and the colour of the profile, in conjunction with the glazing manufacturer's guidelines.

The glazing bead ensures that the glass edge is not clamped too tightly. Additionally, the geometry of the sealing joint can be defined by shaping both the glazing rebate stop and the glazing bead. For further information, please refer to IVD Guidance Sheet No. 10 (Bulletin No.10).

2.4.3. Glazing with single-sided glazing tape

The external glazing tape is essential for ensuring that the installed insulating glass unit is not rigidly affixed within the rebate, thereby preventing the occurrence of localised excessive stress or strain. This flexibility is crucial for accommodating thermal expansion and contraction, as well as other dynamic forces that the glazing system may encounter throughout its service life.

2.4.4. Glazing without glazing tape

Glazing systems that do not include glazing tapes require careful selection and detailed design. When selecting this type of glazing, it is critical to adhere to the tolerances outlined in ift Guideline VE 13/2 *Glazing of timber windows without glazing tape*. Deviating from these specified tolerances could introduce the risk of breakage of the insulating glass unit due to excessive stress.

2.4.5. Dry glazing – sealing lips, sealing strips and gaskets

The gaskets used in the glazing system must be fully compatible with the system components. The sealing process should align with the protocols set out in Section 4.0. Special attention must be paid to corners and joints to ensure they are sealed effectively, thus maintaining a durable and functional seal.

Materials such as silicone, thermoplastic elastomer (TPE) and polyvinyl chloride (PVC) are commonly used for fabricating these gaskets. In environments exposed to the elements or in areas subject to high humidity, such as indoor pools and wet rooms, it is imperative that the weather seals are continuous and provide a complete seal around the perimeter on both sides. This is also crucial in situations where the glazing system is subject to dynamic stresses, including pressure load cycles or torsional forces, to ensure the integrity and continuity of the weather seal, i.e. to ensure that it does not fail.

All gasket specifications must conform to the standards prescribed in EN 12365. Additionally, the gaskets must be suited to the method of frame fixing and the thickness of the glass unit, inclusive of any tolerances. They must also possess sufficient elastic force to accommodate any appropriate movements and stresses without compromising the seal.

2.4.6. Contact pressure

For glazing beads affixed with screws, it is the responsibility of the manufacturer to detail the specific torque settings. These settings are determined by factors such as the spacing between screws, their distance to the corners of the glazing bead and the type of screws employed. It is crucial to ensure that the glazing bead applies a uniform pressure along the edge of the glass. If the contact pressure is excessive, it can lead to permanent damage to the edge seal of the insulating glass units, compromising their integrity and performance.

2.4.7. Flatness

When selecting frame materials for glazing systems, it is essential to choose those whose glass supporting areas will maintain a permanent flat profile under the design loads.

2.4.8. Deflection limit

The frames must possess sufficient rigidity to ensure that any deflection under maximum load does not exceed 1/200th of the span of the edge length.

2.4.9. Tightness and sealing

Sealants and gaskets must exhibit resistance to various factors, including weather conditions, environmental impacts and cleaning agents. The sealing joints in wet glazing systems are considered maintenance joints and should undergo regular inspections. At a minimum, an annual review of the joint sealants is recommended in order to assess their adhesion to both the frame and glass, as well as to check for any signs of embrittlement. Any necessary renewals should be carried out promptly.

In general, gun-applied sealants are suitable for sealing joints across all types of frame materials used in window construction. However, it is necessary to adhere to the specific instructions provided by the sealant manufacturer. The effectiveness of the seal/sealant is greatly influenced by the correct pre-treatment or preparation of the materials or substrates involved. All surfaces in the sealing system must be thoroughly inspected and tested. Should there be any alterations to the adherends, re-testing and approval from the producer or manufacturer are required.

An integrated approach is essential, particularly with regard to the long-term functionality and durability of window constructions.

2.5. Taking glass dimensions

When measuring glass dimensions, it is important to consider the following factors:

- Perimeter glazing clearances: These are the spaces left around the edge of the glass to allow for expansion and contraction, as well as to accommodate any movement within the frame.
- Glazing rebates: The recesses or indents in the frame that receive the glass must be respected to ensure a proper fit and adequate support for the glass.
- Grooves in the rebate platform: Also known as clipping grooves, these are designed to facilitate the installation of the glass and the securing of the glazing beads or other retention systems.
- Tolerance of frame and glazing: The permissible variations in the dimensions of both the frame and the glass must be accounted for to ensure a correct fit. This includes allowances for manufacturing and installation tolerances.

3. Determining the thickness of the glazing

The glazing thickness calculation depends on the specific loads to which the glass will be subjected.

- For **facade glazing**, which is usually installed at an angle of up to 15° (the distinction between vertical and horizontal glazing may differ from 15° in other regulations, e.g. in Germany, where it is 10°)from vertical, **wind load** is the primary factor.
- **Roof glazing** must account for additional factors including **wind load**, **snow load** and the dead **load** of the glass itself.
- For **insulating glass units** (IGUs), the internal pressure differences must also be factored into the calculations.

To accurately determine the loads, the principal should consult the relevant standards, regulations and established best practices within the construction industry. This includes defining specific considerations such as the height and shape of the building, as well as the geographical location of the construction site, which can influence environmental loading conditions.

4. Transport, storage and installation

The integrity and durability of both single glazing and insulating glass units depend to a large extent on how they are handled, transported and stored. The glass surfaces, glass edges and edge seal of insulating glass units must remain undamaged throughout transport, storage and installation. To ensure this, the following special precautions must be observed:

- Single glass and insulating glass units should be transported exclusively on racks or in crates that are equipped with devices to secure the load.
- Glass panes must be transported with support across the entire thickness of the pane, which is particularly important for large and heavy units.
- During glazing operations, it is acceptable to temporarily lift an insulating glass unit by attaching the lifting device to only one pane of the unit.
- The guidelines provided by the insulating glass and sealant manufacturers must be closely followed.
- Units should be stored and placed in an approximately vertical or perpendicular orientation on suitable racks or fixtures.
- All regulations and guidelines issued by government safety organisations for the storage and transportation of glass must be adhered to.

- Supports used to prevent tilting, as well as base and top securing devices, must not damage the glass surface, edges or edge seal. These supports should be perpendicular to the pane surface and should provide full contact across the entire width of the glass unit.
- When transporting glass units of varying sizes, care should be taken to prevent the glass edges from causing friction marks on adjacent glass surfaces. When stacking multiple glass panes, non-absorbent spacers such as paper inlays, intermediate pads or stacking shims are necessary.
- Insulating glass units must be shielded from harmful chemical or physical influences on-site.
- When transporting on racks, glass panes must be properly secured without exerting undue pressure on them.
- If transported in crates, especially those not designed to withstand static or dynamic loads, careful consideration must be given to handling the crates and the use of transport ropes. The units should only be stored or placed vertically on appropriate racks or fixtures. Crates are intended for transport and are not suitable for long-term storage.
- Insulating glass units stored outdoors require protection from prolonged exposure to moisture and solar radiation with a suitable full-size cover.
- Prior to installation, each glass unit must be inspected for damage. For example, thermally toughened panes with edge damage penetrating more than 15% into the glass volume should not be installed.
- Furthermore, the dead load and any external impacts, such as wind loads, live loads or snow loads must be safely transferred to the primary load-bearing structure to ensure the stability and safety of the glazing system.

4.1. Blocking

Glazing blocks serve several major functions within a glazing system:

- They distribute and accommodate the weight of the glass pane within the frame, ensuring that the frame adequately supports the pane.
- They maintain the position of the frame to prevent any changes that could affect the structure or function of the glazing system.
- They ensure the operability of any opening elements within the system, such as windows or doors.
- They create a permanent separation between the edges of the glass pane and the frame, maintaining a minimum clearance of 5 mm from the glazing rebate platform.
- They support the glass pane in accordance with structural engineering principles, contributing to the overall stability of the glazing system.

Frames must be dimensioned to adequately support the weight of the glass panes. The width of the glazing block must exceed the thickness of the glass by at least 2 mm. The thickness of setting blocks, including any compensation blocks, must be at least equal to the minimum edge clearance between the glass and glazing rebate platform, and therefore sufficient for ventilation and/or drainage. For guidance on the requirements for and installation of glazing blocks, please refer to EN 12488.

Before installing glass in the area where glazing blocks are used, any excess sealant that extends beyond the edge of the insulating glass must be removed. The blocks must not apply excessive pressure on the glass edge, which could lead to damage.

Additionally, glazing blocks must not cause excessive deflection of the frame profiles. The maximum deflection limits for the frame profiles must be observed. In stick facade systems, particular care must be taken to ensure that the deflections of the transom profiles of the insulating glass units positioned above do not accumulate, causing the lower panes to bear the loads from the panes above.

For laminated safety glass (LSG) and/or heavy glass units (exceeding 500 kg), it is advisable to mark the support edges and detail them with a smooth ground edge as per DIN 1249-11. This is necessary even for lighter glass weights, especially for LSG units. Prior consultation with AGC Glass Europe and AGC INTERPANE is recommended before placing an order.

4.2. Protection from UV radiation

The edge seal of insulating glass typically lacks resistance to ultraviolet (UV) radiation. Consequently, it is imperative that the edge seal is either completely obscured by the frame or safeguarded against UV exposure through appropriate measures, such as the application of cover strips, enamelling or equivalent protective methods. In the absence of such protective measures, the edge seal of the insulating glass must be constructed from a UV-resistant material, such as silicone, to prevent degradation.

This principle is not only applicable to installed units but also extends to the storage of insulating glass units (IGUs) on transport racks. When IGUs are stored, they must be protected from UV radiation in order to preserve the integrity of the edge seal during transportation and prior to installation.

4.3. Processing tools and devices

It is essential to employ only appropriate tools and equipment during the handling and installation of glass in order to prevent damage. The edges of the glass, in particular, must not come into contact with hard or rigid objects, such as caulking chisels or screwdrivers, which can cause chips or cracks.

When using block levers, exercise caution to avoid causing spalling or flaking at the glass edges. Gentle and precise manipulation is necessary in order to preserve the integrity of the glass during installation and adjustments.

4.4. Transport and installation at high altitudes

When installing or transporting insulating glass units (IGUs) to locations that are significantly higher or lower in altitude than the production site, special design considerations and potentially pressure equalisation measures are required.

Additional factors that must be taken into account include the specific glass products being used, as well as the format, dimensions and cavity temperature of the IGU. It is crucial that all enquiries or orders for IGUs include detailed information regarding the intended installation site, particularly the altitude, to ensure that the units are designed and manufactured to perform optimally in their final environment.

5. Additional requirements depending on the application

5.1. Thermal loads

Thermal stress, which can lead to the sudden breakage of glass panes, is often caused by partial or localised temperature loads due to differences in thermal expansion across the glass surface. To mitigate this risk, it is crucially important to avoid significant temperature differentials over the glass surface and within the entire glazing system.

Thermal loads can arise from various situations, such as those described below:

- The subsequent application of absorbent films, (finger) paints, posters and the installation of blinds or furniture on the room side without sufficient distance to the glass, etc., which leads to heat build-up, can lead to thermally induced glass breakage when exposed to solar radiation.
- The installation of poured asphalt flooring indoors, on balconies, or terraces can cause intense, uneven and unilateral (non-uniform) heating of the glass. It is important to shield the glass from these effects using appropriate protective measures.
- When positioning radiators, a minimum distance of 30 cm from the glass pane is recommended to prevent excessive thermal stress. If the inner pane of an insulating glass unit is made of thermally toughened glass, this minimum distance can be reduced to 15 cm. The radiator should span the same width as the insulating glass unit to promote uniform heating of the glass pane. Installing heat shields between the radiator and the glass pane can help reduce heat loss and the thermal load on the glass. The heat shield should be placed at least 10 cm away from the glass pane to ensure adequate airflow and prevent overheating.

5.2. Glass in sliding doors or sliding windows

For glazing systems that incorporate any form of insulating glass units, and particularly those with body-tinted glass, the use of thermally toughened glass (TSG) or heat-strengthened glass (HSG) is advisable. These types of glass are less sensitive to thermal stress because they can withstand significant temperature increases caused by solar radiation.

However, if there is adequate ventilation between sliding elements, the need for TSG or HSG may be mitigated. Proper ventilation can prevent the build-up of heat and reduce thermal stress. This principle is also applicable to sliding units that are partially open. Ventilation can be facilitated by measures such as a door stop, which allows air to circulate.

The same consideration holds true for installation locations where the sliding doors are not subject to direct solar radiation. In such scenarios, the risk of thermal stress may be inherently lower.
For specific cases or when in doubt, we recommend conducting a thermal stress analysis in consultation with AGC Glass Europe and AGC INTERPANE.

5.3. Sites with high air humidity (high hygrometry)

Buildings or rooms that experience elevated levels of air humidity, such as indoor pools, bathrooms and various types of production floors like those found in breweries, butcher shops, bakeries, flower shops, dairies and dry cleaners, require special attention. This also extends to residential spaces like bedrooms and living rooms that are not well-ventilated, where condensation may form on interior surfaces.

In these environments, more rigorous standards are necessary for the internal tightness of the structure to prevent moisture ingress and for the selection of materials that can withstand high humidity without deteriorating. Ensuring effective pressure equalisation via the glazing rebate to the outside and permanent drainage is essential in all cases.

Implementing additional openings in the top corner of the glazing rebate has been shown to be effective in practice. These openings facilitate the escape of trapped moisture, thereby enhancing the overall performance of the glazing system in humid conditions.

5.4. Horizontal glazing

Unlike vertical glazing, horizontal glazing is exposed to higher thermal and mechanical loads, such as wind, snow and ice loads, as well as dead loads. The glazing system must therefore be able to permanently withstand all of these loads. In some cases, narrower cavities are required to minimise the insulating glass unit's exposure to higher climatic loads (isochore pressure).

Stepped insulating glass must be used if the outer pane of the insulating glass unit is designed as eaves. For thermal reasons, the outer pane should usually be TSG or HSG.

It is not acceptable for a complete IGU to extend beyond the boundary of the glazing system. In such cases, a stepped insulating glass configuration is advised. This configuration is distinguished by having at least one edge, including the edge seal, that is susceptible to UV radiation exposure. For stepped IGU configurations, it is important to follow the guidelines set out in Section 4 *Transport, storage and installation*, and in particular subsection 4.2 *Protection from UV radiation*, to ensure the longevity and performance of the IGU.

5.5. Balustrades

Glass units are suitable for use as balustrades or barriers without the need for additional railings, provided they meet stringent safety requirements. It is mandatory that these glass units are constructed from laminated safety glass (LSG) or thermally toughened glass (TSG) or a combination thereof, and also with heat-strengthened glass (HSG), to ensure they can withstand the necessary loads and impacts.

When determining the appropriate glass thickness and selecting the necessary types of glass, as well as designing the glass retention system, it is essential to adhere to the regulations and guidelines set forth in the relevant glass design and construction standards.

5.6. Spandrel units

For spandrel units special care needs to be taken with the design. Accordingly, please refer to our technical note on spandrels and shadow boxes.

In this *Glazing Guide*, we give a brief summary of the key recommendations set out in our document titled *Technical Information: Shadow Boxes and Spandrels.*

This technical information helps architects and engineers design spandrels and shadow boxes in such a way as to avoid failures from high heat. It distinguishes between spandrels (opaque glass units) and shadow boxes (transparent glass with a backing), with the latter being better for matching vision glass. Key design principles for minimising thermal risk include:

- **Glass specifications:** All glass must be heat-treated. Triple IGUs and laminated glass on the inner pane are strongly discouraged as they trap excessive heat.
- **Coating:** A solar control coating with low-e properties is the optimal choice to reflect solar energy away from the assembly, keeping the components cooler.
- **Colour:** Using lighter colours for the painted surface of a spandrel or the backing material of a shadow box is critical, as darker colours absorb significantly more heat.
- **Construction details:** The air cavity behind the glass should be ventilated to help dissipate heat. For insulating glass units, using a silicone secondary seal is mandatory due to its high-temperature resistance.

Painted glass

There are a multitude of techniques available for colouring glass or convert it into a mirror. When it comes to the installation, intended use and/or fixing of these specialised types of glass and mirrors, it is essential to follow the manufacturer's instructions (for example AGC's FIX-IN System and the corresponding guidelines and documents) and the state of the art for the installation) closely. Additionally, it may also be necessary to consult addition guidelines, including national and technical guidelines. These guidelines also extend to the evaluation of visual quality, ensuring that the finished installation meets the aesthetic and performance standards expected of such products.

All-glass corners and glass joints

When designing and detailing glass joints and all-glass corners made of insulating glass, additional considerations are necessary to ensure structural integrity and aesthetic quality. These considerations include:

- Treatment of glass edges: Exposed glass edges, particularly in stepped insulating glass units, should typically be arrised or smooth ground to remove sharpness and prevent injury or damage. For edges that are visible in the final installation, polishing is recommended to enhance the visual appeal.
- Joint geometry: The geometry of the joints is crucial for the stability and performance of the glass assembly.
    - Joint width b ≥ 8 mm
    - Joint depth t = 0.5 • b, min. 6 mm
- Structural considerations for butt joints: Joints between glass panes, often referred to as 'butt joints', are not usually included in structural calculations due to their non-load-bearing nature. If butt joints are required to bear structural loads, they must be specifically designed for this purpose and may require project-specific approval.
- Adherence to guidelines: It is essential to follow the processing and application instructions provided by the sealant manufacturer, as well as to comply with relevant codes of practice.

6. Characteristics of glass products

6.1. Float glass

Float glass, as defined by EN 572-2, serves as the basic product for a wide range of glass products. It is characterised as flat, transparent, can be either clear or coloured, and is made of soda-lime silicate glass. Its surfaces are parallel and polished, achieved through a process of continuous casting and floating on a molten metal bath, resulting in glass of very high optical quality.

This basic glass is used to produce various refined glass products, including but not limited to coated glass, insulating glass units, toughened safety glass, laminated safety glass and decorative glass.

The general properties and characteristics of basic soda-lime silicate glass products are detailed in EN 572-1, which provides specifications for quality and standards that these products must meet.

6.2. Toughened safety glass (with or without heat soak test)

Toughened safety glass (TSG), is governed by standard EN 12150-2. TSG may also undergo a heat soak process in compliance with EN 14179. This process is crucial for mitigating the likelihood of spontaneous breakage. It is imperative to adhere to the pertinent national codes and guidelines governing the manufacture and application of heat-soaked glass.

6.3. Heat-strengthened glass

Heat-strengthened glass (HSG) is governed by standard EN 1863-2 and requires the manufacturer's verification to ensure suitability for use.

Table 2 outlines the key characteristics of float glass, HSG and TSG, with further details specified in the corresponding product standards.

Characteristics of glass products			
	Annealed glass	**Heat-strengthened glass**	**Thermally toughened glass**
Ultimate bending strength s_B	45 N/mm2	70 N/mm2	120 N/mm2
Resistance to temperature differentials and sudden temperature change DT	40 K	100 K	200 K
Cutting capability	Yes	No	No
Breakage pattern	Some radial cracks, large pieces	Some radial cracks, large pieces	Small crumbs

Table 2

6.4. Patterned glass

Patterned glass is governed by standard EN 572-5. Owing to its distinctive fracture structure and unique breakage pattern, which are the result of its manufacturing process, the selection of patterned glass or wired patterned glass (which incorporates wire mesh) must be undertaken with utmost care. It is essential to ensure adherence to building code regulations and additional technical guidelines for its application.

6.5. Texture orientation

When cutting standard sizes, the texture is typically aligned parallel to the upper edge of the glass. Deviations from this norm are permissible only if the texture orientation is clearly indicated on the drawing and the order explicitly states "**TEXTURE according to drawing**". Should the texture span multiple glass units, this specification must be distinctly highlighted in the order.

The aforementioned principle is equally applicable to motif glass, such as sandblasted and printed glass varieties.

6.6. Laminated glass

Laminated glass is a type of glass that consists of two or more layers of glass bonded together with an interlayer, typically made of polyvinyl butyral (PVB), SentryGlas (Ionomer), ethylene-vinyl acetate (EVA) or other materials. The interlayer holds the glass layers together even when broken, preventing shards from scattering and providing additional strength and durability. Laminated glass and laminated safety glass must conform to EN 12543 and EN 14449.

The nature of the interlayer film is such that it can also improve acoustic, safety and fire-resistance properties, or can be coloured for decorative purpose.

In addition, adherence to EN 356, EN 12600, EN 1063, EN 13541 and EN 13501 may be requested by the customer's specifications or national building regulations and codes.

Laminated glass and laminated safety glass with exposed edges are permissible, provided that the edges are finished to a high standard, i.e. either:

- smooth-ground;
- polished;
- or bevelled.

The required quality of edge finishing must be clearly stated in the order.

The required edge quality must be specified when ordering. It is not possible to avoid optical effects on the cut-off edge, film residues in the seam area or film protrusions when using laminated glass as the final cut size.

Optical variations may occur within an approximately 15 mm edge zone on external glazing if the interlayer film at the glass edge is consistently exposed to moisture. Such variations are deemed acceptable. However, alternative standards may be established in consultation with the glass manufacturer.

To avert these visual effects, the design must ensure that the interlayer film on the glass edge is not subject to continuous moisture, either through the design itself or by ensuring adequate ventilation. In canopies, for instance, this can be addressed by employing laminated safety glass with a protruding edge (step).

It is crucial for the durability and performance of the laminated glass that the edges are cleaned professionally at regular intervals. These cleaning intervals should be determined based on environmental conditions, such as urban centres or areas prone to high levels of pollution from other parts of the building.

Additionally, it is important to be aware that interactions with other materials may result in specific characteristics, such as the formation of bubbles (refer to Section 2.2. *Basic requirements,* specifically subsection 2.2.4 *Material compatibility* for further details).

6.7. Coated glass

Glass products may be enhanced with a diverse range of coatings to modify their visual aesthetics, technical performance or to grant specific surface properties. They should conform to and be classified

according to EN 1096. The most prevalent coatings are designed to alter the energy efficiency of the glazing, with a focus on coatings that improve thermal insulation or modify solar transmittance. These coatings typically confer a distinct colour on the glass.

From the outset of the design and planning phase, it is crucial to establish the aesthetic criteria, such as the reflection of coated glass and the colour imparted by the coating or the glass substrate itself. This must be done in conjunction with the manufacturer.

For major projects, it is advisable to use full-scale mock-ups of the building components to specify the optical properties and reach a common understanding with the manufacturer about the expected visual quality of the finished product. In the initial stages, products can also be specified based on 'work samples', which are typically measure 200 x 300 mm. These stipulations apply to both curved and flat glazing. When considering coating options for curved glass, factors such as geometry, glass configuration and size make it necessary to reach individual agreements with the manufacturer. Due to the extensive range of parameters, it is not feasible to provide general specifications for achievable Ug-values, g-values and so forth. The specified Ug-values and the luminous and solar characteristics typically pertain to flat glazing systems with identical glass configurations and are determined in accordance with EN 673 and EN 410.

6.8. Photocatalytic coatings

During the processing, glazing and handling of coated glass, it is important to adhere to the specific glazing guidelines provided by the coating manufacturer, particularly with regard to avoiding the use of silicone or silicone oil.

For cleaning purposes, standard cleaning methods and materials are recommended. Abrasive cleaning agents should be strictly avoided to prevent damage to the coating.

Any contamination that occurs during the construction phase should be promptly addressed by removing it with a generous amount of water.

6.9. Insulating glass units

When dealing with insulating glass units (IGUs) that feature exposed edge seals, it is necessary to implement protective measures to shield these seals from ultraviolet (UV) radiation. This can be achieved through by using cover strips, partial printing or other suitable methods, as detailed in Section 4, *Transport, storage and installation,* specifically subsection 4.2 *Protection from UV radiation*.

Typically, the coating on a coated IGU is removed around the edge seal area. In cases where edge seals are exposed, the transition between coated and uncoated regions may become visible on the facade, resulting in colour effects. Since these effects are a result of the manufacturing process and the inherent physical properties of the materials, they do not constitute a valid reason for claims or complaints.

6.10. Small insulating glass units

Insulating glass units (IGUs) categorised as ‘small’ are defined by their edge length, which is less than 50 cm for double glazing units and less than 70 cm for triple glazing units Due to the increased load on both the glass and the edge seal, these small-sized units are subject to greater stress compared to their larger counterparts. It is therefore crucial to consider the specific factors impacting the performance of small-sized IGUs.

During the manufacturing process, the cavity of an IGU is hermetically sealed, encapsulating the air pressure and temperature conditions present at the time of production. Subsequent fluctuations in temperature and air pressure, which may occur due to changes in weather or during transportation to areas at different altitudes, can alter the internal pressure of the cavity. This variation in pressure places additional stress on the glass panes and the edge seal.

Asymmetric glass configurations and IGUs with enlarged cavities, such as those used for sound control or triple-glazed units with two cavities exceeding 16 mm, are particularly at risk. These configurations are

subject to higher loads, which, under adverse conditions, could result in glass breakage or compromise the integrity of the edge seal over time.

For IGUs with unfavourable aspect ratios (a ratio of width to height of 3:1 or greater) or those with large cavity widths (a single cavity over 16 mm or two cavities over 12 mm), it is advisable to use toughened safety glass (TSG) or heat-strengthened glass (HSG) for the pane(s) at risk of breakage, typically the thinner pane.

When small glass panes are integrated into windows with traditional glazing bars, a more aesthetically attractive alternative is to use 'Vienna-style' glazing bars, which provide a similar visual effect.

6.11. Insulating glass units with thermal insulation or solar control function

The technical properties of coated insulating glass units are obtained by coating the glass surface inside the cavity. The technical data depend partly on the installation position of the coating. For this reason, a sticker indicates the correct installation position. If you need to integrate coated insulating glass with wired glass, you must consult the insulating glass producer. This ensures compatibility and addresses any potential technical considerations. When combining coated insulating glass units (IGUs) with tinted glass, the tinted pane should be made of toughened safety glass (TSG) or heat-strengthened glass (HSG) in order to meet the necessary performance criteria.

6.12. Sound control insulating glass

Sound control insulating glass is characterised as single glass or insulating glass units (IGUs) that significantly enhance sound insulation. The efficacy of sound insulation is largely dependent on the complete system, which includes both the window and facade elements. Key considerations for sound control insulating glass are listed below:

- Adherence to the standard glazing principles applicable to all IGUs is required for sound control insulating glass units.
- Typically, the mass per unit area for sound control glass units is greater. This means careful attention must be paid to the detailing and to the structural integrity of the frames, building hardware and glazing blocks.
- The sound insulation performance of sound control glass depends on the entire window unit being completely airtight, including the fixings and connecting joints. It is vital to ensure that the contact pressure of the casement or sash is consistent along the entire perimeter.
- Offset sealing levels
- Utilisation of sound control insulating glass that has been tested in accordance with EN ISO 10140-2 is recommended.
- Proper execution of wall connecting joints is crucial.
- The design of the window and the type of opening mechanism, such as side-hung or tilt-and-turn windows, can influence sound insulation.
- The size of the window also plays a role, with correction values provided in EN 14351-1, Annex B.

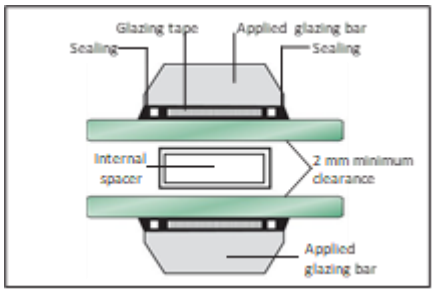
Sound control glass typically features an asymmetric configuration. The positioning of the thicker pane does not significantly impact the sound insulation function due to the generally diffuse nature of incident sound. However, in situations where noise comes from a specific direction, the thicker pane is usually installed on the exterior for visual consistency.

6.13. Components installed in a cavity

Care must be taken to ensure that the glazing bars are aligned parallel to the frame profiles. When assessing the load case for climatic design loads, the restriction on pane deflection caused by the glazing bars must be considered. Climatic loads can cause the panes to deflect, potentially narrowing the cavity width.

To maintain the functionality of the (moving) elements, it is important to adhere to the system-specific minimum cavity widths relative to the dimensions of the unit. This consideration should be in addition to the structural design loads stipulated in the relevant standards, which include wind loads, live loads and climatic loads.

Example of a 'Vienna-style' glazing bar:



6.14. Technical glass

Technical glass encompasses a range of glass products whose functional attributes or properties can be modified through the application of an electrical voltage. The deployment of such products necessitates a more intensive level of collaboration among all stakeholders compared to standard fenestration projects. This collaborative approach should include the involvement of various professionals, such as project planners and designers (architects, general contractors, etc.), technical experts (e.g., planners of technical building services (HVAC, electrical, plumbing), facade designers, structural engineers), glass manufacturers, window and facade/curtain wall producers, as well as building services technicians (specialists in electrical engineering, heating technology, etc.).

- For the design, planning and execution phases, adherence to product-specific glazing guidelines is essential. Understanding the basic operational modes and control system design of the technical glass.
- Ensuring clear communication regarding the requirements for access points and the planning of wiring/cable routes to integrate the technical glass effectively within the building's services infrastructure.
- Conducting thorough acceptance testing and performance checks to verify that the technical glass operates as intended and meets the project's specifications.

6.15. Curved glass

Incorporating curved glass into window and facade systems demands meticulous design and planning.

For initial guidance on the use of thermally curved glass in construction, BF Bulletin 009/2011 *Guideline on thermally curved glass for building applications*, published by the German Federal Flat Glass Association, serves as a valuable resource. This document offers foundational information and best practices to assist in the successful application of curved glass elements in architectural projects.

6.16. Mirrors

When handling and installing mirrors, observe the specific installation instructions and specifications provided for our Mirox product range. For comprehensive guidance, refer to Technical Guideline No. 11, *Mirrors – Handling and Installation* or our FIX-IN guidelines. They outline the best practices and procedures for ensuring mirrors are installed correctly and safely, while maintaining their aesthetic appeal and structural integrity.

6.17. Vacuum insulating glass

Vacuum insulating glass stands out for its superior thermal insulation capabilities, coupled with a slender profile and reduced weight. It is important to acknowledge that the specifications for the installation and processing of vacuum glass are distinct from those applicable to conventional insulating glass units. These unique requirements are typically provided by the manufacturers.

For detailed information on handling and installation procedures, please consult the documentation for our FINEO product range.

6.18. Fire- Resistant Glass

Certain glasses (e.g. Pyrobelite, Pyrobel, Pyropane or Polished Wired Glass) offer protection against fire. In all cases, fire resistance test reports do not simply cover glass alone but rather all construction components. The installation must comply with all points covered in the test report. Components may only be modified after an extension, site opinion or similar report from an official laboratory has been obtained. The desired classification can only be attained if the maximum dimensions and usage instructions given in the reports and other official documents are respected.

For the handling and installation of Fire Resistant Glass please consult our processing and installation guidelines specific for this product. For the construction of fire resistant glazing systems, national rules my apply. Please contact your local contact for further questions.

6.18. Alarm Glass

AGC and AGC INTERPANE are offering a security glass product with an alarm functionalities/ connections.
ipasafe Alarm is available both as an insulating glass unit and as laminated safety glass. To ensure correct handling, processing and installation, it is essential to consult the specific processing and installation guidelines provided. For further assistance or clarification of these guidelines, the AGC Glass Europe and AGC INTERPANE technical support teams are available to provide the necessary expertise.

7. Glass maintenance

The presence of dirt on glass surfaces is a common occurrence due to natural and building-related factors. Under normal circumstances, regular cleaning at appropriate intervals poses no issues for glass. However, depending on various factors such as time, location, climate and building conditions, substantial accumulations of water and and/or impurities in the form of chemical and physical deposits can occur on the glass surface. In such cases, professional cleaning and maintenance is crucial.

The glazing should be cleaned and maintained during the design phase, during the installation phase and during use. The minimum frequency recommended for glazing maintenance is every six months. However, special cleaning operations can be carried out if normal cleaning is not enough (due to climatic or other reasons).

General instructions for correctly maintain and cleaning AGC Glass Europe and AGC INTERPANE glazing are given below:

1. Always clean and maintain glass under safe conditions.
2. Carefully read the manual(s) to determine which chemical agents and detergents can be used for cleaning and maintenance. Follow the instructions. When in doubt, contact the manufacturer.

3. Products containing hydrofluoric acid and fluorine derivatives must not be used, since they can damage the coating, enamel and/or surface of the glass.
4. Highly acidic and alkaline products must not be used, since they can abrade the glass surface.
5. Ensure the chemical compatibility between the products used and other components (seals, paints used on the frame, aluminium, stone, etc.).
6. The surface of etched glass should always be wet cleaned across the entire surface. Never perform spot cleaning.
7. Do not wash the glass when it is fully exposed to the sun. Avoid washing it when it is too cold or hot.
8. Take advantage of the washing process to inspect seals, drainage and frames.
9. Make sure that the cloths, squeegees and other tools used for cleaning are always themselves clean and in good condition.
10. Ensure that the cloths and squeegees used for cleaning are soft in order to avoid scratching while cleaning.

More information and requirements can be found in the AGC Glass Europe and AGC INTERPANE cleaning guides. For special products, such as Clearsight and coated glasses, please refer to their respective cleaning guides.

8. Glass breakage

As a supercooled liquid, glass is an inherently brittle material that lacks the capacity for plastic deformation, unlike metals. When the elastic limit of glass is surpassed due to thermal or mechanical forces, breakage occurs instantaneously.

Advancements in production technology have significantly mitigated the presence of intrinsic stress within glass. Consequently, breakage typically arises from external influences rather than material flaws. It is important to note that the liability for breakage rests with the entity in possession of the glass at the time of the incident. It is imperative to implement suitable protective measures for your glass units.

Specific types of glass, such as wired glass and tinted glass used in conjunction with insulating glass units, are particularly susceptible to breakage under mechanical and thermal stress due to their unique physical characteristics. To mitigate this risk, adhere to the guidelines set out below.

Tinted or absorbing glass is more likely to absorb solar radiation than standard clear glass, which can lead to thermal stress. This stress is caused by the cooling effect due to shading or shadows on the glass.

- Heat build-up due to inadequate ventilation.
- Under certain conditions, these stresses may initiate cracking from the edges of the glass pane.
- To prevent this from happening, especially when the glazing is subject to direct solar exposure, the following precautions should be taken:
    - Ensure that the glazing is either fully exposed to sunlight or completely shaded.
    - Ensure there is sufficient, undisturbed ventilation.
- Match the absorptance levels of the frame material and glazing beads to that of the glass.
    - Allow for the natural expansion and movement of the glass, and avoid any rigid installations that could impede this.

In cases where it is not feasible to meet these criteria for specific applications, the risk of breakage in tinted glass units can be reduced by choosing thermally toughened or heat strengthened glass, which are more resistant to breakage.

8.1. Outer pane of double and triple insulating glass units

For an energy absorption ≥ 55% or ≥ 50% with a slope deviating from the vertical (90°), we recommend tempering the glass in order to prevent the risk of thermal breakage. There is no defined limit, only an undefined range of boundaries.

8.2. Central pane of triple insulating glass unit

If the centre pane has an energy absorption of ≥10%, then a design using tempered glass is recommended. In cases of increased thermal load during installation (e.g. roller blinds on the room side or blinds on the weather side, reduced external or internal heat dissipation, or highly asymmetrical glass structures (e.g. cavity and/or glass thicknesses), separate considerations and/or calculations are necessary. This is not a set limit, but rather a limit range.

In addition, for smaller panes with a cavity exceeding 16 mm, or for configurations with two cavities each greater than 12 mm and when combined with an unfavourable aspect ratio and asymmetric pane structure, the thinner pane should be made of toughened safety glass (TSG). However, in some cases it can be also made of heat-strengthened glass. The appropriate glass type must be verified in each individual case.

For particular instances that fall outside the standard parameters, AGC Glass Europe and AGC INTERPANE offer their expertise to provide technical guidance and evaluate the installation conditions to ensure the optimal selection of glass and configuration for the specific project in question.

References

Glazing rebates: BF Bulletin 021/2017 *Fitness for purpose of linear-mounted glass"*
Glazing using double-sided glazing tapes: IVD Guidance Sheet No. 10
Glazing with single-sided glazing tape: ift Guideline VE-13/2 *Glazing of timber windows without glazing tape*
Glazing without glazing tape: ift Guideline VE 13/2 *Glazing of timber windows without glazing tape*
Deflection limit of frames: BF Bulletin 021/2017 *Fitness for purpose of linear-mounted glass*
Blocking design: Glaziers' Technical Guideline No. 3 *Blocking of glazing units*
Thermal loads on glass: VFF Guidance Sheet V.02. *Thermal loads on glass in windows and facades* and BF Information sheet 006/2016 *BF information on subsequently applied films*
VFF Guidance Sheet V.07 *Glass joints and all-glass corners of windows and facades*
Use of laminated safety glass: BF Bulletin 013/2013 *Laminated safety glass (LSG) for use in building*
Colour: VFF Guidance Sheet V.03 *Colour consistency of transparent glass in building*, Issue 09/2004
Coated glass: Guideline *GEPVP – Code of Practice for in-situ Measurement and Evaluation of the Colour of Coated Glass used in Facades*, Issue 2005, and ISO/DIS 11479 *Glass in building - Coated glass – Part 2: Colour of facade*, 2011 version
Components installed in a cavity: BF Bulletin 016 *BF Bulletin for the assessment of glazing bars in the cavity*
Technical glass: ift Guideline EL 01/1 or VFF Guidance Sheet KB.03 *Smart Windows*
Curved glass: BF Bulletin 009/2011 *Guideline on thermally curved glass for building applications*
Installation of mirrors: Glaziers' Technical Guideline No. 11, *Mirrors – Handling and Installation*

Glossary

DGU:	double glazing unit
HSG:	heat-strengthened glass
HST:	heat soak test
IGU:	insulating glass unit
LG:	laminated glass
LSG:	laminated safety glass
PVC:	polyvinyl chloride
TGU:	triple glazing unit
TPE:	thermoplastic elastomer
TSG:	tempered/toughened safety glass
TSG-H:	tempered/toughened safety glass with heat soak test