8. **Transparent glass construction** ..................100

8.1 **Façades** ..............................................100

8.1.1 Façade functions .....................................101

Warm façade | Cold façade | Double skin façade

8.1.2 Façade constructions ................................104

Stick-System-Façade | Structural glazing façade | Point supported façade | Membrane façades

8.2 **Parapet glass (spandrels)** .......................110

8.2.1 Colour application on SunGuard®-coatings .110

8.2.2 Roll technique (roller coating) ..................111

8.2.3 Screen-Print technique ............................111

8.2.4 More production techniques ....................112

8.3 **Design glass** ........................................112

8.3.1 Production techniques .............................113

Screen-print directly onto the glass | Transfer colour print on glass | Design laminated safety glass | Coloured films in laminated glass | Decorative laminated glass

8.4 **Bent architectural glass** ..........................116

8.4.1 Requirements ........................................116

8.4.2 Glass types ...........................................117

8.4.3 Types of bending ....................................117

8.4.4 Determination of shape ............................118

8.4.5 Special features ......................................119

Local optical distortions | Outline precision | Torsion | Edge displacement | Tangential junctions

8.4.6 Static specifics .......................................121

8.5 **Special glass applications** ......................122

8.5.1 Walk-on glazing ....................................122

8.5.2 Glass elevators ......................................123

8.5.3 Switchable glass ....................................124

8.5.4 Electromagnetic damping glasses, Radar reflection damping glass ........................................124

8.5.5 Anti-reflection-glazing .............................126
For centuries, generations have used glass for filling “light holes” in solid outer walls. This has drastically changed in the last three decades. Today, glass itself forms and shapes space and creates room enclosures, thus creating transparent architecture that allows people to feel close to nature. Experts use the generic term “façade” to describe any external architectural construction that serves as protection against weather and dangers of any kind.

In addition to science, research and technology, art and architecture in particular have given rise to a host of possibilities when it comes to façades made from glass. Aesthetics, functionality and construction are the most important aspects of using glass as an architectural element, and all of these factors must be precisely defined at the start of planning. A glass’s finish on a façade always influences its reflective properties, which can range from being produced so that the glass is very reflective, reflects an overall colour or has weak reflection. The change of daylight due to weather, the sun’s changing position in the sky, the colour of the sky and the seasonal change of vegetation influence reflection, and interior light conditions also impact on glass’s appearance from the outside. Glass façades are generally composed of transparent and opaque areas that can be produced so that interior spaces are visible, or are “optically neutralised” and rendered “invisible” by using a specific type of glass. Reflections during the daytime also influence whether a person on the street can see into the interior.

The coloured adjustment between a translucent window and an opaque balustrade is only approximately possible as the colour impression of the translucent pane is always affected by the room behind the pane and its light conditions. In addition to the original function of a façade to provide protection, further decisive criteria relating to functionality are also in focus, especially for glass façades. Not only is there a possibility of obtaining energy from the façade, but one must also consider protection from heat during the summer (∆ Chapter 5.5). With regard to the constructive periphery of concrete, steel or aluminium, it should always be assured that, in addition to static loads caused by wind, suction and snow the glass weight can also be considered.

8.1 Facades
Generally, glass façades must be looked at from two perspectives, namely function and construction.

8.1.1 Façade functions
The façade function describes the mode of operation of the building shell. There are generally three different possibilities:

8.1.1.1 Warm façade
The warm façade describes a single-shell system in which thermal insulation with an interior vapour barrier is connected to a balustrade panel (sandwich panel). This single-shell system is located behind an opaque pane of glass that protects it from the weather.

This sandwich panel is installed in the façade construction as a whole below the transparent insulating glass and attached using clamping strips. The sill’s vapour diffusion resistance is achieved by applying a sealer and edge lipping. Thus, the opaque and transparent elements serve not only to enclose the room and protect it against weather, but also to protect the room from excessive heat, noise and, if need be, to keep fire from penetrating into the room. These opaque panels need a four-sided frame in the form of post-and-beam construction.
8.1.2 Cold façade

The physical construction and technical functions are performed in the sill area of a two-shell construction. The outer shell is used for weather protection as well as the visual design. It is designed with a ventilated glass window so that trapped heat and moisture can be removed. This pane is usually made of solar control glass and colour coordinated with the transparent window. Installation options range from all-sided, two-sided to supporting systems attached at various points, which allows for a broad spectrum of individual design. Underneath the transparent insulating glass windows, the thermal insulation of the wall area is realised with insulating opaque wall areas behind these parapet planes.

8.1.3 Double skin façade

This kind of façade goes by many names. It is also referred to as “second skin” or “attached façade”. This construction method principally consists of a flash-off façade similar to the cold façade described above, but the interspace between the two shells for the railing is broader and the transparent façade construction elements, i.e. insulation glass windows are integrated. The attached façade can be installed outside in front of an existing façade for visual and acoustic reasons. This design is called an interactive façade. The interspace is generally used to install additional solar protection devices such as blinds. The potential hot air and condensate are gradually transported to the outside.

In the past, inner skin shells were mostly made out of solar protection single-pane safety glass. The tendency today is to use laminated safety glass consisting of two pre-tempered glasses due to the increased structural stability that is present in case of failure.

The alternative is an inner skin of additional solar protection in the interspace. This construction, however, allows the warm air generated by solar radiation to escape in a targeted manner. The air is then transmitted via appropriate aggregates to the energy management of the building. This method is called active double skin façade and can reduce the operational costs of the building.

The function of a glass façade is strongly influenced by the glass that is used. In the past, “simpler” glass was preferred for production reasons. Today, GUARDIAN offers a broad range of suitable solar control glass with highly effective coatings.

This range is generally based on ExtraClear® float glass in order to give the outer shell in a ventilated façade as much neutrality as possible. This combination reduces the transmission of short wave solar energy by reflection but ensures the unhindered emission of the long wave heat radiation from the interspace to the environment. The stronger these reflections the less additional sun protection devices between the glass panes are needed and
unobstructed views are possible. This range is listed in ➔ Chapter 10.

With this development of high-tech coatings on glass and their tempering and laminating options and bendability, we offer our customers enormous competitive advantages and new impulses for façade construction. A large number of these types of glass can be finished with many design components to individualise them (➔ Chapter 8.3).

8.1.2 Façade constructions

Joining the glass to the building and the shell is as important as the function.

8.1.2.1 Stick-System-Façade (Mullion-Transom-System)

The majority of today’s glass façade still consists of post and beam. Here, the load-bearing posts extend from the foundation to the roof of the building in a fixed, aesthetically pleasing manner and at a statically determined and technically feasible distance from each other. These posts are anchored to the building design and transfer all applied loads into it. The “long fields” that thus react to the top are then intersected by a defined number of horizontal beams that bear the weight of the glass and convey it into the posts. After installing the glass and precisely placing the glazing blocks, pressure pads are fixed with screws, both on the posts and on the beams. The pressure pads fasten the glass elements and seal them. In order to derive the built up humidity caused by condensation water in the rebate area, an inner drainage is installed with an opening to the outside. The optical closing is generally made by cover strips which have to be fixed by clips and are available in nearly all anodised colours. These strips mainly influence the outer colour scheme.

A large number of systems are available on the market. They range from extremely small to very large, depending on the desired visual façade’s appearance and function. Generally, the extremely small profiles do not have an obvious window function and are installed in ventilated or air conditioned buildings in order not to interrupt the sophisticated grid design. Post and beam constructions are approved systems and can in most cases be used without any legal restrictions.

8.1.2.2 Structural glazing façade

Whereas clamping and cover strips project from the glass surface on the stick system façade described above, the benefit of this bonded façade is that it appears absolutely uniform. In this design, an aluminium adapter frame, into which the glass element is bonded, invisibly supports the glass load. This module is then mounted in front of a post and beam construction into which the loads are conveyed. The complexity of this façade technique, together with the long term experience of leading glue and sealant producers, make it feasible that structural glazing façades can only be executed as integral systems. The manufacturers of such systems have the concession of the building inspection authorities. Otherwise, an
acceptance test has to be made in an individual case before installation.

The glass weight, and the weight of the outer pane which appears not to be fixed has to be distributed generally via mechanical fastening angles into the construction. Such façades, even without the mechanical holding of the outer pane, can be installed in countries such as Germany up to a total building height of eight meters.

In this case, most glazing consists of a special stepped insulating glass with UV resistant edge bonding (Chapter 3.4) which can absorb loads which arise and convey them. As outer pane, a one pane safety glass with a thickness of at least 6 mm has to be used. Because of this construction, there are all sided free glass edges which stand in a determined distance to the next element and are sealed with special structural glazing silicone. It is very important to ensure the adhesion from silicone with the glass edges and the compatibility of all used materials (Chapter 9.10).

The final visual appearance is a plain glassy area, in which the "silicone-seams" nearly disappear. Especially for this façade system, GUARDIAN offers a variety of coated glass with the appropriate authorisations.

8.1.2.3 Point supported façade

This façade technique, of recent development, is based on point-fixed bearing connections as single holders. In this system, the active strengths of the glazing are transmitted to a mostly moveable mounted point supporting button that transports the active strengths via a metallic conjunction into the massive substructure.

In the conventional method, anchor bolts are mounted through the glazing, covered with an elastic core to avoid glass/metal contacts and fixed with counter panes. These covering and fixing panes project from the surface. An alternative is conical perforations that gain stability with special conical fittings by the clamping power on the edges of the boreholes. This form allows even façade surfaces without any outstanding elements.

Another development is holding points, which are placed on the level of PVB films and thus form a laminated safety glass, of which the outer pane is plain and the backside pane has outstanding connecting threads for mounting. The dimensions of the glazing for such construction account for the allowed deformation of the panes and the flexibility of the fittings. The stresses arising from loads are induced through the holding buttons without any restraint into the load bearing construction. The joints between the individual glassy façade elements are sealed with UV-resistant closing systems. In this fashion, attached façades out of monolithic glasses can be built as well as insulating glazing façades. In the latter, the
glass rebate is ventilated through appropriate systems and enables the condensation water to be diverted.

8.1.2.4 Membrane façade

A variation of the point-supported façade with drill holes in the glazing was developed in the past few years. Like a tennis racket, the whole façade is strung with a network of steel cables in the grid dimension of the glass panes.

The joints of the horizontal and vertical cables are fixed with fasteners which serve at the same time as fittings for the façade glass in the relevant four corners. Loads affecting the façade are transported through these fittings into the cables from where they are conducted into the bearing frame construction. Thanks to the sealing of the joints, similar a point supported design, the network of cables disappears optically behind the glass edges and offers a construction-free perspective through the façade.

The corner positioning of the glass elements without boreholes avoids increased stress concentrations and enables greater dimensioning freedom.

Prestressing of the ropes is realised to ensure that the whole area can be deformed under load and all functions are maintained before the load peaks are conveyed via the vertical ropes into the grounding and the roof frame. This construction requires approval in each individual case.
8.2 Parapet glass (spandrels)

Spandrels are often complete glass panels which in addition to concealing constructive and functional parts of the building such as paving tiles, pillars, heating ventilation and air-conditioning elements also hide electrical wire ducts and tubes. As a result, opaque parapet glasses are frequently installed in front of intermediate ceilings on each floor of a building in the façade thus interrupting the transparent glass elements. The desired optical effect can thus be adapted to or contrasted with the transparent glazing.

For larger projects, it is recommended that a 1:1 sample presentation be created to achieve the desired optical appearance in the later façade. The outer parapet is normally a single pane of safety glass to avoid thermally influenced glass breakage. The opacity of these glasses can be achieved through various production modes, depending on which optical effects are to be achieved. Regardless of the production technique, the adhesion and compatibility of the typical colours on the particular glass coating are important, as along with their tempering capability.

GUARDIAN has broad experience both in coating of float glass and further processes such as bending, tempering, laminating and various colour applications to achieve opacity or translucency. The most frequently used colours are ceramic colours which can be coated in different techniques on the back side of the pane. Various techniques are available, namely, roller coating, spraying, printing or curtain coating.

8.2.1 Colour application on SunGuard® coatings

Many SunGuard coatings with the special Silacoat® coating system can be printed with ceramic paints. Ceramic paints can react with the glass coating during the burning-in process, and that may lead to dulling, cloudiness or, in the worst case, complete degradation of the layer. It is therefore very important to test the compatibility of the particular paint type and the coating under production conditions. Improper tempering conditions may also cause poor results (penetration, colour, homogeneity, consistency, tightness). Moreover, each printing of a coated surface can lead to colour drifting after the burning-in process. Therefore adequate sampling should be made, as the processor is responsible for the final product and has to control its quality.

Detailed information as to the production of SunGuard glasses for parapets (spandrels) and special notes concerning the choice of colours can be found in the technical manual “Ceramic print – spandrel glass”.

8.2.2 Roll technique (roller coating)

The colour application with rollers using the roll technique provides an outstanding and even visual appearance, both during subsequent varnish coating and the application of ceramic colour which bonds firmly with the glass surface and coating in the following tempering process. This technology is adopted for larger quantities and is ideal for parapet glasses.

8.2.3 Screen-Print technique

The screen-print which is mainly dedicated for painting partial areas and used for specific design components is less suitable for larger areas and homogeneous painting (Chapter 8.3.1).
8.2.4 More production techniques

Another technology is based on a uniform and permanently flowing curtain of colours over the whole pane width. The pane is passed evenly under this colour curtain and covered homogeneously by it. This process is mainly used for large format colour applications to achieve the highest possible homogeneity, with thicker paint application over the whole pane. This method results in an extremely high material usage and is therefore rarely used today. The spray technique for colour application on small series and individual panes such as samples represents an alternative.

8.3 Design glass

Not only are the design of parapet panes is further refined in functional terms in modern architecture. Transparent elements are also receiving more and more visual and functional decorative facets. Glass offers a variety unlike any other construction material. From etching shot blasting and ceramic screen printing to laminated glass with internal films, the design achieved can be a decorative ornament or symbol or even an all over illustration or matting.

8.3.1 Production techniques

In addition to edging and shot blasting, five further very different process are currently available for the production of design glasses.

8.3.1.1 Screen-print directly onto the glass

One colour screen print printing directly onto glass has a long tradition. The enamel or ceramic paint, which is a mixture of finely milled glass and bonding colour pigments is pressed with a scraper through the open parts of the sieve onto the glass. The open sections form the motif to be printed in this respect with the aid of the colour. In the subsequent pre-tempering process, the motif is permanently joined to the glass surface by melting.

Many SunGuard® coatings are compatible with ceramic paint and are suitable for printing on Chapter 8.2.1. The open sections form the motif to be printed in this respect with the aid of the colour. In the subsequent pre-tempering process, the motif is permanently joined to the glass surface by melting.
8.3.1.2 Transfer colour print on glass

The transfer print offers an alternative to achieve a multi-coloured print instead of single colour screen printing. In addition, enamel and ceramic colours can also be transferred through digital printing onto transfer films, thus reproducing multi-coloured motifs. These printed films are then fixed on glasses to be tempered. During the tempering process, these transfer films burn residue-free and the painted colours bond as previously described. Besides all kinds of ornaments, this method can also generate illustrations which have the same quality as coloured photos.

8.3.1.3 Design laminated safety glass

Large sized illustrations, like the photographic slides technology of the past, are produced with the same digital print method but with other paint components and films. The illustrations are inserted between the PVB films of the laminated safety glass and then compressed. Colours and films are lightfast and UV resistant and create a decorative pane which retains its individuality. Despite this additional laminate, the laminated glass retains its outstanding characteristics (→ Chapter 7.4.2), supplemented by the individual design component.

8.3.1.4 Coloured films in laminated glass

The same lamination process can today avail of a large range of different colour films which can be combined to achieve every conceivable colour in laminated glass. This method enables the creation of completely transparent coloured glass. In addition, with supplementary dispersion films to further define translucency, products such as colourful blinds can be produced. These films are also UV resistant for outdoor use, thus preserving their radiant colour effect without affecting the characteristics of the laminated glass.

8.3.1.5 Decorative laminated glass

An alternative to these safety glasses are laminated glasses which are produced by filling the interface of two panes with resin. Decorative elements (e.g. mesh wire or other plain accessories) can be integrated into the resin and give the resulting glass sandwich a unique decorative configuration. These laminated glasses are typically not safety glasses (as defined in applicable laws relating to safety glass) and may be installed as such only when they are legally approved for construction.
8.4 Bent architectural glass

Architects and designers love to interrupt straightness, corners and edges with soft curves. This is why, in addition to round interior glass products and accessories, curved glass façades also exist. By the middle of the 19th century, architects were bending glass, a technique developed in England, and this exists today in a slightly modified form.

In building envelope applications, glass is generally bent through a thermal gravity process.

The procedure is as follows: a glass pane is laid over a bending form and heated to 550 - 620 °C in the bending oven. Having reached the softening temperature, the plain pane descends (through gravity) slowly into the bending mould and adopts its shape. The subsequent cooling down phase defines the shape of the glass. Slow cooling, free from residual stress, produces a glass which can be further processed, whereas fast cooling creates a partially or fully tempered glass which is not suitable for further processing (→ Chapter 7.1).

8.4.1 Requirements

Generally, bent glass is not a regulated building material, and it should ensure functionality such as thermal insulation, solar and noise protection. In addition, it must meet the requirements of building laws, such as fall prevention measures and load bearing regulations, to the same extent as plane glass.

To verify this and be allowed to install bent glasses, manufacturers must provide an AbZ (general approval by a construction supervising body), an ETA (European Technical Approval) in Europe, or a permit should be obtained in each case before construction can begin.

8.4.2 Glass types

In principle, all plane types of glass which are used in construction are bendable. However, slight restrictions apply to panes fitted with combination functional coatings. Individual parameters like bending radius, bending shapes, glass thicknesses and coatings should be aligned in advance. Bent glasses are indeed special high-tech products and therefore require very careful preparation in the early planning stage, along with the agreement of all those involved. In addition to types of glass already mentioned (normal glass, laminated glass and tempered glass), bent laminated glass and insulating glasses can also be produced. In the case of the last two mentioned, increased tolerances need to be considered for installation. The varying reflection characteristics of plain and bent glasses should also be taken into consideration. Glasses of the same type standing side by side can have a slightly different optical appearance. 1:1 sampling is recommended for larger projects. The design possibilities for the glass areas mentioned in 8.9 may also be utilised, with some restriction depending on the bending involved.

Basically all coated architectural glass from GUARDIAN SunGuard® and many from GUARDIAN ClimaGuard® can be bent or have a bendable alternative. GUARDIAN will directly inform you about the restrictions of the individual types concerning ways and shapes of bending.

8.4.3 Types of bending

A distinction is generally made between bent glass, slightly bent glazing with a bending radius of more than two meters and severely bent glass with small radii. Moreover there is a difference between glass which is bent cylindrically and spherically. Cylindrically bent glass is bent along one axis, and spherically over two axes.
Float glass is, in principle, suitable for all these bending shapes. Due to the production technology involved, fully tempered and heat strengthened glass are used mainly for cylindrical bending. This process is also recommended for glass with coatings, as the production process is short and thereby more “gentle” on the layers. Spherical and conical bending production durations and are frequently more difficult to realise with coated glass types. The smallest possible bending radius is approx. 100 mm for glass with a thickness < 10 mm and about 300 mm for glass > 10 mm thick. These possibilities depend on the manufacturer and should be checked in advance.

8.4.4 Determination of shape

Exact descriptions of the dimensions are required for the shape determination of bent glass. In addition to thickness of the glazing, the height of the panes and the width of at least another two of the five dimensions needs to be determined in the following drawing for inner and outer execution. It should always be noted that, with the exception of the opening angle, all data refers to the same surface (concave = inside, convex = outside).

8.4.5 Specifics

Special tolerances and production shaping conditions, which should be strictly considered, apply to bent glasses:

8.4.5.1 Local optical distortions

The local distortions of fully tempered and heat strengthened glass may differ from the specifications for plain glasses, as glass geometry, size and thickness may have a greater influence on bending than with the plain design. These should be agreed in advance with the manufacturer in all cases.

8.4.5.2 Outline precision

Outline precision means the accuracy of bending. This should be within a tolerance range of ± 3 mm in relation to the target contour so that the glass can be processed further without any difficulties.
8.4.5.3 Torsion

Torsion describes the exactness to the plane parallelism of the edges or unbent edges. In this case, the largest irregularity after bending should also not exceed ± 3 mm per metre glass edge.

8.4.5.4 Edge displacement

Diverging from the specifications of plain laminated and insulating glass, the displacement at the edges may increase after bending. It is absolutely necessary to find common conformity in advance.

8.4.5.5 Tangential junctions

The tangent is the straight line which has its origin in a particular point of the curve. Thereby the line is perpendicular compared with the bent radius of the curve. Without this tangential transition there would be a sharp angle at this spot which can be achieved with glass, but is not advisable. There are normally larger tolerances at the sharp angle than with tangential transitions.

8.4.6 Static specifics

The deformation and mechanical stress of a bend can be defined through finite element models with the aid of the shell theory. The curvature, depending on installation conditions in the case of monolithic glass, can have a positive effect due to the shell bearing impact, namely in the direction of thinner glasses. Insulating glass, however, does not achieve this effect as readily.

The curvature of the glass means that the bending strength is increased and, consequently, extremely high climatic loads can arise. This must be considered, especially when units have tangential attachment pieces at a curvature. This can result in broader edge seals which affect later glass installation.
8.5 Special glass applications

Thanks to continuous improvements in engineering and architecture, hardly any limits exist to construction with glass. Even areas of a high security relevance are constructed today with glass constructions and controlled by climatic zones. The following provides a brief insight into the technologically ambitious regions of building with glass.

8.5.1 Walk-on glazing

Walk-on glazing generally involves horizontal glass installations which are designed for regular personnel and heavy load traffic. They should be evaluated differently from tread-on glazing, which is only designed for short-term accessing for cleaning and maintenance purposes.

Walk-on glass superstructures generally consist of laminated safety glass with an additional upper protective pane. This bonded protective pane should consist of at least 6 mm fully tempered or heat strengthened glass. The laminated safety glass unit, coupled underneath, with at least 2 panes of 12 mm thickness, forms the bearing capacity which may be considerably thicker or have more panes, depending on demand and execution. Mostly float glass panes with each 1.52 mm PVB film interlayers are used for this unit. In order to be allowed to install this pane pursuant to TRLV (technical guidelines for linear supported glazing), it should consist of at least 10 mm fully tempered or heat strengthened glass. The laminated safety glass unit, coupled underneath, with at least 2 panes of 12 mm thickness, forms the bearing capacity which may be considerably thicker or have more panes, depending on demand and execution. Mostly float glass panes with each 1.52 mm PVB film interlayers are used for this unit. The basis for the installation of walk-on glazing are an absolute bending rigidity substructure, an elastomer bearing material with 60 - 70 shore A-hardness and a minimum bearing with a width of 30 mm.

8.5.2 Glass elevators

One highlight of today’s architecture is transparent elevators, which gives users the feeling of floating. In this application, the shafts, lifts and cars are made of glass. These types of constructions must meet a number of safety and mechanical requirements that are regulated in the European elevators directives 95/16 EC 7/99 and EN 81 02/99. Additional national requirements may exist, such as building regulations of the respective federal state in Germany. For a glass shaft, proof of stability for an applied force of 300 N on an area of 5 cm² is required. Depending on the size of the cars, the walls, which are fixed and mounted on all sides, create different demands on the characteristics of the laminated glass to be used. If the glazing stretches from the floor to the ceiling, a crosspiece should be installed in the vicinity of a height of 0.90 - 1.10 m which should not be supported by glass.

Doors, on the other hand, need to meet special requirements which should be assessed according to the fixture, mechanism and dimensions. Lifts made of glass are always custom-made products which can only be realised together with everybody involved. All lift glass components should have a permanent and visible identification marking.
8.5.3 Switchable glass

A recent development is switchable, electrochromic glass, where a special magnetron coating is made to change its solar energy transmission when electrical voltage changes. The g-value of the glazing can be adapted accordingly to suit the season or weather relevance (summary heat protection → Chapter 5.5).

The g-values of such glasses, which are integrated into a two pane insulating glass construction, are approx. 35 % without electrical voltage and 6 % during peak current supply. Naturally enough, light transmission also changes in this context. This development is certain to continue in the coming years and thus create even more options for façade constructions with glass.

Please address inquiries referring to your project directly to GUARDIAN.

8.5.4 Electromagnetic damping glasses, Radar reflection damping glass

Modern wireless communication is based on electromagnetic waves. In addition, high-voltage power lines and ordinary electrical equipment also emit these waves. Therefore, it is becoming frequently more necessary to reduce this unavoidable but unwanted radiation here in certain building areas. This can be done in tap-proof rooms in high security areas, even up to a complete level of shielding, or close to airports for a targeted reduction of fields to avoid interference and incorrect signals during radar communication with aircraft.

Determination of electromagnetic waves is realised in a similar fashion to sound waves using a logarithmic scale, so that a considerable reduction can be achieved with even limited damping. The following applies in this respect:

<table>
<thead>
<tr>
<th>Damping [dB]</th>
<th>Reduction [%]</th>
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<tbody>
<tr>
<td>5</td>
<td>app. 38</td>
</tr>
<tr>
<td>10</td>
<td>app. 90</td>
</tr>
<tr>
<td>15</td>
<td>app. 97</td>
</tr>
<tr>
<td>20</td>
<td>app. 99</td>
</tr>
</tbody>
</table>

This damping is achieved by special, different glass coating on outer and inner panes which lead to phase displacements through a determined distance of the interface, and that effects an erasure of the resulting, reflecting, electromagnetic radiation.

GUARDIAN provides a range of specially coated SunGuard® solar control glasses, some of which have properties for reducing the radar reflection in some glass constructions. An overview is contained in → Chapter 10.3.

Please contact GUARDIAN for further information and advice.

**ClimaGuard® Premium or ClimaGuard 1.0 heat protection glasses**

SunGuard® HP or SunGuard High Selective solar control glasses with a coating surface resistance < 5 Ohm provided excellent insulation against high frequency radiation, or so-called electrical smog, especially in residential areas.

A triple glazing with two heat protection coatings achieved HF-transmission reductions of approx. 42 dB at 900 MHz (GSM 900 mobile service) and about 47 dB in the vicinity of 1900 MHz (GSM 1800 mobile service). In contrast to that, a simple double glazing with only one sun protection coating achieves a HF transmission reduction of approx. 32 dB at 900 MHz and about 28 dB at 1900 MHz. It has to be considered, that only system solutions in the closed window with, for example, steel reinforced frames and posts and grounding of the system will grant an efficient protection against electric smog.

Please contact GUARDIAN directly for further information on additional options.

Glass structures with these special coatings and corresponding edge connections make their contribution today in the area of transparent façades. However, no defined product range is
available, but rather only a glass combination which must be determined in advance in terms of the following criteria:

- What exactly must be shielded and where?
- Which frequency ranges must be damped and to what extent?
- How can the edge parameters for glass windows and window brickwork be realised?

8.5.5 Anti-reflection glazing

Despite the excellent transparency of modern glazing, the view from the bright exterior to the darker interior may be hindered by reflection, depending on the viewing angle and incidence of light. Shop window glazing in particular can diminish the view of items behind the glass due to reflections. A newly developed coating from GUARDIAN provides the remedy. The coating on both glass surfaces reduces the degree of reflection on glazing with one pane to less than 1%. This type of glazing is especially suitable for:

- items displayed in shop windows
- glazed openings in control rooms and visitor terraces
- show cases and protective panes in museums
- partition glazing in stadiums
- interior partition glazing in hospitals and clean rooms
- zoological gardens and aquariums
- protection glazing for direction signs and display panels

Generally speaking, it is observed that insulating glazing is only effective when all installed glass areas in the system are coated in this manner. This new coating is also combinable and can be pre-tempered as tempered glass. For more information and the availability of anti-reflection coated glass, please contact GUARDIAN.