architectural glass
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## Glass Selector

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The chart below suggests where to use what type of glass and has been divided into three categories:

- **Primary use:** `P`
- **Secondary use:** `S`
- **Not normally used:** `N`

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glass options

Float Glass
Rolled/Patterned Glass
Painted Glass
Decorative Glass
Fire-Rated Glass
Glass Options

Introduction

This section lists the various monolithic (single lite) glass products that Oldcastle BuildingEnvelope™ can provide. Two or more lites of most of these products can be combined to produce insulating glass units and laminated glass products.

For complete Product Performance data, log on to www.oldcastlebe.com and choose GlasSelect®.

The glass products are divided into categories and subcategories and then, in some cases, further divided by color:

Float Glass

Clear Float Glass
Since 1959, when the float process was introduced, soda-lime glass has been the primary type of glass used for commercial applications. Hot glass floats on a bath of molten tin, where a continuous glass ribbon is formed and then cooled through an annealing lehr before being cut. Clear float glass is nearly colorless, with a visible light transmittance ranging from 75% to 92%, depending on thickness. Clear glass can be the outboard and/or the inboard lite of an insulating glass unit or a laminated glass product. Clear float glass comes in the following types:

Standard Clear
Available from a variety of manufacturers including Guardian, Pilkington and PPG. Thicknesses available range from 3/32" to 3/4".

Low-Iron Glass
Iron in the glass batch ingredients causes the slight green tint in standard clear float glass. By reducing the iron content, the glass has a clearer (less green) appearance. Products available include Pilkington Optiwhite®, PPG Starphire® and Guardian UltraWhite®.

Standard Tints
Colorants are added to clear float glass to produce tinted float glass with visible light transmittance of between 18% to 85%, depending on color and thickness. When incorporated as the outboard lite of an insulating glass (IG) unit, tinted glass will increase the thermal and solar performance to that level achieved with monolithic glass. Tinted, heat absorbing glass often requires the heat-treatment of the outboard lite to improve the resistance of the glass to solar-driven thermal stress. Glass size, type and job conditions are contributing factors. It is recommended that a thermal stress analysis be performed on all projects.

Spandrel Glass

Decorative Glass
i-Glass®, Montage®, Silk-screened, Rolled/Patterned Glass, Vanceva® Laminated Glass, Sandblasted, Acid-etched

Fire-Rated Glass
Glass Options

**Float Glass (continued)**

Standard Tints are available in the following colors:

**Blue:**
- PPG Optiblue®
- PPG Solarblue®

**Blue Green:**
- Pilkington Optifloat™ Blue-Green

**Bronze:**
- Pilkington Optifloat™ Bronze
- PPG Solarbronze®

**Green:**
- Pilkington Optifloat™ Green
- PPG Solexia™

**Gray:**
- Guardian CrystalGray®
- Pilkington Optifloat™ Grey
- PPG Solargray®

**High Performance (Spectrally Selective) Tints:**

High Performance Tints offer dramatically improved benefits when compared with standard tints. The ratio of the visible light transmittance to the solar heat gain coefficient is referred to as the Light to Solar Gain (LSG) Ratio. The higher the LSG ratio, the better the glazing is at reducing unwanted solar heat while maximizing desirable natural light transmittance. The Department of Energy (DOE) defines spectrally selective glass as having an LSG of 1.25 or greater. High Performance Tinted glass often requires the heat treatment of the outboard lite to improve the resistance of the glass to solar-driven thermal stress. Glass size, type and job conditions are contributing factors. It is recommended that a thermal stress analysis be performed on all projects. Spectrally selective products are available in the following colors:

**Blue:**
- Pilkington Arctic Blue™
- PPG Pacifica™

**Blue Green:**
- PPG Azuria™
- PPG Caribia™

**Green:**
- Guardian TwilightGreen™
- Pilkington EverGreen™
- PPG Atlantica™

**Gray:**
- Pilkington SuperGrey™
- PPG Graylite® II

**Low-Emissivity (Low-E) Glass:**

Low-emissivity glass may have various combinations of metal, metal oxide and metal nitride layers of coatings that are nearly invisible to the eye and that reflect reradiated long-wave IR energy. The Low-E coating reduces heat loss through the glass in winter by reflecting interior long-wave IR back into the home or office. When incorporated into insulating glass (IG) units, Low-E glass significantly improves the unit’s thermal performance (lower U-Value) and can be designed to also reduce solar heat gain. Low-E coatings are available by the following types and color appearance:

**Neutral:**
- Oldcastle BuildingEnvelope™
- Guardian SunGuard® SuperNeutral® 68 (SN 68) on Clear
- Guardian SunGuard® SuperNeutral® 62 (SN 62) on Clear
- Guardian SunGuard® SNX 62/27 on Clear
- Pilkington Energy Advantage™ Low-E on clear
- PPG Solarban® 60 on Clear
- PPG Solarban® 70XL
- PPG Solarban® 72 on Starphire®
- PPG Sungate® 400 on Clear
- PPG Sungate® 500 on Clear

**Neutral Gray:**
- Guardian SunGuard® Neutral 40 on Clear
- Guardian SunGuard® SN 54 on Clear
- Pilkington Solar E™

**Neutral Blue:**
- Guardian SunGuard® Neutral 50 on Clear
- Guardian SunGuard® Light Blue 63 on Clear
- PPG Solarban® z50
Glass Options

**Float Glass (continued)**

**Blue:**
- PPG Solarban® 60 on Pacifica™
- PPG Solarban® 60 on Solarblue®
- PPG Solarban® 70XL on Pacifica™
- PPG Solarban® 70XL on Solarblue®

**Blue Green:**
- PPG Solarban® 60 on Azuria™
- PPG Solarban® 60 on Caribia®
- PPG Solarban® 70XL on Azuria™
- PPG Solarban® 70XL on Caribia®

**Bronze:**
- PPG Solarban® 60 on Solarbronze®
- PPG Solarban® 70XL on Solarbronze®

**Gray:**
- Guardian SunGuard® SuperNeutral® 68 (SN 68) on CrystalGray®
- Guardian SunGuard® SuperNeutral® 62 (SN 62) on CrystalGray®
- Guardian SunGuard® SuperNeutral® 54 (SN 54) on CrystalGray®
- Guardian SunGuard® SNX 62/27 on CrystalGray®
- Pilkington Solar E™ on Grey
- PPG Solarban® 60 on Solargray®
- PPG Solarban® 70XL on Solargray®

**Green:**
- Guardian SunGuard® Neutral 40 on Green
- Guardian SunGuard® Neutral 40 on TwilightGreen™
- Guardian SunGuard® Neutral 50 on Green
- Guardian SunGuard® Neutral 50 on TwilightGreen™
- Guardian SunGuard® Light Blue 63 on Green
- Guardian SunGuard® Neutral 61 on Green
- Guardian SunGuard® SuperNeutral® 68 (SN 68) on Green
- Guardian SunGuard® SuperNeutral® 68 (SN 68) on TwilightGreen™
- Guardian SunGuard® SuperNeutral® 62 (SN 62) on Green
- Guardian SunGuard® SuperNeutral® 62 (SN 62) on TwilightGreen™
- Guardian SunGuard® SuperNeutral® 54 (SN 54) on Green
- Guardian SunGuard® SuperNeutral® 54 (SN 54) on TwilightGreen™
- Guardian SunGuard® SNX 62/27 on Green
- Guardian SunGuard® SNX 62/27 on TwilightGreen™
- Guardian SunGuard® AG 43 on Clear
- Guardian SunGuard® AG 43 on CrystalGray®
- Guardian SunGuard® AG 43 on Green
- Guardian SunGuard® AG 43 on TwilightGreen™
- Guardian SunGuard® AG 50 on Clear
- Guardian SunGuard® AG 50 on CrystalGray®
- Guardian SunGuard® AG 50 on Green
- Guardian SunGuard® AG 50 on TwilightGreen™
- Guardian SunGuard® Royal Blue 40 on Clear
- Guardian SunGuard® Royal Blue 40 on CrystalGray®
- Guardian SunGuard® Royal Blue 40 on Green
- Guardian SunGuard® Royal Blue 40 on TwilightGreen™
- Guardian SunGuard® Neutral 61 on Clear
- Guardian SunGuard® Neutral 61 on Green
- Pilkington Arctic Blue™ Eclipse Advantage™
- Pilkington Blue-Green Eclipse Advantage™
- Pilkington Bronze Eclipse Advantage™
- Pilkington Clear Eclipse Advantage™
- Pilkington EverGreen™ Eclipse Advantage™
- Pilkington Grey Eclipse Advantage™
- PPG Solarban® R100 on Atlantica™
- PPG Solarban® R100 on Azuria™
- PPG Solarban® R100 on Caribia®
- PPG Solarban® R100 on Clear
- PPG Solarban® R100 on Optiblue®
- PPG Solarban® R100 on Pacifica™
- PPG Solarban® R100 on Solarblue®
- PPG Solarban® R100 on Solarbronze®
- PPG Solarban® R100 on Solargray®
- PPG Solarban® R100 on Solarblue®
- PPG Solarban® R100 on Solargray®
- PPG Solarban® R100 on Starphire®

*Reflective/Radiant Low-E coatings are usually designed to be used on the #2 surface on an insulating glass (IG) unit with a clear inboard lite.*
Neutral Low-E coated glass has an exterior appearance that is similar to clear, uncoated glass. All Neutral Low-E coatings can be used on the #2 surface, and most can be used on the #3 surface of an insulating glass unit. If used with clear glass, the Neutral Low-E coating is on the #2 surface.

If used in conjunction with a Standard or High Performance Tint for additional solar control, the tinted glass is placed in the outboard lite position, and the Neutral Low-E coating is used on the #2 or #3 surface. These products most often require heat treatment to improve the resistance of the glass to solar-driven thermal stress. Glass size, type and job conditions are contributing factors. It is recommended that a thermal stress analysis be performed on all projects.

**Reflective Glass:**

Reflective glass products consist of various pyrolytic or sputtered coatings that are applied to clear and tinted glass substrates to produce a large family of products with a wide range of visual properties (color, transmittance, reflectance) and performance properties (shading coefficient, U-Value). Reflective glasses can be used in vision and/or spandrel applications to create uniform or contrasting building aesthetics. When used as the outboard lite of an IG unit with a Low-E glass inboard, the lowest (best) solar heat gain coefficient and U-Value can be achieved.

Pyrolytic reflective glass products, i.e., PPG Solarcool®, can be installed with the coating on the #1 or #2 surface. The first surface reflective coating applications have higher reflectivity and the greatest solar energy rejection (lowest air-conditioning costs). However, the #1 coating is facing the building’s exterior and is more susceptible to scratching and staining. Also, the color of the glass is hidden by the #1 surface coating color. The second surface reflective coated products have excellent (low) shading coefficients; plus they have lower reflectivity and permit the true color of the glass substrate to be viewed from the exterior. Since the coating is not exposed, it is protected from cleaning scratches and staining.

*For Product Performance data, log on to www.oldcastlebe.com, choose GlasSelect®, and choose “silver” as the glass color.*

Reflective glass often requires heat treatment (tempering or heat-strengthening) to improve the resistance of the glass to thermal stress breakage. Many variables affect thermal stress, including glass size, color, coating position and job conditions. It is recommended that a thermal stress analysis be performed on all projects.

Reflective coatings are applied to either Standard Tints or High Performance Tints and are available in the following colors:

**Blue:**
- PPG Solarcool® Pacifica™
- PPG Solarcool® Solarblue®
- PPG Vistacool™ Pacifica™

**Blue Green:**
- PPG Solarcool® Azuria™
- PPG Solarcool® Caribia®
- PPG Vistacoool™ Azuria™
- PPG Vistacoool™ Caribia®

**Bronze:**
- PPG Solarcool® Bronze
Glass Options

**Float Glass** (continued)

**Green:**
Guardian SunGuard® Silver 20 on Green
Guardian SunGuard® Silver 32 on Green
PPG Solarcool® Solexia™

**Gray:**
PPG Solarcool® Gray
PPG Solarcool® Graylite®
PPG Vistacool™ Solargray®

**Silver:**
Guardian SunGuard® Silver 20 on Clear
Guardian SunGuard® Silver 32 on Clear

**Spandrel Glass**

Spandrel glass is glass that has been rendered opaque for non-vision applications. Its major use is to mask materials or construction from view from the exterior of a building. Such areas are commonly the hung-ceiling area above a vision lite or the knee-wall area below a vision lite.

The indoor surface of spandrel glass is not suitable for use as a finished wall. Additional suitable material, such as sheet rock, metal paneling or scrim, must be installed on the indoor side when used in quasi-vision areas such as transom lites, column covers, etc.

To create consistency between the vision and non-vision areas, depending on aesthetic design, the IG units are fabricated with the spandrel glass as either the inboard or outboard lite. Both lites of glass must be heat-treated (tempered or heat-strengthened) to withstand the higher thermal stresses typical in spandrel applications.
Glass Options

Decorative Glass

Decorative glasses are available in a wide range of types, patterns and colors, including the following:

**i-Glass™**

i-Glass™ utilizes a new digital printing technology that provides architects, designers and owners the ability to create custom graphics and artistic designs that are applied directly to the surface of glass.

**Montage®**

Montage® Visual Effects Glass is a totally new concept in glazing. Montage® provides architects, designers and owners the ability to create unique custom effects by combining at least two of our standard designs and technologies.

Montage® allows you to mix and match textured pattern glass, silk-screened glass, and laminated glass designs into your very own vision. Each effect can stand alone or be utilized as components to create other products, such as insulating glass units.

**Silk-Screened**

Silk-screened glass is float glass with ceramic frit paint screened onto it and then fired in a tempering oven. A wide range of decorative effects can be achieved by varying the pattern or design, the paint color, the surface coverage and the glass tint. The glass solar properties can be fine-tuned to meet job thermal performance specifications as well.

Standard patterns, such as lines with 50% coverage, dots with 40% coverage and holes with 60% coverage, are used extensively in overhead glazing for both decorative and thermal performance reasons. Because silk-screened glass is either heat-strengthened or tempered, it has increased resistance to mechanical and thermal stress. Imitation acid-etched and sandblasted fired-on ceramic frit is much more durable and easier to clean than actual acid-etched or sandblasted glass.

For further details on the silk-screened glass, please see the Silk-screened Glass Tab, section 11H.

**Rolled/Patterned**

When one or more of the rollers in the rolled glass process has a pattern on it, patterned glass is produced. This glass is usually available in thicknesses of 1/8” (3 mm) to 3/16” (5 mm); however, a very limited number of patterns are available in thicknesses up to 3/8” (10 mm). Colors may also be available, but are extremely limited. Patterned glass is also called figured glass or obscure glass because the pattern of the rollers reproduced on the glass surface obscures the details of the objects viewed through the glass. The degree of obscurity depends upon both the pattern design and depth. Patterned glass surfaces produce diffuse reflections as opposed to the specular reflections which occur with float glass. Patterned glass diffuses transmitted light and spreads it in many directions to produce a translucent effect as opposed to the transparent effect produced by float glass. Patterned glass does not provide complete privacy. Some patterned glasses cannot be heat-treated because of the variations in glass thickness and/or the depth of the pattern.

Below are some common patterned glasses. Other patterns are available.

- P-516
- Pattern 62
- Spraylite
- Industrex
- Aquatex
- Niagara
- Rain
- Smooth Rough
- Reeded

**Vanceva® Design Laminated Glass**

The Vanceva® Design interlayer system from Solutia provides architects and interior designers with a unique level of performance and versatility for interior and exterior glazing applications. Combining colors, Solutia’s interlayer systems mix form with function, providing all the benefits of laminated glass with high design. Ten basic colors form the
Glass Options

Decorative Glass (continued)

foundational palette. These can be combined to create more than 1,000 transparent and translucent colors. These pigmented interlayers are heat and light stable and therefore form colors that will not fade.

For full details on this type of decorative glass, please see the Laminated Glass Tab, page 40.

Sandblasted Glass

Sandblasting results in a “frosted” glass appearance. Transparent float glass is transformed into a decorative, partially or fully translucent glass, depending on the amount of surface area that is sandblasted.

Sandblasting is produced by pressure-spraying glass with various grit abrasives to create a wide range of surface textures. Sandblasting can be done to give an entire piece of glass a uniform frosted or obscure appearance. Masking off the clear areas with a protective film can also produce a very intricate custom design.

Sandblasting glass obscures the view from one space to another without blocking out natural light. Sandblasting breaks down the glass, leaving a finely ground surface that refracts and scatters light rays.

Heat-treated glass, both heat-strengthened and tempered, should not be sandblasted because it will decrease the strength of the glass. All sandblasting should be done on annealed glass, prior to any heat-treating.

Untreated sandblasted glass can be difficult to clean and remove fingerprints from. Surface treatments are available that can “seal” the rough surface to make cleaning easier.

Acid-etched Glass

Acid-etching is another process for producing a frosted glass surface. Like sandblasting, acid-etching can be applied to the entire glass surface to produce a uniform frosted look or a custom pattern or design can be produced.

Acid-etching, or “embossing”, as it is sometimes called in the trade, involves principally the use of hydrofluoric acid. There are several different processes that are used to produce a variety of decorative glass effects.

Most people consider acid-etched glass to have a softer, more pleasing appearance than sandblasted glass. It generally does not have the fingerprint problems that sandblasted glass has.

Fire-Rated Glass

Today’s fire-rated glass offers architects more choices than ever. In addition to blocking flames and smoke, products are now available that also resist impact, insulate for energy efficiency and reduce glare. Plus, fire-rated glass no longer has to look institutional, but can be a key part of a building’s design.

What is fire-rated glass?

Most glass offers little, if any, fire protection. Fire-rated glass is made from a transparent glass ceramic material known for its outstanding heat resistance. With structural fires capable of quickly reaching extremely high temperatures, fire-rated glass helps contain the spread of smoke and fire. Due to potential failures, active systems alone, such as sprinklers, are not sufficient for fire protection.
Fire-rated glass, along with fire-rated walls, provides around-the-clock protection and does not require activation.

**How does glass earn a fire rating?**
Fire-rated glass must pass a series of tests established by national test standards. Independent laboratories (such as UL) conduct the tests, then assign a rating corresponding to the time the glass should be expected to perform reliably in a fire—anywhere from 20 minutes to 3 hours. A second test required in the U.S. for a rating of 45 minutes or more is the hose stream test, which demonstrates the ability of the glass, framing system and surrounding materials to withstand the thermal shock that occurs when water from fire hoses or sprinklers hits the glass. Once a product has successfully completed the testing, it is assigned a fire rating.

**What are the requirements for safety ratings?**
Building codes require that glass installed in high traffic or other hazardous locations, such as doors, sidelites and windows near the floor, meet safety glazing requirements. If fire-rated glass is required in such locations, it must also meet the safety code requirements.

**What are the different types of fire-rated glass?**
Oldcastle BuildingEnvelope™ can fabricate and supply a full range of fire-rated glass options to meet today’s demanding needs as either monolithic, laminated or as an IGU.

- **FireLite®** – a 3/16" (5 mm) thick fire-rated and safety-rated glazing material, composed of FireLite® and surface-applied, approved fire-rated film. It is listed for use in doors, sidelites, transoms and borrowed lites with fire rating requirements ranging from 20 minutes to 3 hours.

- **FireLite Plus®** – a nominal 5/16" (8mm) thick laminated, fire-rated and safety-rated glazing material. It is listed for use in doors, sidelites, transoms and borrowed lites with fire rating requirements ranging from 20 minutes to 3 hours.

- **FireLite® IGU** – composed of FireLite® products and a variety of tempered or annealed float glass products. It is listed for use in fire-rated applications with ratings from 20 minutes to 3 hours.* Available incorporating a variety of glass products, including (but not limited to):
  - Tinted
  - Low-E
  - Reflective
  - One-Way Mirror
  - Art

  *3 hour rated units must be specified with FireLite NT® or FireLite Plus®.

All FireLite® products are transparent and available in two different surface finishes, standard and premium grade.

A variety of other specialty fire-rated products are also available upon request.
Glass Options

Additional Important Information

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To view performance data on a wide range of glass make-ups, or to build your own product specification, log on to www.oldcastlebe.com and choose GlasSelect.
Insulating Glass

Sell Sheet

Product Information

Product Specifications
Our IG units are sealed combinations of two or more lites of glass separated by a dry airspace. IG units improve the thermal performance of windows, thus significantly reducing heating and air-conditioning costs. IG units also reduce interior condensation in cold climates, and increase comfort near windows, thus maximizing the usable interior space.

**Insulating Glass Applications**

*Insulating glass (IG) units are used in a wide range of applications including:*

- Commercial/Residential Fixed and Operable Windows
- Curtain Walls
- Storefronts
- Sloped/Overhead Glazing
- Non-vision (Spandrel) Locations
Insulating Glass

Introduction

Insulating glass use in residential and commercial construction has risen steadily over the years to where the majority of all new and renovation construction today includes IG units. IG units not only save on monthly heating and cooling costs, but they also reduce the initial size and cost of the heating and cooling equipment required on a project.

By combining Low-E coatings, tinted glasses, reflective coatings, silk-screened patterns, laminated glass products and more, a wide variety of insulating glass configurations are available to satisfy a wide range of performance and aesthetic requirements. IG units can be fabricated to meet state energy codes, sound control requirements, seismic requirements, impact resistance, bullet resistance and hurricane and blast resistance requirements. IG units can be designed to reduce heat loss and solar heat gain entering the building, with a minimal reduction of visible light transmittance.

IG units will have a warmer room-side glass surface temperature than single glazing, thus reducing condensation and moisture-related problems.

Description

IG units are sealed combinations of two or more lites of glass separated by a dry airspace. Desiccated spacers are dual sealed with polyisobutylene primary sealant and an organic or silicone secondary sealant, depending on the project specifications and the application. (See the diagrams below.) Argon gas-filled IG units are available to further improve the insulating properties (reduce the U-Value) of a standard air-filled IG unit.

The glass lites of an IG unit can be annealed, heat-strengthened, tempered or laminated, as needed, to meet building code requirements, safety glazing standards and design requirements. The lites of an IG unit can be of equal or unequal thickness.

Insulating Glass Unit

Glass Types Available

<table>
<thead>
<tr>
<th>Outboard Lite</th>
<th>Inboard Lite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Clear &amp; Low-E</td>
</tr>
<tr>
<td>Tints</td>
<td>Clear &amp; Low-E</td>
</tr>
<tr>
<td>Low-E</td>
<td>Clear</td>
</tr>
<tr>
<td>Spectrally Selective Tints</td>
<td>Clear &amp; Low-E</td>
</tr>
<tr>
<td>Patterned</td>
<td>Clear &amp; Low-E</td>
</tr>
<tr>
<td>Reflective #1 or #2</td>
<td>Clear &amp; Low-E</td>
</tr>
</tbody>
</table>

Others include: Laminated Glass, Spandrel Glass, Silk-Screened Glass and Other Decorative Glass.
Insulating Glass

Glass Options
Insulating glass units are fabricated according to project specifications. IG units can be constructed using a large variety of glass products including clear, low iron, Low-E, standard or high performance (spectrally selective) tints; and reflective, silk-screened, spandrel, laminated, decorative and wired glass to achieve desired aesthetics, meet design criteria and/or to improve solar control and thermal performance.

For a list of available glass products/colors, go to the Glass Options Tab, Section 11C.

For more information on silk-screened, spandrel and laminated glass products, go to their respective Product Information Tabs.

Capabilities
The standard 1" commercial IG unit is made up of two lites of 1/4" glass and a nominal 1/2" airspace. Custom IG unit designs can be fabricated with glass thicknesses ranging from 1/8" to 3/4" and with airspace thicknesses ranging from 3/16" to 1". Maximum sizes for IG units are determined by a number of considerations. Size, thickness, weight, aspect ratio, application and load requirements are the factors utilized to make this determination.

For more information log on to http://www.oldcastlebe.com/products/architectural-glass/insulating-glass/capabilities

Applications
Insulating glass units are used in essentially all exterior building applications, including vertical glazing, sloped glazing, overhead glazing and skylights, in both vision and spandrel (non-vision) areas. Depending on the glass type used, IG units can be designed for light and solar control; sound control; ultraviolet screening (to reduce fading); hurricane, earthquake and blast resistance; security; bullet resistance; and decorative applications.

IG units are also used for interior applications such as sound control and to reduce energy usage for climate-controlled (hot or cold) rooms.

See the Glass Selector Tab, Section 11B, for some typical applications.

Residential Applications
Insulating glass has become the standard for both new and replacement residential windows. Most residential IG units are made with one outboard lite of clear glass and an inboard lite of clear glass, often with a Low-E coating to further reduce heat loss.

When the short-wave infrared (IR) energy of the sun strikes an object in the house, some of the energy is absorbed and reradiated as long-wave IR (heat) energy. The Low-E coating reflects this heat energy back into the residence. In cold climates, the Low-E coating is normally placed on the #3 surface of the unit. This is done to maximize passive solar heat gain from the sun,
Insulating Glass

Applications (continued)

while still improving (reducing) the winter nighttime heat loss (winter U-Value). In warm climates, the Low-E coating is positioned on the #2 surface of an IG unit to minimize solar heat gain. The U-Value remains unchanged for the second or third surface application.

Commercial Applications

Most commercial buildings spend the majority of their energy dollars on cooling loads, even in cold climates, due to the internal heat generated by lights, people, copiers, computers and other office equipment. Also, there has been an increase in the number and size of windows to maximize the use of natural daylight to reduce energy usage and lighting costs, as well as the positive effect on employee productivity. Therefore, the major emphasis in commercial buildings is to reduce heat gain (minimize the shading coefficient/the solar heat gain coefficient). Of lesser importance, but still quite significant in cold climates, is the need to minimize nighttime heat loss (winter U-Value).

There are now a large number of high performance/spectrally selective tints, with and without reflective or Low-E coatings, that do an excellent job of reducing heat gain. And there are a number of Low-E glasses that not only improve (reduce) the winter U-Value, but also reduce heat gain.

Characteristics

Certification

Oldcastle BuildingEnvelope™ insulating glass units are independently tested and certified according to North American standards for quality and performance. The US and Canadian tests are performed in accordance with the new harmonized standard ASTM E2190. IGCC (Insulating Glass Certification Council) sponsors the certification program of independent laboratory tests and periodic audits in the US while IGMA (Insulating Glass Manufacturers Alliance) sponsors the certification program in Canada. Oldcastle BuildingEnvelope™ is an active member in both IGCC and IGMA. Oldcastle BuildingEnvelope™ US insulating glass products are listed in the IGCC Certified Products Directory. Oldcastle BuildingEnvelope™ Canadian insulating glass products are listed in the IGMA Certified Products Directory.

Condensation on Interior Glass Surfaces

Condensation on building interior glass surfaces (the #4 surface of an IG unit) is a common wintertime complaint in much of North America. Condensation not only reduces visibility, it also leads to severe damage of the surrounding construction from this moisture. Condensation occurs on interior glass surfaces when the surface temperatures fall below the dew-point temperature of the room. The relative humidity in a room at which condensation will occur on the glass surface depends on the interior glass surface temperature, which in turn depends on all the factors affecting heat flow through the glass. These factors include the inside and outside air temperatures and airflows adjacent to the glass surfaces, and the IG unit thermal transmittance (U-Value). Because Low-E glass improves (lowers) the IG unit U-Value, using Low-E glass will increase the unit’s interior glass surface temperature. Thus an additional benefit of using Low-E glass is that it permits a higher relative humidity in a room before condensation will occur. This can improve occupant comfort and performance in the winter months.
Insulating Glass

Characteristics (continued)

Vision-Spandrel Color Match
Spandrel glass can be designed to contrast or harmonize with the vision glass. A wide range of colors and glass products are available to do this, as discussed in the Spandrel Tab, Section 11I, of this binder. The best match for a vision IG unit is a spandrel IG unit using the same exterior glass (normally a tinted or reflective glass) and a spandrel glass as the interior lite, with the coating on the #4 surface of an IG unit.

It should be understood that the degree of color and visual similarity of a building’s vision and spandrel glass will vary greatly, depending on the time of day, sky conditions, the vision area lighting and interior shading conditions (drapes, miniblinds, etc.), as well as on the color, reflectance and light transmittance of the glass.

Assuming the vision and spandrel IG units have the same exterior lite, the visual difference between them will be less noticeable under the following conditions:
• the more reflective the exterior lite is
• the lower the light transmittance of the exterior lite is
• the brighter the sky conditions

Additional Important Information

Specifications
For North America a sample section can be found in the last section of this binder titled: Sample Architectural Glass Specifications.

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To view performance data on a wide range of glass make-ups, or to build your own product specification, log on to www.oldcastlebe.com and choose GlasSelect®.
heat-treated glass

Sell Sheet

Product Information
Heat-treated glass offers increased resistance to impact, wind loads and thermal stress breakage. Annealed glass is heated to approximately 1,150°F (621°C) and rapidly air-cooled to become heat-strengthened or fully tempered.

**Heat-Treated Glass Applications**

*Heat-treated glass is used in a wide range of applications including:*

- Patio and Storm Doors
- Entrance Doors and Sidelites
- Tub and Shower Enclosures
- Commercial/Residential Fixed and Operable Windows
- Displays
- Partitions
- Storefronts
- Handrails

**Anaheim Convention Center**
Anaheim, California
Architect: HOK
Heat-Treated Glass

Introduction

“Heat-treated glass” is a general term used in the glass fabrication industry to describe glass that has been processed through a tempering oven to change its strength and breakage characteristics (i.e., the size and/or shape of the glass pieces after breakage). There are two distinct heat-treated products: heat-strengthened glass and fully tempered glass, as defined in ASTM C1048 Standard Specification for Heat-treated Flat Glass–Kind HS, Kind FT Coated and Uncoated Glass. Compared to annealed glass (non-heat-treated glass), both have increased strength to resist higher levels of impact, mechanical load and thermal stress. Heat-strengthening adds strength to the glass while limiting the change in its breakage characteristics. Tempered glass is stronger than heat-strengthened glass and significantly reduces the broken piece sizes to meet the safety glazing standards.

Description

Glass is heat-treated by heating annealed glass to a temperature of approximately 1,150°F (621°C), then rapidly cooling it. The glass is cooled by a carefully controlled airflow (also known as quenching), which uniformly cools all glass surfaces simultaneously. High airflow rates produce tempered glass and much lower airflow rates produce heat-strengthened glass.

The cooling process places the surfaces of the glass in a state of high compression and the central core in a state of compensating tension.

Cross-section of the compression and tension zones in tempered glass.
Heat-Treated Glass

**Fully Tempered Glass**

Fully tempered glass, normally referred to as just “tempered glass,” is approximately four times stronger than annealed glass of the same thickness and configuration. When it is broken, tempered glass fractures into many small pieces, reducing the probability of serious injury compared to annealed glass. Tempered glass meets all safety glazing standards including the federal safety glazing standard, CPSC 16 CFR 1201. Because tempered glass fractures into many small pieces, it tends to vacate the opening when broken, more than heat-strengthened and annealed glass does.

**Heating-Strengthened Glass**

Heat-strengthened glass is approximately twice as strong as annealed glass of similar thickness and configuration. Heat-strengthened glass generally fractures in a manner similar to annealed glass and tends to remain in the opening when broken. It is intended for general glazing where additional strength and/or resistance to mechanical and/or thermal stress are desired. Heat-strengthened glass is NOT a safety-glazing product and therefore should not be used where safety glazing is required.

**Capabilities**

**Glass Options**

Most architectural glass products can be heat-treated. Some patterned glass and decorative glass with a deep surface pattern may not be heat-treatable. Silk-screened and ceramic spandrel glass are always either heat-strengthened or tempered as part of their fabrication process. When spandrel glass is incorporated into insulating glass units, both lites must be heat-treated. Heat-absorbing glasses, such as tints, reflective glasses and some Low-E glass, may require heat treatment to reduce the probability of thermal-stress breakage, especially when used as part of an insulating glass unit.

For a list of available glass products/colors, go to the Glass Options Tab, Section 11C.

For more information on silk-screened, spandrel glass and insulating glass products, go to their respective Product Information tabs.

For monolithic glass performance data, log on to www.oldcastlebe.com and choose GlasSelect™.

**Thickness**

Glass thicknesses from 1/8” through 3/4” can be tempered. Glass thicknesses from 1/8” through 1/4” are commonly heat-strengthened. And 3/8” can be heat-strengthened on a limited and project-specific basis.

**Size**

The minimum and maximum heat-treated glass sizes are restricted by the thickness of the glass and production equipment capabilities. Generally, the minimum size is 12” in width and length, and the maximum width and length are 84” x 144”, respectively. Specific oversize ovens are able to process some glass types up to 98” in width and 200” in length.
Heat-Treated Glass

Applications

Heat-Strengthened
Due to its superior glass retention properties, heat-strengthened glass is the preferred heat-treated glass product for applications where additional strength is needed to meet mechanical loads (wind or snow) or thermal loads caused by certain tinted or coated glasses. Heat-strengthened glass is widely used in laminated glass for additional strength, such as in overhead and sloped glazing. Heat-strengthened glass cannot be used in any safety glazing applications.

Tempered
Tempered glass is used when the strength requirements exceed the capabilities of heat-strengthened glass, and for all safety glazing applications. Tempered glass is commonly used in sliding doors, storm doors, atriums, partitions, windows, storefronts, display cases, bath and shower enclosures and all-glass doors and entrances. Tempered glass should not be installed in areas where it is exposed to temperatures greater than approximately 400°F because it will begin to lose its degree of temper (reverting back to annealed glass).

See the Glass Selector Tab for some typical applications.

Characteristics

Properties Unaffected by Heat-Treating
The color, chemical composition and light transmission characteristics of glass remain unchanged after the heat-treating process. The physical properties of glass, such as the compressive strength, hardness, specific gravity, the softening point, thermal conductivity, solar transmittance, stiffness and expansion coefficient, also remain unchanged.

Deflection
It is important to note that heat-treating does not change the deflection characteristics of glass. In many cases, even though thinner heat-treated glass may be strong enough for a specific application, thicker glass may need to be specified in order to reduce the amount of glass deflection. The project design professional establishes the maximum allowable deflection, as well as the design loads, on a project. Given a specific glass size and the design load, Oldcastle BuildingEnvelope™ can determine if the glass will meet the specified maximum deflection requirement.

Breakage Characteristics
The higher the amount of residual stress in a piece of glass, the smaller the particle size will be when the glass fractures. When annealed glass fractures, the cracks are far apart and the pieces are normally quite large with sharp edges. As a result of the heat-treating process, tempered glass fractures into small particles when broken, thus meeting the safety glazing requirements of the federal safety glazing standard, CPSC 16 CFR 1201, the Canadian safety glazing standard CAN/CGSB-12.1 and the American National Standard, ANSI Z97.1. These safety glazing standards require the ten largest particles of the test specimen to weigh no more than the equivalent weight of 10 SQ IN of glass thickness. The breakage characteristics of heat-strengthened glass can vary within the allowable stress range of the product (3,500 to 7,500 PSI surface compression). Heat-strengthened glass typically fractures into large pieces that are more similar to annealed glass than to tempered glass.

Fabrication
Fabrication work such as cutting, polishing, grinding, drilling, notching, sandblasting, etching or any other process that modifies the glass must be completed prior to heat-treating the glass. ASTM C1048 provides specific limitations and requirements for the size and location of holes and notches. Any fabrication process completed after the glass is heat-treated, such as sandblasting or V-grooving, will reduce the strength of the glass.
Heat-Treated Glass

Characteristics (continued)

Roller Wave Distortion in Heat-Treated Glass
Since the glass is heat-treated in a horizontal oven, it contains waves created by contact with ceramic rolls during the heating process. This waviness, or roller wave distortion, can be detected when viewing reflected images from a distance. To minimize the appearance of roller wave distortion, the glass orientation in the oven becomes critical. When the direction of roller waves is critical, roller waves are typically specified and ordered parallel to the horizontal ( sill) or base dimension.

Flatness
Due to the nature of the heat-treating process, heat-strengthened and tempered glass is not as flat as annealed glass. The deviation for flatness depends on glass thickness, width and length and other factors. ASTM C1048 contains information on the permissible overall bow and warp, and on localized warp.

Strain Pattern
Heat-treated glass may display visible strain patterns, also known as quench marks. These appear as geometric patterns of iridescence or darkish shadows. The strain pattern may appear under certain lighting conditions, particularly in the presence of polarized light. This phenomenon is a result of localized stresses imparted by the rapid air-cooling (quenching) of the heat-treating process. This strain pattern is an inherent characteristic of heat-treated glass and is not considered a defect.

Thermal Shock Resistance
Heat-treated glass will withstand greater thermal shock than the same thickness and configuration of annealed glass. Thermal shock results when a rapid temperature change between the surface and core of the glass occurs. When this temperature differential is of sufficient magnitude, the glass will fracture. To fracture 1/4" (6 mm) annealed glass, the average temperature differential would be approximately 100°F (38°C). To fracture 1/4" (6 mm) heat-strengthened and tempered glass, the average temperature differential would be about 250°F (121°C) and 400°F (204°C), respectively. The resistance to thermal shock also decreases with increased glass thickness.

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

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laminated glass

Sell Sheet

Safety and Burglary-Resistant Glass

Sloped and Overhead Glazing, Skylights and Point-Supported Canopies

Sound Control

Light and Solar Control

ArmorProtect®

ArmorResist®

Hurricane Impact-Resistant Glass

Blast-Resistant Glass

Decorative Laminated Glass

Installation Guidelines
Rhythm City Skybridge
Davenport, Iowa
Architects: Holabird & Root and Neumann Monson, P.C.
Laminated Glass is a multifunctional glazing material that can be used in a variety of applications. It is manufactured by permanently bonding two or more lites of glass with layers of polyvinyl butyral (PVB) interlayer, under heat and pressure, to create a single construction.

### Laminated Glass Applications

*Laminated Glass is used in a wide range of applications including:*

- Sloped/Overhead Glazing
- Museums
- Prisons
- Government Buildings
- Jewelry Stores
- Banks
- Airports
- Schools
- Hospitals
- Hotels
- Interior Partitions
- Office Buildings
- Residential Buildings

---

Resch Center
Greenbay, Wisconsin
Laminated safety glass is a multifunctional glazing material that can be used in applications ranging from residential to commercial installations. All model building codes require that the glass used in certain locations, such as doors, sidelites, overhead glazing, patio doors, tub and shower enclosures and certain other glazed openings, must be safety glass that meets the requirements of the Consumer Products Safety Commission (CPSC) 16 CFR 1201 Safety Standard for Architectural Glazing Materials. Oldcastle BuildingEnvelope™ laminated glass meets these requirements.

When impacted, laminated glass breaks safely and remains an integral part of the opening. The plastic interlayer minimizes splinters and glass fragments, reducing the risk of injury or property damage. In addition, the external envelope of the building is maintained, and therefore boarding up may not be necessary. This is particularly important during natural disasters such as hurricanes, tornadoes and earthquakes, and it is subsequently widely specified for these types of applications. Impulse burglaries can also be resisted by laminated glass because it is difficult to gain access or remove property, even if a puncture is made in the interlayer.

Laminated safety glass is manufactured by permanently bonding two or more lites of clear, tinted, Low-E, patterned, or reflective glass with one more or more layers of polyvinyl butyral (PVB) or ionomer sheets. Assembly takes place in the carefully controlled environment of a clean room, ensuring no contaminants are trapped in the product. Final bonding is achieved in an autoclave under heat and pressure, which creates a single solid construction. The glass can be annealed, heat-strengthened or fully tempered, and the lites can be of equal or unequal thickness. Laminated safety glass can be used as the inboard, outboard or both lites in an insulating glass unit.

By combining tinted glass, reflective coatings, printed ceramic silk-screened patterns and pigmented interlayers, a wide array of laminated glass configurations can be used to meet specific visual, aesthetic, security, performance and code requirements.

### Breakage Behavior of Glazing Materials:

#### Laminated Glass

Meets safety glazing standards because on impact, when the glass breaks, the broken pieces typically remain adhered to the PVB or ionomer interlayer.

#### Annealed Glass

Easily fractures; breakage typically produces long razor-sharp shards; is not a safety glazing material.
Safety and Burglary-Resistant Glass

**Description** (continued)

<table>
<thead>
<tr>
<th>Glass Designation</th>
<th>Construction (Glass-PVB-Glass)</th>
<th>Weight</th>
<th>Test Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>Metric inches</td>
<td>Metric mm</td>
<td>Traditional LBS/FT²</td>
</tr>
<tr>
<td>inches</td>
<td>mm</td>
<td>mm</td>
<td>LBS/FT²</td>
</tr>
<tr>
<td><strong>Traditional</strong></td>
<td><strong>Metric inches</strong></td>
<td><strong>Metric mm</strong></td>
<td><strong>Traditional LBS/FT²</strong></td>
</tr>
<tr>
<td>1/4</td>
<td>5.8</td>
<td>Laminated - 0.015 - Laminated</td>
<td>2.7 - 0.38 - 2.7</td>
</tr>
<tr>
<td>1/4</td>
<td>6.1</td>
<td>Laminated - 0.030 - Laminated</td>
<td>2.7 - 0.76 - 2.7</td>
</tr>
<tr>
<td>1/4</td>
<td>6.4</td>
<td>1/8 - 0.015 - 1/8</td>
<td>3 - 0.38 - 3</td>
</tr>
<tr>
<td>1/4</td>
<td>6.8</td>
<td>1/8 - 0.030 - 1/8</td>
<td>3 - 0.76 - 3</td>
</tr>
<tr>
<td>5/16</td>
<td>7.5</td>
<td>1/8 - 0.060 - 1/8</td>
<td>3 - 1.52 - 3</td>
</tr>
<tr>
<td>5/16</td>
<td>8.2</td>
<td>1/8 - 0.090 - 1/8</td>
<td>3 - 2.28 - 3</td>
</tr>
<tr>
<td>3/8</td>
<td>10.8</td>
<td>3/16 - 0.030 - 3/16</td>
<td>5 - 0.76 - 5</td>
</tr>
<tr>
<td>7/16</td>
<td>11.5</td>
<td>3/16 - 0.060 - 3/16</td>
<td>5 - 1.52 - 5</td>
</tr>
<tr>
<td>7/16</td>
<td>12.2</td>
<td>3/16 - 0.090 - 3/16</td>
<td>5 - 2.28 - 5</td>
</tr>
<tr>
<td>1/2</td>
<td>12.8</td>
<td>1/4 - 0.030 - 1/4</td>
<td>6 - 0.76 - 6</td>
</tr>
<tr>
<td>9/16</td>
<td>13.5</td>
<td>1/4 - 0.060 - 1/4</td>
<td>6 - 1.52 - 6</td>
</tr>
<tr>
<td>13/16</td>
<td>14.2</td>
<td>1/4 - 0.090 - 1/4</td>
<td>6 - 2.28 - 6</td>
</tr>
<tr>
<td>13/16</td>
<td>21.5</td>
<td>3/8 - 0.060 - 3/8</td>
<td>10 - 1.52 - 10</td>
</tr>
<tr>
<td>13/16</td>
<td>22.2</td>
<td>3/8 - 0.090 - 3/8</td>
<td>10 - 2.28 - 10</td>
</tr>
</tbody>
</table>

This table shows data for symmetrical lay-ups. Asymmetrical lay-up, having two different thicknesses of glass, are also available on request.

(1) Applies to CPSC 16 CFR 1201 and CAN/CGSB-12.1. All laminated safety glass also meets ANSI Z97.1.

**Performance**

**Safety**

Laminated safety glass is tested using a taped, leather bag filled with lead shot weighing 100 LBS. A standard size piece of glass is clamped vertically in a frame. The impactor is supported from a wire cable so that it will impact the glass in the center. The ball is lifted to the required height and allowed to swing freely into the glass. Numerous cracks and fissures may occur but no shearing or opening through which a 3-inch diameter sphere may pass freely. All laminated glass with a minimum of 0.015" (0.38 mm) PVB meets the requirements of safety glass as defined by ANSI Z97.1, CPSC 16 CFR 1201, Category I (9 square feet or less) and CAN/CGSB-12.1, Category I. Laminated glass with a PVB or ionomer thickness of 0.030" (0.76 mm) and greater also meets the requirements of CPSC 16 CFR 1201, Category II (over 9 square feet ) and CAN/CGSB-12.1, Category II.

**Burglary**

Thicker PVB and ionomer laminates will also meet the requirements of Underwriters Laboratories, UL 972 Burglary Resisting Glazing Material. This standard uses a 5 LB. steel ball dropped on the glass from various heights to simulate a typical “smash and grab” attack.

**Structural Strength**

Laminated glass strength and deflection are discussed in detail in ASTM E1300 Standard Practice for Determining the Load Resistance of Glass in Buildings. The model building codes contain requirements for wind, snow and dead loads on glass. The applicable state laws and local building codes must be checked to determine minimum glass strength requirements governing each project.
Butt Joint Glazing Systems
Laminated glass supplied by Oldcastle BuildingEnvelope™ can be used for butt joint glazing systems—i.e., systems where the glass is captured in a frame on two edges, and the other two edges butt up against each other with a small space, without use of a frame. Any silicone sealant used at this butt joint can, under certain circumstances, cause a discoloration of the edge of the PVB laminate over time. The extent of this depends on the actual sealant, but it generally does not exceed 1/4". Where possible, especially in internal applications, it is advisable not to use any sealant on the gaps between the glass. If a sealant is used, please check for compatibility with the manufacturer of the sealant. The use of a black sealant often produces a better visual effect. Lonomer laminates will typically perform better in these applications as they are generally stiffer and have improved edge stability (resistance to moisture and chemical attack).

Inspection and Quality
The tolerance and quality standards for these products are detailed in ASTM C1172 Standard Specification for Laminated Architectural Flat Glass—reference to which should be made in any specification.

<table>
<thead>
<tr>
<th>Safety Standard</th>
<th>Category/Class</th>
<th>Weight of Impactor LBS</th>
<th>Height of drop Inches</th>
<th>Energy FT-LBS</th>
<th>Required thickness of PVB, inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSC 16 CFR 1201</td>
<td>I</td>
<td>100</td>
<td>18</td>
<td>150</td>
<td>0.015</td>
</tr>
<tr>
<td>CPSC 16 CFR 1201</td>
<td>II</td>
<td>100</td>
<td>48</td>
<td>400</td>
<td>0.030</td>
</tr>
<tr>
<td>ANSI Z97.1</td>
<td>A</td>
<td>100</td>
<td>48</td>
<td>400</td>
<td>0.030</td>
</tr>
<tr>
<td>ANSI Z97.1</td>
<td>B</td>
<td>100</td>
<td>18</td>
<td>150</td>
<td>0.015</td>
</tr>
<tr>
<td>ANSI Z97.1</td>
<td>C</td>
<td>100</td>
<td>12</td>
<td>100</td>
<td>0.015</td>
</tr>
<tr>
<td>CAN/CGSB-12.1</td>
<td>I</td>
<td>100</td>
<td>18</td>
<td>150</td>
<td>0.015</td>
</tr>
<tr>
<td>CAN/CGSB-12.1</td>
<td>II</td>
<td>100</td>
<td>48</td>
<td>400</td>
<td>0.030</td>
</tr>
</tbody>
</table>

**ASTM C1172 Length and Width Tolerance for Rectangular Shapes of Symmetrically Laminated Glass**

<table>
<thead>
<tr>
<th>Laminate Thickness Designation, t inches (mm)</th>
<th>Transparent Glass inches (mm)</th>
<th>Patterned and wired glass inches (mm)</th>
<th>Heat-Strengthened and Tempered Glass inches (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 (6.4) ≤ t ≤ 1/2 (12.7)</td>
<td>+5/32 (4.0) - 1/16 (1.6)</td>
<td>+5/16 (7.9) - 1/8 (3.2)</td>
<td>+7/32 (5.6) - 3/32 (2.4)</td>
</tr>
<tr>
<td>1/4 (6.4) &lt; t ≤ 1/2 (12.7)</td>
<td>+1/4 (6.4) - 1/16 (1.6)</td>
<td>+5/16 (7.9) - 1/8 (3.2)</td>
<td>+1/4 (6.4) - 1/8 (3.2)</td>
</tr>
<tr>
<td>1/2 (12.7) &lt; t ≤ 1 (25.4)</td>
<td>-1/4 (6.4) - 1/8 (3.2)</td>
<td>+5/16 (7.9) - 1/8 (3.2)</td>
<td>-5/16 (7.9) - 1/8 (3.2)</td>
</tr>
</tbody>
</table>

Note: The length and width is measured from edge to edge and includes any flares, mismatch or offset.
Safety and Burglary-Resistant Glass

Performance (continued)

ASTM C1172—Maximum Allowable Laminating Process Blemishes: inches (mm)

<table>
<thead>
<tr>
<th>Blemish</th>
<th>Up to 25 FT² (2.5 m²)</th>
<th>25-75 FT² (2.5-7.0 m²)</th>
<th>Over 75 FT² (7.0 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boil (bubbles)</td>
<td>1/16 (1.6)</td>
<td>1/8 (3.2)</td>
<td>1/4 (6.4)</td>
</tr>
<tr>
<td>Blow-in; edge bul</td>
<td>B CE 1/4 (6.4) EE 3/32 (0.8)</td>
<td>B CE 1/4 (6.4) EE 1/16 (0.8)</td>
<td>B CE 5/16 (8.0) EE 3/32 (2.4)</td>
</tr>
<tr>
<td>Fuse</td>
<td>1/32 (0.8)</td>
<td>1/16 (1.6)</td>
<td>3/32 (2.4)</td>
</tr>
<tr>
<td>Hair, lint (single strand)</td>
<td>light intensity</td>
<td>light intensity</td>
<td>light intensity</td>
</tr>
<tr>
<td>Inside dirt (dirt spot)</td>
<td>1/16 (1.6)</td>
<td>3/32 (2.4)</td>
<td>3/32 (2.4)</td>
</tr>
<tr>
<td>Lint areas of concentrated lint</td>
<td>light intensity</td>
<td>light intensity</td>
<td>light intensity</td>
</tr>
<tr>
<td>Separation, discoloration</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Short Interlayer; un laminated area chip</td>
<td>B CE 1/4 (6.4) EE 1/16 (0.8)</td>
<td>B CE 1/4 (6.4) EE 3/32 (2.4)</td>
<td>B CE 1/4 (6.4) EE 1/4 (6.4)</td>
</tr>
<tr>
<td>Interlayer scuff;</td>
<td>light intensity</td>
<td>light intensity</td>
<td>light intensity</td>
</tr>
</tbody>
</table>

A - The central area is an area, formed by an oval or circle, whose axis, when centered, does not exceed 80% of the overall dimension. The outer area is the area outside the central area. B - not applicable; CE—covered edge of glass edge bite; EE—exposed edge (if CE or EE is unknown, use CE tolerance. Light intensity—barely noticeable at 36 inches (914.4 mm); medium intensity—noticeable at 36 inches (914.4 mm) but not at 11 feet (3352.8 mm). All imperfections noted should be separated by a minimum of 12 inches (305 mm).

Special Applications

Oldcastle BuildingEnvelope™ regularly supplies laminated glass for special applications such as swimming pools and aquariums, zoo enclosures, glass floors and stairs, balustrades and handrails. These applications all have structural loading conditions very different from those for conventional architectural glass and therefore require careful consideration. To date, there are no national consensus standards for these applications.

Typically, the loading is of a longer-term duration than for wind load. The key issue related to the selection of the appropriate glass types and thicknesses for these applications is limiting the maximum stress in the glass in order to keep the probability of breakage to a very low level. Often, failure of this type of glass constitutes a life safety issue. Where total failure of the glazing is unacceptable, multiple lite laminated glass should be used and designed so that a breakage of one lite will not result in total failure. The remaining lites must be designed to provide reasonable assurance that they will withstand the load for a limited period of time until the unit can be replaced.

Determining the risk of failure and deciding on the appropriate design of the glazing are the responsibility of the design professional, so reference should always be made to an engineer with experience in these types of glass design.
Safety and Burglary-Resistant Glass

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

For specifications on other laminated glass make-ups, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com and click on “Project Assistance” and enter your request.

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Sloped and Overhead Glazing, Skylights and Point-Supported Canopies

**Introduction**

Glass which slopes more than 15° from the vertical is considered sloped glazing by the major model building codes. Laminated glass is the preferred product for sloped and overhead glazing, because the glass is retained in the opening, even when broken, reducing the possibility of injury from falling glass. Costly and unsightly screens are therefore not required. Laminated products are widely used in malls and in atriums in hotels and offices.

**Description**

Laminated glass for use in sloped and overhead glazing can be used monolithically or fabricated into insulating glass units. Insulating glass units typically consist of an outboard lite of heat-strengthened glass that resists accidental damage caused by falling objects and an inboard laminated glass that captures any fragments. Tempered glass is not normally recommended for the outboard lite as small broken particles can easily slide down the outside of the roof and onto the ground in the event of accidental damage. Tempered glass is also not desirable for the laminated lite because of the “wet blanket” effect. Pointed supported applications are the exception and must be fully tempered.

This type of laminated glass often incorporates heat-strengthened or tempered glass to meet the structural performance requirement, so that heavy snow loads and high wind loads can be accommodated. In addition, when tinted, Low-E, or reflective glass is used to control the solar heat gain, it is usually necessary to use heat-strengthened glass to avoid the possibility of thermal breakage. When heat-strengthened or tempered glass is used in a laminated glass, the recommended minimum interlayer thickness is generally 0.060” (1.52 mm).

**Capabilities**

Oldcastle BuildingEnvelope™ can calculate the most suitable glass for use in any given application. However, it is the responsibility of the design professional to calculate and provide the equivalent design load. This calculation must take into account the correct combination of snow load (if applicable), wind load, anticipated human live load, and dead load. Without the equivalent design load Oldcastle BuildingEnvelope™ must rely on the conservative limits recommended by the American Architectural Manufacturers Association (AAMA) for four-side uniform support.
Sloped and Overhead Glazing, Skylights and Point-Supported Canopies

Capabilities (continued)

AAMA Guidelines for Overhead Glazing

<table>
<thead>
<tr>
<th>Designation in inches</th>
<th>Glass Type</th>
<th>Outboard Lite in inches</th>
<th>Inboard Construction Glass-PVB-Glass in inches</th>
<th>Air Space in inches</th>
<th>Maximum Size in SQ FT</th>
<th>Weight LBS/FT²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>Annealed</td>
<td></td>
<td>1/8 - 0.030 - 1/8</td>
<td>1/8 - 0.030 - 1/8</td>
<td>12</td>
<td>3.42</td>
</tr>
<tr>
<td>3/8</td>
<td>Annealed</td>
<td></td>
<td>3/16 - 0.030 - 3/16</td>
<td>3/16 - 0.030 - 3/16</td>
<td>18</td>
<td>5.05</td>
</tr>
<tr>
<td>1/2</td>
<td>Annealed</td>
<td></td>
<td>1/4 - 0.030 - 1/4</td>
<td>1/4 - 0.030 - 1/4</td>
<td>24</td>
<td>6.67</td>
</tr>
<tr>
<td>5/16</td>
<td>Heat-strengthened</td>
<td></td>
<td>1/8 - 0.060 - 1/8</td>
<td>1/8 - 0.060 - 1/8</td>
<td>25</td>
<td>3.58</td>
</tr>
<tr>
<td>7/16</td>
<td>Heat-strengthened</td>
<td></td>
<td>3/16 - 0.060 - 3/16</td>
<td>3/16 - 0.060 - 3/16</td>
<td>40</td>
<td>5.21</td>
</tr>
<tr>
<td>9/16(1)</td>
<td>Heat-strengthened</td>
<td></td>
<td>1/4 - 0.060 - 1/4</td>
<td>1/4 - 0.060 - 1/4</td>
<td>40</td>
<td>6.83</td>
</tr>
<tr>
<td>13/16(1)</td>
<td>Heat-strengthened</td>
<td></td>
<td>3/8 - 0.060 - 3/8</td>
<td>3/8 - 0.060 - 3/8</td>
<td>40</td>
<td>10.09</td>
</tr>
<tr>
<td>1 1/16(1)</td>
<td>Heat-strengthened</td>
<td></td>
<td>1/2 - 0.060 - 1/2</td>
<td>1/2 - 0.060 - 1/2</td>
<td>40</td>
<td>13.33</td>
</tr>
<tr>
<td>7/8</td>
<td>Annealed</td>
<td>1/8</td>
<td>1/8 - 0.030 - 1/8</td>
<td>1/8 - 0.030 - 1/8</td>
<td>12</td>
<td>5.05</td>
</tr>
<tr>
<td>1 1/16</td>
<td>Annealed</td>
<td>3/16</td>
<td>3/16 - 0.030 - 3/16</td>
<td>3/16 - 0.030 - 3/16</td>
<td>18</td>
<td>6.67</td>
</tr>
<tr>
<td>1 1/4</td>
<td>Annealed</td>
<td>1/4</td>
<td>1/4 - 0.030 - 1/4</td>
<td>1/4 - 0.030 - 1/4</td>
<td>24</td>
<td>8.29</td>
</tr>
<tr>
<td>7/8</td>
<td>Heat-strengthened</td>
<td>1/8</td>
<td>1/8 - 0.060 - 1/8</td>
<td>1/8 - 0.060 - 1/8</td>
<td>25</td>
<td>5.21</td>
</tr>
<tr>
<td>1 1/8</td>
<td>Heat-strengthened</td>
<td>3/16</td>
<td>3/16 - 0.060 - 3/16</td>
<td>3/16 - 0.060 - 3/16</td>
<td>40</td>
<td>6.83</td>
</tr>
<tr>
<td>1 5/16</td>
<td>Heat-strengthened</td>
<td>1/4</td>
<td>1/4 - 0.060 - 1/4</td>
<td>1/4 - 0.060 - 1/4</td>
<td>40</td>
<td>8.45</td>
</tr>
</tbody>
</table>

These are conservative designs assuming the glass is horizontal with maximum snow load. Detailed engineering design particularly on sloped glazing can often increase the maximum allowable size.

(1) These products are recommended for point-supported canopies.

Point-Supported Canopies

Point-supported canopies are commonly used as features at entrances to offices, stores and residential properties. They are defined as overhead glazing where the glass is supported by fasteners that pass through holes in the glass and that cannot be offered in annealed glass due to high stresses. The support structure can be either above or below the glass. This type of design is specifically excluded from ASTM E1300 Standard Practice for Determining the Load Resistance of Glass in Buildings and needs careful, specific engineering design.

Oldcastle BuildingEnvelope™ regularly supplies this type of glass but insists that a thorough engineering design should be completed. Oldcastle BuildingEnvelope™ offers the following design guidelines for point-supported glass:

1. The glass in these applications is typically designed as a non-enclosed structure as the wind load acts both as an uplift on the upper surface and a pressure on the lower surface. Adding this wind load to the snow load and dead load can result in very large loads.
Sloped and Overhead Glazing, Skylights and Point-Supported Canopies

Capabilities (continued)

2. The maximum stress on point-supported canopies may not be at the point of maximum bending moment. The holes and fasteners often create large local stresses that must be accounted for. Fasteners must therefore have a flexible capability so that local loads do not develop as a result of deflections.

3. Deflection is often the limiting design criterion on these types of applications. If one is designing for strength, a safety factor of 5 should be used.

4. It is extremely important that the holes are sized to give adequate clearance from fasteners. It is common in laminated glass to experience a small amount of slippage between the two lites, and therefore extra clearance is often used to avoid any problems.

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

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Sound Control

Introduction

Shielding a building’s environment from increasing noise levels, especially near airports and busy highways, is a critical factor in the specification of glazing materials for both new and renovated structures. Laminated glass is a proven, effective solution for acoustical protection.

Description

Sound Pressure is measured in decibels (dB) and has a logarithmic scale. A difference of 10dB indicates a difference of 10 times the sound pressure level. A difference of 20dB indicates a 100 times difference in sound pressure level. As a rule of thumb, the sound pressure level drops by about 6dB every time the distance is doubled. The sound transmission class (STC) is the common measure by which acoustical performance is rated. It is a weighted average over the frequency range 100 to 5,000 Hz of the STL (Sound Transmission Loss). The higher the STC rating, the more able the material is to resist the transmission of sound. The ASTM E90 Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements describes a standard test method for measuring the Sound Transmission Loss for building components. The ASTM E413 Standard Classification for Rating Sound Insulation describes the method by which the STC is calculated.

In addition to STC, there are several other methods of determining a weighted average. The ASTM E1332 Standard Classification for Determination of Outdoor-Indoor Transmission Class (OITC) is used for external building components. In Europe the ISO 140-3 Acoustics Measurement of Sound Insulation in Buildings and of Building Elements defines a weighted average, Rw. Each of these classifications gives slightly different classification numbers. It is important that an acoustic consultant be retained to determine the exact requirements.

Sound sources vary in the range of wavelengths. Airports, for example, generate noise in both the low and high-frequency range, whereas other sources of unwanted noise may generate noise only in one frequency range. In these cases, using the single-number STC, OITC or Rw rating may not be adequate. The acoustics engineer in these cases will need to know the attenuation at each 1/3 octave band frequency, as shown in the following tables.

The greatest sound transmittance occurs at different wavelengths for each different thickness of glass, because each has a different mass. Combining different thicknesses of glass, either in an IG unit or a laminated glass makeup, can significantly improve performance. The shear damping characteristics of PVB that are used in laminated glass further reduce the sound transmission. Laminated glass can reduce the perceived noise level by nearly 50% at certain frequencies.

It is very important that suitable windows or frames be used. They must be well made and have a mass capable of dampening sound transmission. Operable windows must have good seals; otherwise, the window will “leak” sound. All joints must be sealed, and the space between the opening and the window must also be filled with a suitable sealant during installation.
Sound Control

Description (continued)

Typical Improvement in Sound Attenuation when using Laminated Glass

(1) Sound Transmission Loss Measurement performed at Riverbank Acoustical Laboratories.
## Sound Control

### Laminated Glass: Sound Transmission Loss Data

Laminated Glass: Sound Transmission Loss Data

| 1/3 Octaveband (Hz) | 100  | 125  | 160  | 200  | 250  | 315  | 400  | 500  | 630  | 800  | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 | 4000 | 5000 | STC | OITC | Rw |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|    |      |    |
| 1/4" Lam-0.030"-Lam RAL-TL85-215 | 24   | 26   | 27   | 27   | 28   | 29   | 30   | 31   | 32   | 34   | 35   | 35   | 35   | 35   | 36   | 35   | 36   | 35   | 39   | 43   | 46   | 35   | 31   | 35   |
| 1/4"-0.030"-1/8" RAL-TL85-170  | 25   | 26   | 28   | 27   | 29   | 30   | 32   | 34   | 35   | 35   | 36   | 35   | 35   | 35   | 36   | 35   | 35   | 35   | 38   | 43   | 46   | 35   | 31   | 35   |
| 1/8"-0.060"-1/16" RAL-TL85-172  | 33   | 35   | 37   | 36   | 37   | 38   | 39   | 40   | 41   | 43   | 45   | 46   | 46   | 46   | 48   | 49   | 51   | 36   | 40   | 44   | 44   | 36   | 33   | 36   |
| 3/16"-0.030"-3/16" RAL-TL85-200 | 27   | 27   | 30   | 31   | 31   | 33   | 34   | 35   | 36   | 35   | 34   | 37   | 41   | 45   | 49   | 52   | 36   | 33   | 36   |      |      |      |      |
| 1/4"-0.030"-1/16" RAL-TL85-229  | 27   | 27   | 30   | 31   | 31   | 33   | 34   | 35   | 36   | 36   | 35   | 36   | 37   | 36   | 37   | 37   | 37   | 36   | 41   | 44   | 44   | 36   | 33   | 36   |
| 1/4"-0.060"-1/16" RAL-TL85-233  | 25   | 27   | 30   | 31   | 31   | 33   | 34   | 35   | 36   | 36   | 35   | 36   | 37   | 37   | 37   | 37   | 37   | 36   | 41   | 44   | 44   | 36   | 33   | 36   |
| 1/4"-0.030"-1/16" RAL-TL85-225  | 25   | 27   | 30   | 31   | 31   | 33   | 34   | 35   | 36   | 36   | 35   | 36   | 37   | 37   | 37   | 37   | 37   | 36   | 41   | 44   | 44   | 36   | 33   | 36   |
| 1/4"-0.060"-1/16" RAL-TL85-232  | 26   | 27   | 30   | 31   | 31   | 33   | 34   | 35   | 36   | 36   | 35   | 36   | 37   | 37   | 37   | 37   | 37   | 36   | 41   | 44   | 44   | 36   | 33   | 36   |
| 1/4"-0.030"-1/16" RAL-TL85-228  | 29   | 30   | 32   | 34   | 35   | 35   | 36   | 38   | 38   | 36   | 38   | 36   | 38   | 42   | 46   | 49   | 52   | 55   | 57   |      |      |      |      |
| 1/2"-0.060"-1/4" RAL-TL85-230  | 29   | 30   | 32   | 35   | 35   | 37   | 38   | 38   | 37   | 37   | 41   | 44   | 48   | 48   | 50   | 53   | 56   | 56   | 41   | 38   | 41   | 36   | 36   | 41   |

### Insulating Glass: Sound Transmission Loss Data

Insulating Glass: Sound Transmission Loss Data

| 1/3 Octaveband (Hz) | 100  | 125  | 160  | 200  | 250  | 315  | 400  | 500  | 630  | 800  | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 | 4000 | 5000 | STC | OITC | Rw |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|    |      |    |
| 1/8"-1/4"AS-0.060-1/8" (SEALED) RAL-TL85-212 | 26   | 21   | 23   | 23   | 26   | 21   | 19   | 24   | 27   | 30   | 33   | 36   | 40   | 44   | 46   | 39   | 46   | 39   | 45   | 44   | 49   | 48   | 36   | 32   |
| 1/4"-1/2"AS-1/4" (SEALED) RAL-TL85-204 | 29   | 22   | 26   | 18   | 25   | 25   | 31   | 32   | 34   | 36   | 39   | 40   | 39   | 36   | 46   | 52   | 58   | 35   | 28   | 35   |      |      |
| 3/16"-1/4"AS-3/16" (SEALED) RAL-TL85-215 | 20   | 25   | 18   | 17   | 26   | 28   | 33   | 36   | 38   | 39   | 41   | 44   | 46   | 43   | 43   | 40   | 48   | 51   | 35   | 27   | 37   |      |      |
| 1/4"-1/4"AS-1/4" (UNSEALED) RAL-TL85-203 | 22   | 19   | 27   | 23   | 31   | 30   | 35   | 36   | 39   | 41   | 42   | 41   | 36   | 37   | 46   | 51   | 56   | 37   | 30   | 37   |      |      |
| 3/16"-4/4"AS-3/16" (UNSEALED) RAL-TL85-216 | 24   | 28   | 30   | 33   | 30   | 38   | 38   | 44   | 46   | 50   | 50   | 50   | 51   | 49   | 41   | 42   | 50   | 52   | 44   | 35   | 44   |      |      |

1. The data here is based on samples tested at Riverbank Acoustical Laboratories in accordance with ASTM E90-97, ASTM E413-87 and ASTM E1332-90 and are not guaranteed for all samples or applications.
2. See important note on page 14.
### Sound Control

#### Capabilities (continued)

**Laminated Insulating Glass: Sound Transmission Loss Data**

| 1/3 Octaveband (Hz) | 100 | 125 | 160 | 200 | 315 | 400 | 500 | 630 | 800 | 1000 | 1250 | 1600 | 2000 | 2500 | 3150 | 4000 | 5000 | STC | OITC | Rw |
|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|-----|-----|-----|
| 1/4" Lam-1/4" AS-1/8" (SEALED RAL-TL05-296) | 32 | 31 | 30 | 28 | 27 | 24 | 26 | 28 | 31 | 34 | 37 | 39 | 41 | 43 | 49 | 52 | 51 | 57 | 35 | 31 | 35 |
| 1/4" Lam-3/8" AS-3/16" (SEALED RAL-TL05-190) | 27 | 27 | 26 | 24 | 22 | 28 | 35 | 38 | 39 | 40 | 42 | 43 | 45 | 41 | 45 | 52 | 57 | 37 | 31 | 37 |
| 1/4" Lam-1/2" AS-3/16" (SEALED RAL-TL05-236) | 26 | 23 | 25 | 23 | 27 | 31 | 34 | 36 | 38 | 39 | 41 | 43 | 45 | 46 | 43 | 49 | 55 | 51 | 39 | 31 | 39 |
| 1/4" Lam-1/2" AS-1/4" (SEALED RAL-TL05-235) | 28 | 20 | 29 | 24 | 26 | 30 | 34 | 36 | 39 | 42 | 43 | 44 | 44 | 41 | 40 | 47 | 52 | 56 | 39 | 31 | 39 |
| 3/8" Lam-1/2" AS-1/4" (SEALED RAL-TL05-192) | 28 | 17 | 28 | 29 | 33 | 34 | 38 | 40 | 40 | 41 | 41 | 41 | 41 | 40 | 43 | 49 | 54 | 58 | 40 | 31 | 40 |
| 1/4" Lam-1" AS-3/16" (UNSEALED RAL-TL05-239) | 22 | 27 | 27 | 28 | 31 | 35 | 38 | 41 | 42 | 43 | 44 | 45 | 47 | 47 | 45 | 50 | 58 | 61 | 42 | 33 | 42 |
| 1/4" Lam-2" AS-3/16" (UNSEALED RAL-TL05-173) | 24 | 25 | 34 | 33 | 34 | 40 | 41 | 44 | 44 | 46 | 47 | 47 | 48 | 48 | 46 | 50 | 55 | 56 | 45 | 35 | 45 |
| 1/2" Lam-2" AS-3/16" (UNSEALED RAL-TL05-194) | 27 | 36 | 33 | 33 | 35 | 39 | 41 | 45 | 45 | 46 | 46 | 46 | 49 | 51 | 52 | 56 | 60 | 62 | 46 | 38 | 46 |
| 1/2" Lam-2" AS-3/8" (UNSEALED RAL-TL05-196) | 34 | 37 | 33 | 38 | 40 | 42 | 44 | 48 | 47 | 46 | 45 | 42 | 46 | 51 | 55 | 59 | 61 | 62 | 46 | 42 | 47 |
| 1/2" Lam-1" AS-3/16" (UNSEALED RAL-TL05-239) | 24 | 30 | 32 | 32 | 36 | 39 | 42 | 45 | 47 | 50 | 51 | 50 | 53 | 57 | 57 | 60 | 62 | 63 | 47 | 36 | 47 |
| 1/4" Lam-4" AS-3/16" (UNSEALED RAL-TL05-194) | 26 | 36 | 34 | 37 | 43 | 44 | 44 | 48 | 49 | 51 | 51 | 50 | 51 | 50 | 47 | 51 | 58 | 60 | 48 | 39 | 48 |
| 1/2" Lam-4" AS-3/16" (UNSEALED RAL-TL05-195) | 30 | 37 | 33 | 38 | 37 | 42 | 45 | 49 | 50 | 51 | 50 | 48 | 50 | 53 | 53 | 57 | 61 | 64 | 49 | 41 | 49 |
| 1/2" Lam-4" AS-3/8" (UNSEALED RAL-TL05-197) | 38 | 38 | 33 | 40 | 40 | 43 | 46 | 51 | 52 | 52 | 50 | 45 | 48 | 53 | 56 | 59 | 62 | 64 | 49 | 44 | 50 |
| 3/4" Lam-4" AS-1/8" (UNSEALED RAL-TL05-240) | 29 | 33 | 31 | 36 | 38 | 43 | 44 | 46 | 47 | 49 | 50 | 52 | 52 | 55 | 59 | 59 | 58 | 60 | 40 | 40 | 40 |

(1) The data here is based on samples tested at Riverbank Acoustical Laboratories in accordance with ASTM E90-97, ASTM E413-87 and ASTM E1332-90 and are not guaranteed for all samples or applications.

(2) Airspace

**Note:** The numbers contained in the above tables should be used as a guide and treated as glass only numbers. They may not be indicative of performance in the intended fenestration system. Variables such as an infiltration, size, temperature and glazing methods may have adverse affects on the performance of the entire system. Whenever possible, actual installation practices should be utilized on a mock-up panel to ensure accurate rating of the desired acoustical fenestration products.
### Double-Laminated Insulating Glass: Sound Transmission Loss Data

<table>
<thead>
<tr>
<th>1/3 Octaveband (Hz)</th>
<th>100</th>
<th>125</th>
<th>160</th>
<th>200</th>
<th>250</th>
<th>315</th>
<th>400</th>
<th>500</th>
<th>630</th>
<th>800</th>
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<th>1600</th>
<th>2000</th>
<th>2500</th>
<th>3150</th>
<th>4000</th>
<th>5000</th>
<th>STC</th>
<th>OITC</th>
<th>Rw</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4&quot; Lam 1/2&quot; AS-1/4&quot; Lam</td>
<td>26</td>
<td>21</td>
<td>29</td>
<td>28</td>
<td>30</td>
<td>34</td>
<td>36</td>
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<td>52</td>
<td>57</td>
<td>58</td>
<td>42</td>
<td>33</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>1/4&quot; Lam 1/4&quot; AS-1/4&quot; Lam</td>
<td>28</td>
<td>28</td>
<td>36</td>
<td>32</td>
<td>34</td>
<td>37</td>
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<td>46</td>
<td>37</td>
<td>46</td>
</tr>
<tr>
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<td>28</td>
<td>33</td>
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<td>46</td>
<td>34</td>
<td>46</td>
<td></td>
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<td>42</td>
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<td>40</td>
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<td>42</td>
<td>50</td>
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<td>31</td>
<td>39</td>
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<td>41</td>
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<td>42</td>
<td>50</td>
</tr>
<tr>
<td>1/4&quot;-1/8&quot;-1/2&quot; AS-1/4&quot; Lam</td>
<td>34</td>
<td>38</td>
<td>34</td>
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<td>44</td>
<td>51</td>
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<td>37</td>
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<td>38</td>
<td>51</td>
</tr>
<tr>
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<td>34</td>
<td>42</td>
<td>40</td>
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<td>42</td>
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### Triple Insulating Glass: Sound Transmission Loss Data

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<th>200</th>
<th>250</th>
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<th>5000</th>
<th>STC</th>
<th>OITC</th>
<th>Rw</th>
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</thead>
<tbody>
<tr>
<td>1/4&quot;-1/2&quot; Lam 1/4&quot; AS-1/4&quot; Lam</td>
<td>25</td>
<td>22</td>
<td>29</td>
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<td>52</td>
<td>58</td>
<td>39</td>
<td>31</td>
<td>39</td>
</tr>
<tr>
<td>1/4&quot;-1/2&quot; Lam 1/2&quot; AS-1/4&quot; Lam</td>
<td>22</td>
<td>24</td>
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<td>33</td>
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<td>55</td>
<td>44</td>
<td>33</td>
<td>44</td>
</tr>
<tr>
<td>1/4&quot;-1/2&quot; Lam 1/4&quot; AS-1/4&quot; Lam</td>
<td>28</td>
<td>34</td>
<td>33</td>
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<td>63</td>
<td>46</td>
<td>37</td>
<td>47</td>
</tr>
<tr>
<td>1/4&quot;-1/4&quot; AS-1/4&quot; Lam</td>
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<td>28</td>
<td>38</td>
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(1) The data here is based on samples tested at Riverbank Acoustical Laboratories in accordance with ASTM E90-97, ASTM E413-87 and ASTM E1332-90 and are not guaranteed for all samples or applications.

(2) Airspace

**Note:** The numbers contained in the above tables should be used as a guide and treated as glass only numbers. They may not be indicative of performance in the intended fenestration system. Variables such as air infiltration, size, temperature and glazing methods may have adverse effects on the performance of the entire system. Whenever possible, actual installation practices should be utilized on a mock-up panel to ensure accurate rating of the desired acoustical fenestration products.
Sound Control

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

For specifications on other laminated glass make-ups, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com and click on “Project Assistance” and enter your request.

Contact Us
For any additional information, including details, technical data, specifications, technical assistance and samples, call 1-866-OLDCASTLE (653-2278).

Visit Us on the Web
Log on to www.oldcastlebe.com for project photos, product colors, general inquiries and project assistance.

To view performance data on a wide range of glass make-ups, or to build your own product specification, log on to www.oldcastlebe.com and choose GlasSelect®.
Light and Solar Control

Introduction

Laminated architectural glass may be designed to reduce solar energy transmittance, control glare and screen out ultraviolet (UV) radiation. Transmitted solar energy is reduced by the use of tinted or coated glass, colored interlayers, or combinations of each that absorb part of the solar radiation in the ultraviolet, visible and near-infrared ranges. The absorbed energy is converted to heat, and a large portion is dissipated to the exterior.

Laminated glass can be manufactured using almost all the full range of tinted, reflective and Low-E glasses currently available. In addition, a range of tinted PVB is available. Laminated architectural glass can be combined into insulating glass units for greater thermal performance.

UV Control

Approximately 2% of the total solar radiation comprises ultraviolet light (wavelengths of 290–380 nm). This UV radiation can cause degradation of dyes, pigments and polymers, resulting in decomposition of unprotected plastics and fading of carpets, drapes, art and other interior fixtures. Laminated glass is essentially opaque to UV radiation and is stable over time. Greater than 99% of UV radiation with a wavelength of less than 380 nm is absorbed, even with an 0.030” interlayer.

<table>
<thead>
<tr>
<th>Thickness of Clear Saflex® in 1/4”</th>
<th>No Saflex® 1/4” Clear Glass</th>
<th>0.015” (0.38 mm)</th>
<th>0.030” (0.76 mm)</th>
<th>0.060” (1.52 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% UV energy blocked of total incident energy 290 nm–380 nm wavelengths</td>
<td>29</td>
<td>99</td>
<td>over 99</td>
<td>over 99</td>
</tr>
</tbody>
</table>

Calculation of UV screening performance is based upon integration of transmission curves from 290 nm–380 nm.

Upper lines show 1/4” laminated glass with 0.060”, 0.030” and 0.015” PVB (1.52 mm, 0.76 mm and 0.38 mm). The lower line shows the transmission of 1/4” clear glass.
Light and Solar Control

Introduction (continued)

Damage to interior fabrics and furnishings is caused by a number of factors. These include UV radiation, visible light radiation, oxygen, moisture, elevated temperatures and air pollutants. Not all of these factors can be eliminated; however, minimizing one of the major sources of deterioration helps to significantly slow the process.

The screening of UV radiation has no adverse effect on plant life. This is because the photoreceptors in plants typically absorb radiation in the visible light wavelengths of 450, 660 and 730 nm. Laminated glass does not significantly block transmitted light in these wavelengths.

Thermal Stress

When considering using tinted annealed laminated glass for solar control, it is important to consider thermal stress.

Capabilities

Oldcastle BuildingEnvelope™ offers a full range of laminated products to control light and solar energy. The following table indicates a selection of the performances that can be achieved using clear glass. A complete range of laminated solar control glasses complete with tinted and reflective glass can be found at www.oldcastlebe.com using the GlasSelect® program. For the solar performance for the Vanceva® range of laminated glass products please see page 39.

Color Stability

Extensive testing has been carried out on the hue stability of pigmented PVB interlayers. This testing, which includes natural and accelerated exposure, shows that there is no adverse color shift (yellowing or otherwise). Three-year exposure in Arizona sun showed color shifts below the threshold of normal vision detection.
## Light and Solar Control

**Capabilities**

### Safllex® Laminated Glass Light and Solar Control Characteristics

<table>
<thead>
<tr>
<th>Description, (1)</th>
<th>Clear</th>
<th>StormGlass™</th>
<th>0828 Blue-gray</th>
<th>0855 Light Blue-gray</th>
<th>3609 Dark Neutral Brown</th>
<th>3628 Neutral Medium Brown</th>
<th>3655 Neutral Light Brown</th>
<th>3773 Blue-green</th>
<th>6376 Cool Blue</th>
<th>6428 Medium Bronze</th>
<th>6452 Light Bronze</th>
<th>6544 Gray</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible Light Trans (2)</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>0.015&quot; Clear Safllex®</td>
<td>89</td>
<td>8</td>
<td>74</td>
<td>1.01</td>
<td>0.92</td>
<td>0.79</td>
<td>196</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.030&quot; Clear Safllex®</td>
<td>88</td>
<td>8</td>
<td>72</td>
<td>1.00</td>
<td>0.90</td>
<td>0.78</td>
<td>194</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.045&quot; Clear Safllex®</td>
<td>88</td>
<td>8</td>
<td>70</td>
<td>0.99</td>
<td>0.89</td>
<td>0.77</td>
<td>190</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.060&quot; Clear Safllex®</td>
<td>88</td>
<td>8</td>
<td>71</td>
<td>0.98</td>
<td>0.89</td>
<td>0.77</td>
<td>191</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.090&quot; Clear Safllex®</td>
<td>88</td>
<td>8</td>
<td>68</td>
<td>0.96</td>
<td>0.87</td>
<td>0.76</td>
<td>187</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.100&quot; Clear Safllex® HP</td>
<td>87</td>
<td>9</td>
<td>67</td>
<td>0.95</td>
<td>0.87</td>
<td>0.75</td>
<td>185</td>
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<td></td>
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</tr>
<tr>
<td>0.075&quot; StormGlass™</td>
<td>87</td>
<td>10</td>
<td>71</td>
<td>0.97</td>
<td>0.89</td>
<td>0.77</td>
<td>190</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0828 Blue-gray</td>
<td>30</td>
<td>5</td>
<td>38</td>
<td>1.01</td>
<td>0.64</td>
<td>0.55</td>
<td>140</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0855 Light Blue-gray</td>
<td>52</td>
<td>6</td>
<td>51</td>
<td>1.01</td>
<td>0.74</td>
<td>0.64</td>
<td>160</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3609 Dark Neutral Brown</td>
<td>8</td>
<td>5</td>
<td>15</td>
<td>1.01</td>
<td>0.47</td>
<td>0.40</td>
<td>106</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3628 Neutral Medium Brown</td>
<td>28</td>
<td>5</td>
<td>32</td>
<td>1.01</td>
<td>0.60</td>
<td>0.51</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3655 Neutral Light Brown</td>
<td>55</td>
<td>6</td>
<td>52</td>
<td>1.01</td>
<td>0.75</td>
<td>0.65</td>
<td>162</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3773 Blue-green</td>
<td>72</td>
<td>7</td>
<td>64</td>
<td>1.01</td>
<td>0.84</td>
<td>0.72</td>
<td>180</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6376 Cool Blue</td>
<td>74</td>
<td>7</td>
<td>67</td>
<td>1.01</td>
<td>0.86</td>
<td>0.74</td>
<td>184</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6428 Medium Bronze</td>
<td>28</td>
<td>5</td>
<td>34</td>
<td>1.01</td>
<td>0.61</td>
<td>0.53</td>
<td>135</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6452 Light Bronze</td>
<td>52</td>
<td>6</td>
<td>51</td>
<td>1.01</td>
<td>0.74</td>
<td>0.64</td>
<td>161</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6544 Gray</td>
<td>42</td>
<td>5</td>
<td>47</td>
<td>1.01</td>
<td>0.71</td>
<td>0.61</td>
<td>155</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Information provided by Solutia Inc. The data and information set forth above are based on calculations and are not guaranteed for all samples or applications. All data calculated using Lawrence Berkeley National Laboratory Window 5.2 Product; NFRC/ASHRAE Conditions; center of Glass Values; USD Standard units. Laminates constructed as: 3mm (0.125 inch) Clear glass - [Safllex® Interlayer] - 3mm (0.125 inch) Clear glass. Colored laminate configurations consist of 0.38 mm Safllex® interlayer. All other interlayer thicknesses as designated.


Safllex is a registered trademark of Solutia Inc.
Light and Solar Control

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

For specifications on other laminated glass make-ups, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com and click on “Project Assistance” and enter your request.

Contact Us
For any additional information, including details, technical data, specifications, technical assistance and samples, call 1-866-OLDCASTLE (653-2278).

Visit Us on the Web
Log on to www.oldcastlebe.com for project photos, product colors, general inquiries and project assistance.

To view performance data on a wide range of glass make-ups, or to build your own product specification, log on to www.oldcastlebe.com and choose GlasSelect®.
**Introduction**

**ArmorProtect®** is used where glazing is required to resist penetration for some considerable time, typically measured in minutes rather than seconds. These types of attacks are usually planned, sustained attacks executed by more than one intruder having experience of security glazing and using more than one type of weapon.

When considering these types of attacks, two methods of failure are generally considered. The lesser test is to see when an opening large enough to pass contraband, such as drugs or weapons, is created. The more exacting test is to establish when an opening is created that is large enough for the passage of a whole body.

**Description**

Glass in this product category can be divided into three broad categories.

**ArmorProtect®** burglary and attack-resistant institutional laminates offer improved detention security and provide unobstructed vision while eliminating the confined look of bars and metal screens. Typical applications include penal institutions, detention centers, psychiatric hospitals and police stations. In addition, institutional laminated architectural glass provides increased protection in other high-security locations such as embassies, computer centers and sensitive research centers. These products are multi-ply laminates with three or more layers of glass bonded together with thicker layers of PVB or ionomer. Increasing interlayer thickness yields greater resistance to penetration.

**ArmorProtect® Plus** prolonged attack resistant security glazing laminates contain the toughest plastics available, often containing multiple layers for maximum forced-entry resistance. Typically, these products are used in detention facilities and other secure establishments.

**ArmorProtect® Max** features lightweight laminates with multiple layers of polycarbonate containing no glass and offering prolonged resistance to sustained physical attack. These products also offer ballistic protection.

ArmorProtect® Plus includes a family of multi-ply laminates containing one or more core layers of polycarbonate, often called glass-clad polycarbonates. Polycarbonates offer the strongest available clear plastic and have 250 times the impact strength of glass. Both the inner and outer lites of the laminate are glass, to provide the durability that the polycarbonate alone could not offer. The polycarbonate is laminated to the outer glass lites using an aliphatic urethane interlayer. Both the polycarbonate and urethane are very clear, haze-free plastics that maintain high light transmission, even with thick laminates having multiple layers of polycarbonate and urethane. High visible light transmittance is essential for observing detainees. Composite materials having several thin layers bonded together give a greater attack resistance than one thick layer. The outer glass surfaces add to the durability of heat and light stable glass-clad polycarbonates. The outer glass lites are usually heat-strengthened to provide increased impact resistance against accidental damage during installation and service. Tempered glass should not be used where it is necessary to retain reasonable vision after the glass has been cracked.

Sheets of aliphatic urethane are used to bond the layers of polycarbonate permanently together. The external faces of polycarbonate are protected with a mar-resistant hard coating to provide durability; however, they are not recommended for external use.
Test Procedures
Several test procedures evaluate glazing performance in the medium and maximum security institutional setting. Each one specifies the specimen size and condition, the opening size that constitutes failure, the weapons used and the number of impacts and sequence of attacks using those specified weapons. This section provides only a summary of the various test methods. It is essential that the design professional has a full understanding of the complete test document.

ASTM F1233 Standard Test Method for Security Glazing Materials and Systems (see Table 1).

The H.P. White Laboratories HPW-TP-0500 procedure (replacing the outdated HPW-TP-0100) Transparent Materials for Use in Forced-Entry or Containment Barriers (see Table 2).

The Walker-McGough-Foltz & Lyerla (WMFL) thirty- and sixty-minute “Ballistics and Forced-Entry Test Procedure” (see Table 3).


Oldcastle BuildingEnvelope™ manufactures a comprehensive range of laminated products for Forced-Entry Resistance (see Table 6).

Table 1: ASTM F1233 Main-Force/Forced-Entry Test Sequences

<table>
<thead>
<tr>
<th>Test Implement (Assault)</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
<th>Class V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blunt Impact (Impacts)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sledgehammer (25)</td>
<td>NR (1)</td>
<td>5</td>
<td>10,16</td>
<td>19,22,27</td>
<td>30,33,36,39</td>
</tr>
<tr>
<td>4” pipe/sledge (25)</td>
<td>NR</td>
<td>NR</td>
<td>9</td>
<td>18</td>
<td>29</td>
</tr>
<tr>
<td>Ram (10)</td>
<td>NR</td>
<td>NR</td>
<td>8</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td>Ball peen hammer (10)</td>
<td>1</td>
<td>2</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td><strong>Sharp Tools (Impacts)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ripping bar (10)</td>
<td>NR</td>
<td>7</td>
<td>12</td>
<td>23</td>
<td>NR</td>
</tr>
<tr>
<td>Chisel/hammer (25)</td>
<td>NR</td>
<td>NR</td>
<td>13</td>
<td>25</td>
<td>35,40</td>
</tr>
<tr>
<td>Angle iron/sledge (25)</td>
<td>NR</td>
<td>NR</td>
<td>15</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>1.5” pipe sledge (25)</td>
<td>NR</td>
<td>3</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Fire axe (25)</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>24</td>
<td>32,38</td>
</tr>
<tr>
<td>Wood-splitting maul (25)</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>21</td>
<td>34,41</td>
</tr>
<tr>
<td><strong>Thermal Stress (Minutes)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂ extinguisher (1)</td>
<td>NR</td>
<td>4</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Propane torch (5)</td>
<td>NR</td>
<td>61</td>
<td>112</td>
<td>202</td>
<td>312</td>
</tr>
<tr>
<td><strong>Chemical Deterioration (Amount)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline (0.5 pints)</td>
<td>NR</td>
<td>NR</td>
<td>14</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Acetone (0.5 pints)</td>
<td>NR</td>
<td>NR</td>
<td>26</td>
<td>NR</td>
<td>37</td>
</tr>
<tr>
<td><strong>Total Test Sequences</strong></td>
<td>1</td>
<td>7</td>
<td>16</td>
<td>27</td>
<td>41</td>
</tr>
</tbody>
</table>

(1) NR – Not Required.
### Table 2: H.P. White TP-0500 Ballistics and Forced-Entry Test Procedure

<table>
<thead>
<tr>
<th>Phase I–Ballistics–optional</th>
<th>Level A</th>
<th>Level B</th>
<th>Level C</th>
<th>Level D</th>
<th>Level E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caliber</td>
<td>.38 Special</td>
<td>9 mm</td>
<td>.44 Mag.</td>
<td>7.62 mm, M80</td>
<td>.30-06 AP</td>
</tr>
<tr>
<td>Shots</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

After the sample has successfully resisted one of the optional ballistic threats of the Phase I test, follow numerical sequence (1-54) below.

<table>
<thead>
<tr>
<th>Phase II–Forced-Entry</th>
<th>Level I</th>
<th>Level II</th>
<th>Level III</th>
<th>Level IV</th>
<th>Level V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blunt Impacting (Impacts)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sledgehammer/wedge (25)</td>
<td>1,4</td>
<td>8,10</td>
<td>18,24,26</td>
<td>20,32,39</td>
<td>42,46,48,51,54</td>
</tr>
<tr>
<td>4” dia. pipe/sledge (25)</td>
<td>2</td>
<td>7</td>
<td>17</td>
<td>28</td>
<td>41</td>
</tr>
<tr>
<td>Ram (10)</td>
<td>NA(3)</td>
<td>6</td>
<td>16</td>
<td>27</td>
<td>40</td>
</tr>
</tbody>
</table>

| Sharp Tool (Impacts) |         |          |           |          |         |
| Chisel/hammer (25)    |          |          |           |          |         |
| Angle iron/sledge (25) |        | 12       | 21,23     | 33,36,38 | 47,52   |
| 1-1/2” dia. pipe/sledge (25) | 5       | NA       | NA        | NA       | NA      |
| Fire axe (25)         | NA      | NA       | NA        | NA       | NA      |
| Wood maul (25)        | NA      | 15       | 20        | 31       | 46,53   |
| Keyhole saw (2)       |          |          |           |          |         |
| Hacksaw (2)           |          |          |           |          |         |

| Thermal Stress (Minutes) |         |          |           |          |         |
| Extinguisher, CO₂ (1)   | 3        | 9        | NA        | NA       | NA      |
| Propane burner (5)      | NA      | 11       | 19        | 30       | NA      |
| Acetylene (5)           | NA      | NA       | NA        | NA       | 43      |

| Chemical Deterioration (Amount) |         |          |           |          |         |
| Gasoline (1/2 pint)         | NA      | 14       | NA        | NA       | NA      |
| Windshield washer (1/2 pint) | NA      | NA       | 25        | 34       | NA      |
| Acetone (1/2 pint)          | NA      | NA       | NA        | NA       | 49      |

| Total Forced-Entry Sequences | 5 | 15 | 26 | 39 | 54 |

(1) Pinch or ripping bars may be substituted for any portion of the blunt impacting sequence at the rate of 1 minute for each 5 impacts (test director’s option).
(2) Additional sequences of one-minute intervals in conjunction with all sharp tool sequences except sequences 5 and 15 (see paragraphs 3.5.7 and 3.5.8 of the H.P. White TP-0500 ballistic and forced-entry test procedure).
(3) NA – Not Applicable.

The numbers in this chart indicate the sequence number. For example, to successfully pass Level 1, a glazing must resist 25 impacts from a sledgehammer, followed by 25 impacts from a 4”-diameter pipe, followed by 1 minute of a CO₂ extinguisher, followed by a further 25 impacts from a sledgehammer, followed by 25 impacts from a 1-1/2” pipe—a total of 5 sequences. To successfully pass Level II, the glazing must resist all those sequences of Level 1, followed by all the sequences of Level II detailed in the table—a total of 15 sequences.
Table 3: WMFL Ballistics and Forced-Entry Test Procedure

<table>
<thead>
<tr>
<th>Attack Tools and Sequence of Use</th>
<th>60-Minute Physical Attack</th>
<th>Ballistics and 60-Minute Physical Attack</th>
<th>30-Minute Physical Attack</th>
</tr>
</thead>
<tbody>
<tr>
<td>.44 magnum 240 grain soft point</td>
<td>25 rounds NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Nominal 2 L.B. claw hammer, claw end</td>
<td>5 minutes 5 minutes</td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td>Cold steel chisel or screwdriver hitting end with nominal 2 L.B. hammer</td>
<td>5 minutes 5 minutes</td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td>Nominal 10 L.B. sledgehammer</td>
<td>5 minutes 5 minutes</td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td>1-1/2”-diameter steel pipe, 3 FT. long, or 2” x 2” x 1/4” steel angle, 3 FT. long</td>
<td>5 minutes 5 minutes</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Grade 60, No. 8 rebar, 3 FT. long</td>
<td>5 minutes 5 minutes</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>4” x 4” oak post, 3 FT. long</td>
<td>5 minutes 5 minutes</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Dry chemical fire extinguisher</td>
<td>5 minutes 5 minutes</td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td>Nominal 10 L.B. sledgehammer</td>
<td>5 minutes 5 minutes</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Clothes hanger or knife with 10” long x 1/4” thick cold steel blade, heated during use</td>
<td>5 minutes 5 minutes</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Propane burner with nozzle sized to create approximately a 1”-diameter heat source applied within 4” or less of glass surface</td>
<td>5 minutes 5 minutes</td>
<td>5 minutes</td>
<td></td>
</tr>
<tr>
<td>Nominal 4 L.B. hammer</td>
<td>5 minutes 5 minutes</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>3”-diameter steel pipe, 3 FT. long, or 1” x 1” x 1/4” steel angle, 3 FT. long</td>
<td>5 minutes 5 minutes</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

(1) NA - Not Applicable.
Where more than one weapon is specified in a given 5-minute time period, each weapon was used for approximately equal portions of the time.
Spall is not measured in the ballistic test of WMFL.

TABLE 4: ASTM F1915 Impact Test Criteria: Large Blunt and Sharp Impactors

<table>
<thead>
<tr>
<th>Security Grade</th>
<th>Total Time</th>
<th>1 Blunt Impactor</th>
<th>2 Sharp Impactor</th>
<th>3 Blunt Impactor</th>
<th>Total Number of Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60 min</td>
<td>150</td>
<td>300</td>
<td>150</td>
<td>600</td>
</tr>
<tr>
<td>2</td>
<td>40 min</td>
<td>100</td>
<td>200</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>3</td>
<td>20 min</td>
<td>50</td>
<td>100</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>4</td>
<td>10 min</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

(1) To be performed on both hot and cold conditioned samples.

TABLE 5: ASTM F1915 Impact Test Criteria: Torch and Small Blunt Impactor

<table>
<thead>
<tr>
<th>Security Grade</th>
<th>Blunt Impacts</th>
<th>Security Grade</th>
<th>Blunt Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>150</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>4</td>
<td>50</td>
</tr>
</tbody>
</table>

(1) To be performed on a room temperature sample only.
ArmorProtect® Forced-Entry-Resistant Glass

Capabilities (continued)

Inspection and Installation Guidelines
Tolerances and quality references are detailed in ASTM C1349 Standard Specification for Architectural Flat Glass-Clad Polycarbonate. Most laminated glazing designed for security applications has been engineered to provide extreme performance and therefore contains several layers of glass and plastic lites. Moderate distortion due to the extrusion of the polycarbonate and the heat-treating of the glass lites is unavoidable, especially with thick laminates that provide protection to high test levels. Optical distortion is usually not obtrusive in service and is not a cause for rejection. Holes, notches, pass-throughs, etc., often show greater distortion around these fabricated areas. The correct edge engagement and clearance is very important. (See Installation Guidelines, pages 42-43 for additional information.)

Specifications
For specifications on security laminates, please call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com and click on “Project Assistance” and enter your request.

Table 6: Oldcastle BuildingEnvelope™ Security Laminates for use in Forced-Entry Applications

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Product #</th>
<th>HPW-TP-0500 FE</th>
<th>BR</th>
<th>WMFL</th>
<th>ASTM F1233</th>
<th>ASTM F1915</th>
<th>UL 752</th>
<th>Nominal Thickness inches</th>
<th>Weight LBS/FT²</th>
<th>Max Size inches</th>
<th>Assembly⁽¹⁾</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArmorProtect®</td>
<td>111000</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1/2</td>
<td>5.4</td>
<td>60 x 96</td>
<td>AGL</td>
<td></td>
</tr>
<tr>
<td>ArmorProtect®</td>
<td>112000</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>3/4</td>
<td>7.2</td>
<td>60 x 96</td>
<td>AGL</td>
<td></td>
</tr>
<tr>
<td>ArmorProtect®</td>
<td>113000</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>1</td>
<td>9.1</td>
<td>60 x 96</td>
<td>AGL</td>
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</tr>
<tr>
<td>ArmorProtect® Plus</td>
<td>121000</td>
<td>1</td>
<td>A⁽²⁾</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>7/16</td>
<td>4.6</td>
<td>60 x 96</td>
<td>GCP</td>
</tr>
<tr>
<td>ArmorProtect® Plus</td>
<td>121100</td>
<td>1</td>
<td>A⁽²⁾</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>9/16</td>
<td>5.4</td>
<td>60 x 96</td>
<td>GCP</td>
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<tr>
<td>ArmorProtect® Plus</td>
<td>121200</td>
<td>2</td>
<td>A⁽²⁾</td>
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<td>–</td>
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<td>11/16</td>
<td>6.2</td>
<td>60 x 96</td>
<td>GCP</td>
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<tr>
<td>ArmorProtect® Plus</td>
<td>122000</td>
<td>2</td>
<td>B⁽³⁾</td>
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<td>–</td>
<td>–</td>
<td>13/16</td>
<td>6.4</td>
<td>60 x 96</td>
<td>GCP</td>
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<tr>
<td>ArmorProtect® Plus</td>
<td>123000</td>
<td>3</td>
<td>B⁽³⁾</td>
<td>3</td>
<td>3</td>
<td>–</td>
<td>3/4</td>
<td>6.3</td>
<td>60 x 96</td>
<td>GCP</td>
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<td>7.2</td>
<td>60 x 96</td>
<td>GCP</td>
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<td>B⁽³⁾</td>
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<td>3</td>
<td>2</td>
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<td>–</td>
<td>–</td>
<td>1⁽⁴⁾</td>
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<td>1</td>
<td>1-1/4</td>
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<td>60 x 96</td>
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<tr>
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<td>–</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>3</td>
<td>1-3/8</td>
<td>11.8</td>
<td>60 x 96</td>
<td>GP</td>
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<tr>
<td>ArmorProtect® Max</td>
<td>132000</td>
<td>2-step 14</td>
<td>A</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>3/8</td>
<td>2.5</td>
<td>60 x 96</td>
<td>LPC</td>
<td></td>
</tr>
<tr>
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<td>133000</td>
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<td>A</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1/2</td>
<td>3.4</td>
<td>60 x 96</td>
<td>LPC</td>
<td></td>
</tr>
<tr>
<td>ArmorProtect® Max</td>
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<td>4-step 38</td>
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<td>5.0</td>
<td>60 x 96</td>
<td>LPC</td>
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<tr>
<td>ArmorProtect® Max</td>
<td>135000</td>
<td>5</td>
<td>B</td>
<td>–</td>
<td>–</td>
<td>2</td>
<td>1</td>
<td>6.6</td>
<td>60 x 96</td>
<td>LPC</td>
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<tr>
<td>ArmorProtect® Max</td>
<td>135100</td>
<td>5</td>
<td>C</td>
<td>2</td>
<td>–</td>
<td>3</td>
<td>1-1/4</td>
<td>8.2</td>
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### Capabilities (continued)

#### HP White Test Summary

<table>
<thead>
<tr>
<th>Ballistics</th>
<th>Forces-Entry</th>
<th>HPW-TP-0500</th>
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</thead>
<tbody>
<tr>
<td>Level 1: Steps 1-5</td>
<td>Level A: .38 Special</td>
<td></td>
</tr>
<tr>
<td>Level 2: Steps 1-15</td>
<td>Level B: 9 mm</td>
<td></td>
</tr>
<tr>
<td>Level 3: Steps 1-26</td>
<td>Level C: .44 Magnum</td>
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</tr>
<tr>
<td>Level 4: Steps 1-39</td>
<td>Level D: 7.62 mm</td>
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</tr>
<tr>
<td>Level 5: Steps 1-54</td>
<td>Level E: .30-06 AP</td>
<td></td>
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</tbody>
</table>

#### ASTM F1233 Test Summary

<table>
<thead>
<tr>
<th>Ballistics</th>
<th>Forces-Entry</th>
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</thead>
<tbody>
<tr>
<td>Class 1: Steps 1</td>
<td></td>
</tr>
<tr>
<td>Class 2: Steps 1-7</td>
<td></td>
</tr>
<tr>
<td>Class 3: Steps 1-16</td>
<td></td>
</tr>
<tr>
<td>Class 4: Steps 1-27</td>
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<tr>
<td>Class 5: Steps 1-41</td>
<td></td>
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</table>

#### WMFL Test Summary

<table>
<thead>
<tr>
<th>Ballistics</th>
<th>Forces-Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1: 60 Minutes and 25 rounds .44 Magnum</td>
<td></td>
</tr>
<tr>
<td>Level 2: 60 Minutes</td>
<td></td>
</tr>
<tr>
<td>Level 3: 30 Minutes</td>
<td></td>
</tr>
</tbody>
</table>

---

(1) *GP*—glass-clad polycarbonate with exposed polycarbonate; *GCP*—glass-clad polycarbonate; *LPC*—laminated polycarbonate; *AGL*—all-glass laminate.

(2) These products resisted bullet penetration. They are not designed to resist spalling.

(3) This is not a no-spall ballistics test.
**Introduction**

Laminated glass can be designed to resist attacks by a wide range of weapons. There are many standards and test methods available throughout the world. Almost all of these have two main requirements: (1) the glazing must resist penetration by specified ballistics and (2) the spall or flying shards of glass leaving the rear face, as a result of the impact, cannot exceed the limits of the specified test criteria.

Bullet-resistant laminated glass can typically meet both of these requirements. It is important to note that most ArmorResist® bullet-resistant glazing materials are not classified as forced-entry resistant.

ArmorResist™ laminated glazing products consist of assemblies of several different materials. Figures 1 and 2 show typical compositions.

---

**Description**

Oldcastle BuildingEnvelope™ manufactures two types of bullet-resistant glass to meet the above requirements.

**ArmorResist®** is a multi-ply laminated glass having multiple layers of glass and PVB bonded together into a monolithic unit. The rear most lite of glass is usually a thin glass that allows the glass to meet all the requirements of UL 752. This range of products is the most economical and durable range of bullet-resistant glasses manufactured by Oldcastle BuildingEnvelope™.

**ArmorResist® Plus** is a combination of glass and polycarbonate. PVB and/or a Thermo Plastic Urethane (TPU) is used as the interlayer in this product range. Polycarbonate is one of the toughest clear plastics, having 250 times the impact strength of glass and is used toward the rear of the laminate to flex and absorb the energy of the bullet. The rear face is always exposed polycarbonate with a scratch-resistant coating. ArmorResist® Plus is generally thinner and lighter than the corresponding ArmorResist® product when it is designed to resist the same threat.
ArmorResist: Bullet-Resistant Glass

Description (continued)

Underwriters Laboratories UL 752 Bullet Resisting Equipment is the most well-known standard in the USA. It defines ten levels of attacks ranging from a 9 mm handgun to a 7.62 mm military rifle. This standard defines the type of round, the muzzle velocity and the number of impacts each sample must receive. This standard also details environmental conditioning at high and low temperatures so that this type of glass can be used externally over a wide range of conditions. (See Table 1 below.)

Table 1: UL 752 Ratings of Bullet-Resistant Materials

<table>
<thead>
<tr>
<th>Rating</th>
<th>Ammunition</th>
<th>Projectile Weight</th>
<th>Minimum Velocity(1)</th>
<th>No. of Shots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>9 mm Full Metal, Copper Jacket with Lead Core</td>
<td>124, 8.0</td>
<td>1,175, 358</td>
<td>3</td>
</tr>
<tr>
<td>Level 2</td>
<td>.357 Magnum Jacketed Lead, Soft Point</td>
<td>158, 10.2</td>
<td>1,250, 381</td>
<td>3</td>
</tr>
<tr>
<td>Level 3</td>
<td>.44 Magnum Lead Semi-Wadcutter, Gas Checked</td>
<td>240, 15.6</td>
<td>1,350, 411</td>
<td>3</td>
</tr>
<tr>
<td>Level 4</td>
<td>.30 Caliber Rifle, Lead Core, Soft Point</td>
<td>180, 11.7</td>
<td>2,540, 774</td>
<td>1</td>
</tr>
<tr>
<td>Level 5</td>
<td>7.62 mm Rifle, Lead Core, Full Metal, Copper Jacket, Military Ball</td>
<td>150, 9.7</td>
<td>2,750, 838</td>
<td>1</td>
</tr>
<tr>
<td>Level 6</td>
<td>9 mm Full Metal, Copper Jacket with Lead Core</td>
<td>124, 8.0</td>
<td>1,400, 427</td>
<td>5</td>
</tr>
<tr>
<td>Level 7</td>
<td>.50 mm Rifle, Full Metal, Copper Jacket with Lead Core</td>
<td>55, 3.56</td>
<td>3,080, 939</td>
<td>5</td>
</tr>
<tr>
<td>Level 8</td>
<td>7.62 mm Rifle, Lead Core, Full Metal, Copper Jacket, Military Ball</td>
<td>150, 9.7</td>
<td>2,750, 838</td>
<td>5</td>
</tr>
<tr>
<td>Level 9</td>
<td>.30 Caliber Rifle, Armor Piercing, Steel Core, Lead Point Filler, Full Metal Jacket</td>
<td>166, 10.8</td>
<td>2,715, 828</td>
<td>5</td>
</tr>
<tr>
<td>Level 10</td>
<td>.50 Caliber Rifle, Lead Core, Full Metal, Copper Jacket, Military Ball</td>
<td>710, 45.9</td>
<td>2,810, 856</td>
<td>5</td>
</tr>
<tr>
<td>Supplementary Shotgun</td>
<td>12-Gauge Rifled, Lead Slug, and 12-Gauge 00 Lead Buckshot (12 pellets)</td>
<td>437, 28.3</td>
<td>1,585, 483</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>650, 42</td>
<td>1,200, 366</td>
<td>3</td>
</tr>
</tbody>
</table>

(1) Maximum velocity is 110% of the minimum velocity.
In addition to UL 752, some specifying authorities use the National Institute of Justice standard NIJ 0108.01: Ballistic-Resistant Protective Materials. The test variables are detailed in Table 2 below.

### Table 2: NIJ Standard 0108.01: Ballistic Resistance Test Variables and Requirements

<table>
<thead>
<tr>
<th>Armor Type</th>
<th>Test Variables</th>
<th>Performance Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II-A</td>
<td></td>
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</tr>
<tr>
<td>III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III-A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test Variables**

- **Nominal Bullet Mass**: 2.6g, 10.2g, 8.0g, 10.2g, 8.0g, 15.55g, 8.0g, 9.7g, 10.8g
- **Suggested Barrel Length**: 15 to 16.5cm, 10 to 12 cm, 10 to 12 cm, 15 to 16.5cm, 15 to 16.5cm, 14 to 16cm, 24 to 26cm, 56cm, 56cm
- **Test Bullet Barrel**: Lead, LRHV, RN, Lead, LRHV, FMJ, LRHV, FMJ, FMJ
- **Ammunition**: LRHV, .38 Special, .357 Magnum, 9 mm, .357 Magnum, .38 Special, .357 Magnum, .44 Magnum, 7.62 mm, 30-06 AP

**Performance Requirements**

- **Required Bullet Velocity**: 320±12m/s, 250±15m/s, 381±15m/s, 332±12m/s, 425±15m/s, 358±12m/s, 426±15m/s, 426±15m/s, 838±15m/s, 868±15m/s
- **Required Hits per Armor Specimen**: 5, 5, 5, 5, 5, 5, 5, 5, 5, 1
- **Permitted Penetrations**: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

(2) These items must be specified by the user.*
AmorResist: Bullet-Resistant Glass

Description (continued)

Table 3: Oldcastle BuildingEnvelope™ Security Laminates for Use in Bullet-Resistant Applications

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Product #</th>
<th>UL 752</th>
<th>NIJ</th>
<th>Thickness</th>
<th>Weight</th>
<th>Max Size</th>
<th>Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArmorResist®</td>
<td>211000</td>
<td>1(1)</td>
<td>–</td>
<td>1-3/16</td>
<td>14.7</td>
<td>500 LBS</td>
<td>AGL</td>
</tr>
<tr>
<td>ArmorResist®</td>
<td>211100</td>
<td>1(1)</td>
<td>–</td>
<td>1-5/16</td>
<td>15.5</td>
<td>500 LBS</td>
<td>AGL</td>
</tr>
<tr>
<td>ArmorResist®</td>
<td>212000</td>
<td>2(1)</td>
<td>–</td>
<td>1-1/2</td>
<td>19.3</td>
<td>500 LBS</td>
<td>AGL</td>
</tr>
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<td>ArmorResist®</td>
<td>213000</td>
<td>3(1)</td>
<td>–</td>
<td>2</td>
<td>25.8</td>
<td>500 LBS</td>
<td>AGL</td>
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<td>25.8</td>
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<td>AGL</td>
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<tr>
<td>ArmorResist®</td>
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<td>6(1)</td>
<td>–</td>
<td>2</td>
<td>25.8</td>
<td>500 LBS</td>
<td>AGL</td>
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<td>1-13/16</td>
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<td>AGL</td>
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<td>1-1/2</td>
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<td>AGL</td>
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<td>3A</td>
<td>1-3/4</td>
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<td>500 LBS</td>
<td>AGL</td>
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<td>1.03</td>
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<td>0.93</td>
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<td>60 x 96</td>
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<td>2.27</td>
<td>26.6</td>
<td>60 x 96</td>
<td>GP</td>
</tr>
</tbody>
</table>

UL 752 Test Summary

| Level 1: 9 mm       |
| Level 2: .357 Magnum|
| Level 3: .44 Magnum |
| Level 4: .30-06    |
| Level 5: 7.62 mm    |
| Level 6: 9 mm       |
| Level 7: 5.56 mm    |
| Level 8: 7.62 mm    |
| Level 9: 0.30" AP   |
| Level 10: 0.50" FMJ |

National Institute of Justice: NIJ Standard 0108.01

| Level 1: .38 Special |
| Level 2A: .357 Magnum/9 mm-LV |
| Level 2: .357 Magnum/9 mm-HV |
| Level 3: .44 Magnum/9 mm |
| Level 3: 7.62 mm |
| Level 4: 30-06 |

(1) indicates UL certification and permanent UL logo.
(2) maximum size is limited by the listed weight.
(3) AGL–all-glass laminate; GP–glass-clad polycarbonate with exposed polycarbonate.
(4) indicates UL certification and permanent UL logo - indoor only.
ArmorResist®: Bullet-Resistant Glass

Capabilities

Oldcastle BuildingEnvelope™ manufactures a wide range of bullet-resistant products. (See Table 3 on previous page.)

Bullet-resistant glazing is not necessarily resistant to a sustained physical attack or forced-entry; however, some glazing is designed to be resistant to both forms of attack. Products which have been designed to resist both forced-entry and ballistic attacks are to be found in the Laminated Glass section under Forced-Entry. (See pages 21-26).

Other Considerations

ArmorResist® bullet-resistant glass and ArmorProtect® Plus forced entry products can form part of an insulating glass unit. In the case of ArmorResist®, it is recommended that the bullet-resistant glass be used as the inboard lite of the unit.

Installation

It is most important that bullet-resistant glass be installed in a framework that is also bullet-resistant. It is up to the installer to verify that the total installation resists the specified threat. ArmorResist® is usually nonsymmetrical and has a strike face or impact face that faces the threat.

The opposite face is known as the protected or safe side. Oldcastle BuildingEnvelope™ applies a removable impact face label, which identifies the threat side. This should be left on until final inspection to ensure that the glass has been installed correctly, as it can be difficult to determine this at a later stage. Oldcastle BuildingEnvelope™ does not recommend butt-glazing ArmorResist®, as the bullet can penetrate the small space between the lites. Any speak-hole covers should also be bullet-resistant.

Inspection and Installation Guidelines

Black specks are an inherent, allowable characteristic of the polycarbonate material used in certain Oldcastle BuildingEnvelope™ laminated glass products. Specifications regarding the allowable limits for size are set by industry standards. (See ASTM C1349 for full details.)

The extrusion process of manufacturing polycarbonate material may produce a minor distortion that is noticeable under certain conditions. Holes, notches, pass-throughs, etc., produce greater distortion around these specially fabricated areas. The correct edge engagement and clearance is very important. (See Installation Guidelines, pages 42-43.)

Additional Important Information

Specifications

A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

For specifications on other laminated glass make-ups, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com and click on “Project Assistance” and enter your request.

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Hurricane Impact-Resistant Glass (Windborne Debris)

Introduction

The stringent code requirements of Florida and other coastal regions require that the building envelope be maintained during a hurricane. All elements of the building shell must resist the effects of windborne debris as well as sustained turbulent winds lasting several hours. Extensive research, following Hurricane Andrew in 1992, showed that breach of the envelope led to internal pressurization of the building. This effectively doubled the forces on major structural elements such as walls and roofs, leading to catastrophic failure.

The South Florida Building Code introduced hurricane-impact protection requirements in 1994. To meet these codes in South Florida, the glazing must resist the penetration of either a large missile (a 9 LB wood 2” x 4” traveling at 50 feet per second/33mph) or small missiles (2 gram steel ball bearings traveling at 130 feet per second). These impacts are then followed by 9,000 inward and outward acting pressure cycles.

Other areas of the world are gradually introducing similar codes. The Texas Department of Insurance (TDI) has specified similar testing for property close to the Gulf Coast. The model code of SBCCI, which was used as the basis of the Florida Building Code that was made into law in 2002, includes windborne-debris protection requirements, as does the International Building Code.

Description

The latest national standard is the ASTM E1996 Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes. It defines several other missiles applicable to different wind zones, building types and building heights, while incorporating the requirements of southern Florida. Tables 1 and 2 show the requirements of ASTM E1996, with the southern Florida counties of Broward and Miami-Dade being in Wind Zone 4. Essential facilities are hospitals, evacuation centers and command and control positions, which are required during emergencies. All other building types come under the category of Basic Protection, apart from a few specifically excluded uninhabited buildings such as greenhouses.

Table 1: ASTM E1996 Wind Zones and Missile Types (See Missile Types in Table 2, page 33)

<table>
<thead>
<tr>
<th>System Height</th>
<th>Enhanced Protection (Essential Facilities)</th>
<th>Basic Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 30 FT</td>
<td>&gt; 30 FT</td>
</tr>
<tr>
<td>Wind Zone 1</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>110 - 120 mph + Hawaii</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Zone 2</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>120 - 130 mph more than 1 mile from coast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Zone 3</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>130 - 140 mph or 120 - 140 within 1 mile of coast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind Zone 4</td>
<td>E</td>
<td>D</td>
</tr>
<tr>
<td>&gt; 140 mph (South Florida)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For systems intended to be used 30 feet and higher from ground level, a small missile is used. Following either the small or large missile impact, the specimens are subjected to pressure cycling, as described in Table 3 on the following page. Each cycle takes between one and three seconds, so the complete test can last up to 7-1/2 hours for each specimen. \( P_{\text{min}} \) and \( P_{\text{max}} \) are defined as the design pressures of the system being tested.
Hurricane Impact-Resistant Glass
(Windborne Debris)

Table 2: ASTM E1996–Applicable Missiles

<table>
<thead>
<tr>
<th>Level</th>
<th>Missile</th>
<th>Speed (f/s)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 g ± 5% steel ball</td>
<td>130</td>
<td>Small missile</td>
</tr>
<tr>
<td>B</td>
<td>2 LB ± .25 LB</td>
<td>50</td>
<td>Some residential skylights</td>
</tr>
<tr>
<td>C</td>
<td>4.5 LB ± .25 LB</td>
<td>40</td>
<td>Lower wind zones only</td>
</tr>
<tr>
<td>D</td>
<td>9 LB ± .25 LB</td>
<td>50</td>
<td>Large missile</td>
</tr>
<tr>
<td>E</td>
<td>9 LB ± .25 LB</td>
<td>80</td>
<td>Essential facilities only</td>
</tr>
</tbody>
</table>

Table 3: ASTM E1996–Cyclic Static Air Pressure Loading

<table>
<thead>
<tr>
<th>Loading Sequence</th>
<th>Loading Direction</th>
<th>Air Pressure (P)</th>
<th>Number of Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Positive</td>
<td>0.2 to 0.5 P</td>
<td>3,500</td>
</tr>
<tr>
<td>2</td>
<td>Positive</td>
<td>0.0 to 0.6 P</td>
<td>300</td>
</tr>
<tr>
<td>3</td>
<td>Positive</td>
<td>0.5 to 0.8 P</td>
<td>600</td>
</tr>
<tr>
<td>4</td>
<td>Positive</td>
<td>0.3 to 1.0 P</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>Negative</td>
<td>0.3 to 1.0 P</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>Negative</td>
<td>0.5 to 0.8 P</td>
<td>1,050</td>
</tr>
<tr>
<td>7</td>
<td>Negative</td>
<td>0.0 to 0.6 P</td>
<td>50</td>
</tr>
<tr>
<td>8</td>
<td>Negative</td>
<td>0.2 to 0.5 P</td>
<td>3,350</td>
</tr>
</tbody>
</table>

Testing is carried out on the glazing system. Glass is therefore a component in this system, which includes aluminum, gaskets, sealants, weather-stripping, hardware and fasteners. Most codes require that three identical specimens be tested without penetration. All components used on the tested specimens must be carefully detailed on the test report so that exactly the same system is used in practice. Glass supplied by Oldcastle BuildingEnvelope™ has been successfully tested in many glazing systems for both residential and commercial applications.

All the products supplied by Oldcastle BuildingEnvelope™ for these types of applications have Component Product Approvals from Miami-Dade County. Full details are available on request. This component product approval must be specified on the System Product Approval, which is owned by the manufacturer of the glazing system. System Product Approval is now required in all of Florida.

Each of the test standards mentioned above has slight variations in such items as impact locations and pass/fail criteria. Careful examination of the standards is necessary to ensure that any testing is correctly performed.

Capabilities

Hurricane Impact-Resistant Glass Selection

Oldcastle BuildingEnvelope™ supplies all the main types of laminated glass used for hurricane-resistant applications. (See Table 4 on the following page.) Usually, the laminate is made up of two pieces of glass of the same thickness; however, the two pieces of glass may be annealed, heat-strengthened or tempered, depending on the system in which it was tested.

For small missile performance, glass with an 0.060” PVB interlayer is normally adequate. For best performance, the outer lite of glass should be tempered and the inner lite heat-strengthened.

For large missile performance up to about 25 SQ FT and 65 PSF design pressure, laminated glass with an 0.090” PVB interlayer is usually used. This is combined with various glass configurations, depending on the opening size, design pressure and window or glazing system design.

For the higher-level performance that is required for curtain wall, storefront and large residential...
Hurricane Impact-Resistant Glass
(Windborne Debris)

For the ultimate performance, it is necessary to use a glass-clad polycarbonate construction. The core of this 5-layer laminate is a thin polycarbonate sheet that is the strongest clear plastic available today. It is virtually unbreakable and therefore can resist the greatest forces.

Often, a window or glazing system will only have been tested with a small selection of the products detailed below, so it is essential to check with the system manufacturer in order to specify the correct one. None of the building codes permit the substitution of one product for another, without testing.

### Table 4: Oldcastle BuildingEnvelope™ Hurricane Impact-Resistant Products

<table>
<thead>
<tr>
<th>Product #</th>
<th>Description</th>
<th>Test</th>
<th>2 x 1/8” glass</th>
<th>2 x 3/16” glass</th>
<th>2 x 1/4” glass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Thickness</td>
<td>Weight</td>
<td>Thickness</td>
<td>Weight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>inches</td>
<td>LBS/FT²</td>
<td>inches</td>
<td>LBS/FT²</td>
</tr>
<tr>
<td>411000</td>
<td>Laminated glass with .060 PVB</td>
<td>Small Glassclad polycarbonate</td>
<td>0.31</td>
<td>3.58</td>
<td>0.44</td>
</tr>
<tr>
<td>412000</td>
<td>Laminated glass with .090 PVB</td>
<td>Large Glassclad polycarbonate</td>
<td>0.34</td>
<td>3.75</td>
<td>0.47</td>
</tr>
<tr>
<td>452000</td>
<td>Laminated glass with .100 HP PVB</td>
<td>Large Glassclad polycarbonate</td>
<td>0.35</td>
<td>3.77</td>
<td>0.48</td>
</tr>
<tr>
<td>462200</td>
<td>Laminated glass with .090 SGP</td>
<td>Large Glassclad polycarbonate</td>
<td>0.34</td>
<td>3.75</td>
<td>0.47</td>
</tr>
<tr>
<td>462500</td>
<td>Laminated glass with .100 SGP</td>
<td>Large Glassclad polycarbonate</td>
<td>0.35</td>
<td>3.77</td>
<td>0.48</td>
</tr>
<tr>
<td>472000</td>
<td>StormGlass™ by Oldcastle BuildingEnvelope™</td>
<td>Large Glassclad polycarbonate</td>
<td>0.33</td>
<td>3.67</td>
<td>0.46</td>
</tr>
<tr>
<td>422000</td>
<td>Glass-clad polycarbonate</td>
<td>Large Glassclad polycarbonate</td>
<td>0.43</td>
<td>4.29</td>
<td>0.55</td>
</tr>
</tbody>
</table>

### Additional Important Information

All the laminates detailed in the table above can be supplied with tinted, reflective or Low-E glass to allow the designer and the engineer to control solar heat gain and glare in the building. As the impact codes are adopted by other municipalities outside Florida, more hurricane impact-resistant glass will be supplied as insulating glass units. In this case, the laminated glass lite is usually the inboard lite of the insulating glass unit. For detailed recommendations and glass selection, it is necessary to carefully examine all the requirements of the glazing system and the desired design pressure rating. Oldcastle BuildingEnvelope™ has extensive experience with the testing of hurricane impact-resistant systems and welcomes the opportunity to discuss the selection of a suitable laminated glass for your application.
Tornadoes
The speeds of windborne debris and the peak wind pressures in tornadoes can be, in many cases, much higher than those specified in ASTM E1996.

The Federal Emergency Management Agency (FEMA) has produced a document titled Design and Construction Guidance for Community Shelters. This document presents test methods and construction guidance, and specifies a 15 LB. wood 2x4 fired at 100 mph. This has approximately 14 times the energy of the large missile used in wind zone 4 of ASTM E1996.

Oldcastle BuildingEnvelope™ can manufacture glass to meet these requirements; however, FEMA states in section 6.5, Windows: “Testing indicates that glass windows in any configuration are undesirable for use in tornado shelters. The thickness and weight of glass systems required to resist penetration and control glass spall, coupled with the associated expense of these systems, make them impractical for inclusion in shelter designs”.

Glass and glazing that are designed and tested to resist hurricane impact and cyclic pressure loads can, however, give considerable resistance and protection against lower categories of tornadoes.

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

For specifications on other laminated glass make-ups, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com and click on “Project Assistance” and enter your request.

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Blast-Resistant Glass

**Introduction**

In recent years, the bomb has become the weapon of choice for many terrorist attacks. The high-explosive detonation, with its associated property damage, injury, flames and noise, draws immediate attention and instills fear beyond that of armed attacks.

Extensive research has been carried out following terrorist bombing events in New York, Oklahoma, London, Israel and many other locations. It has been documented that the blast energy causes collateral damage to many surrounding structures, not just the intended target. Glass fragmentation hazards have been identified as a main cause of injury in the targeted site, as well as the peripheral sites. Because collateral damage often extends several blocks from the site of the bomb, it can affect hundreds, possibly thousands, of people, especially in urban areas.

**Description**

Laminated glass is an excellent glazing choice in all types of buildings that may be subjected to bomb blasts. The tough plastic interlayer holds the glass together after an impact, and with the proper framing systems, the glazing will be retained in the opening. Thus, the amount of flying glass, as well as the consequential injuries, can be dramatically reduced.

The pressure from a bomb typically consists of a wave that rises almost instantaneously to a very high peak pressure that falls back to zero in a very short duration, as measured in milliseconds. For example, a 27 LB. bomb detonated from a stand-off distance of 48 FT. produces a peak pressure of 10 PSI (1,440 PSF) for 3.3 milliseconds. The area under the pressure time graph is called the impulse and is measured in PSI-ms. Blast wave energy decreases very rapidly with distance so that the most effective protection is to increase this “stand-off” distance. However, this is not always a viable or economic option.

**Typical Blast Wave–Incident (Side-on) Overpressure**

8 LBS of C-4 explosive (TNT equivalent of 10 LBS) detonated 57 feet from target; atmospheric pressure of 12.9 PSI.
### Blast-Resistant Glass

The General Services Administration (GSA), which is responsible for all US nonmilitary federal buildings, developed an approach for blast resistance. This approach has been included by the Interagency Security Committee (ISC) in their ISC Security Design Criteria document that is now being used to evaluate vulnerability and provide design guidelines for government-owned and leased buildings.

The building type is defined in Table 1, and the protection level is defined in Table 2, taking into account the sensitivity of the area behind the glazing.

#### Table 1

<table>
<thead>
<tr>
<th>ISC Building Classification</th>
<th>Examples</th>
<th>Max Overpressure</th>
<th>Max Impulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>No protection</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>No protection</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>Fed courts, fed buildings, etc.</td>
<td>4 PSI</td>
<td>28 PSI ms</td>
</tr>
<tr>
<td>D</td>
<td>High-level military, e.g., Pentagon</td>
<td>10 PSI</td>
<td>89 PSI ms</td>
</tr>
<tr>
<td>E</td>
<td>White House</td>
<td>Classified</td>
<td>Classified</td>
</tr>
</tbody>
</table>

#### Table 2

<table>
<thead>
<tr>
<th>Hazard 1</th>
<th>Hazard 2</th>
<th>Hazard 3</th>
<th>Hazard 3B</th>
<th>Hazard 4</th>
<th>Hazard 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No glass breakage</td>
<td>Minimal spall</td>
<td>Spall up to 3FT (1m)</td>
<td>Spall up to 10FT (3m)</td>
<td>Hits back wall up to 2FT high</td>
<td>Hits back wall ≥ 2FT high</td>
</tr>
</tbody>
</table>

Hazard 1 allows no breakage at all. This is required in locations where complete vision must be maintained after the event and where personnel would be situated immediately behind the glazing. Control points and lookout positions would fall into this category. Hazards 2-3 and 3B allow increasing amounts of limited spalling, very small chips of glass, so the immediate injuries would be minor. The glazing in these locations would remain in the frame, providing protection from additional outside debris or the weather. Hazards 4 and 5 occur when larger amounts of glass, or other debris, fly off with considerable energy and can cause serious injury to the occupants of the building. The glazing would not always be retained in the frame. Hazards 4 and 5 would only be specified for very low occupancy buildings and/or storage areas.

ASTM F1642 Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings details a test method for this type of glazing. The newest version of this standard has six hazard criteria similar to the GSA recommendations. However, the detailed definitions vary slightly. The frame is an integral part of the blast mitigation glazing system. The blast pressure applies a load to the glass and will be transmitted to the frame through the fasteners, and on to the structure of the building. If the glazing is made very stiff, this entire load will be transmitted to the building, which can damage the structural integrity of the building. In the case where the glazing is very thick and stiff the structure of the building has to be significantly modified and strengthened to accept this additional load.

The Department of Defense (DoD) has produced UFC 4-010-01 DoD Minimum Antiterrorism Standards for buildings. Section B-3.1 deals with Windows, Skylights and glazed doors and two critical sub-sections are included here.
Blast-Resistant Glass

**B.3.1.2 Glazing.** Use a minimum of 6-mm (1/4-in) nominal laminated glass for all exterior windows, skylights and glazed doors. The 6-mm (1/4-in) laminated glass consists of two nominal 3-mm (1/8-in) glass panes bonded together with a minimum of a 0.75mm (0.030-in) polyvinyl-butyral (PVB) interlayer. For insulating glass units, use 6-mm (1/4-in) laminated glass inner pane as a minimum.

**B-3.1.2.2 Glazing Frame Bite.** The glazing shall have a minimum frame bite of 9.5-mm (3/8-in) for structurally glazed systems and 25-mm (1-in) for window systems that are not structurally glazed.

Other subsections in Section B-3.1 give further guidance on installation and anchoring.

### Capacities

The following constructions of laminated glass are most commonly specified for bomb-blast resistance. As with all laminated glazing, the glass can be supplied as tinted or reflective for light and solar control purposes. The lites of glass can be either annealed or heat-strengthened. Oldcastle BuildingEnvelope™ does not recommend tempered laminated glass in this type of application. When insulating glass units are required for thermal performance, Oldcastle BuildingEnvelope™ recommends that both lites of the IG unit be laminated in order to provide maximum protection for those both inside and outside the building. If only one lite in the IG unit is to be laminated, it must be the interior lite so as to protect the occupants of the building.

<table>
<thead>
<tr>
<th>Product #</th>
<th>Construction</th>
<th>Thickness</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>110100</td>
<td>1/8–0.060–1/8</td>
<td>5/16, 8</td>
<td>3.58, 17.5</td>
</tr>
<tr>
<td>110110</td>
<td>3/16–0.060–3/16</td>
<td>7/16, 11</td>
<td>5.21, 25.4</td>
</tr>
<tr>
<td>110120</td>
<td>1/4–0.060–1/4</td>
<td>9/16, 14</td>
<td>6.83, 33.3</td>
</tr>
</tbody>
</table>

### Additional Important Information

**Specifications**

A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

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Decorative Laminated Glass

Introduction

Laminated glass allows great flexibility for decorative glass. Many different effects can be created by deliberately adding other substances to the laminate. Most of the decorative effects offered by Oldcastle BuildingEnvelope™ are light- and heat-stable and therefore can be used both internally and externally.

Silk-screened and Printed Glass

Silk-screened and printed glass (see the Silk-Screened Tab) is used to apply decorative designs to all types of architectural glass. This printed glass can be laminated to increase functional and performance values.

Vanceva® Color

Vanceva® Color offers a unique custom color system that can produce a seemingly endless spectrum of transparent or translucent color options in laminated glass. Applications are almost endless but include curtain walls, atriums, partitions and conference rooms.

The pigmented interlayers are heat- and light-stable, so they will not fade. When subjected to vigorous test conditions, Vanceva® interlayers retained their colorfast properties as well as structural integrity. Vanceva® Color is currently available in a foundational palette of 12 basic colors.

Each of these interlayers is 0.015" thick and can be combined, in up to 6 layers, to form a 0.090" total thickness. Over 1,000 combinations are possible and can help the designer create the perfect blend of tone and intensity. If safety glass is required and only one color is needed, a clear layer of .015" should be added to bring the total up to the minimum requirement of 0.030" for safety glass. The Arctic Snow, Cool White, Polar White and Absolute Black options are added to give translucent or opaque appearance to the product.

A specification for a purple translucent glass could, for example, be the code 1259. This number designates both the layer types and the layer order. It is important to note that this glass is not symmetrical and therefore will have a different look when viewed from opposite sides. For a truly symmetrical glass, the numbering must be symmetric, e.g., 1221.

Example:
Code 1221 = 1/8" clear glass / .015 78% red, .015 78% blue, .015 78% blue, .015 78% red / 1/8" clear glass.
Decorative Laminated Glass

### Vanceva® Data Charts

#### Vanceva® Color Data Chart

<table>
<thead>
<tr>
<th>Vanceva® Design</th>
<th>Color/Design Code</th>
<th>Visible Light Trans(1)</th>
<th>Solar Trans(1)</th>
<th>Inter U-Factor BTU/hr-FT-°F</th>
<th>SC(1)</th>
<th>SHGC(1)</th>
<th>RHG(1) BTU/hr-FT°</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Colors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coral Rose</td>
<td>1</td>
<td>76</td>
<td>70</td>
<td>1.01</td>
<td>0.89</td>
<td>0.77</td>
<td>190</td>
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Information provided by Solutia Inc. The data and information set forth above are based on calculations and are not guaranteed for all samples or applications. All data calculated using Lawrence Berkeley National Laboratory Window 5.2 Product; NFRC/ASHRAE Conditions; center of Glass Values; USD Standard units. Laminates constructed as: 3 mm (0.125 inch) clear glass - (Saflex® Interlayer) - 3 mm (0.125 inch) Clear glass. Colored laminate configurations consist of 0.38 mm Saflex® interlayer. All other interlayer thicknesses as designated.

(1) Trans., transmittance; Refl., reflectance; SC, shading coefficient; SHGC, solar heat gain coefficient; RHG, relative heat gain. For definition of terms, see Section 19 pages 7-11.

Vanceva® is a trademark of Solutia Inc.
Decorative Laminated Glass

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

For specifications on other laminated glass make-ups, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com and click on “Project Assistance” and enter your request.

Contact Us
For any additional information, including details, technical data, specifications, technical assistance and samples, call 1-866-OLDCASTLE (653-2278).

Visit Us on the Web
Log on to www.oldcastlebe.com for project photos, product colors, general inquiries and project assistance.

To view performance data on a wide range of glass make-ups, or to build your own product specification, log on to www.oldcastlebe.com and choose GlasSelect®.
Installation Guidelines

Guidelines

These guidelines are to be used in addition to, and in conjunction with, the guidelines in the latest edition of the Glazing Manual published by the Glass Association of North America and Oldcastle BuildingEnvelope™ Glazing Instructions, section 16, pages 1-6. These should be included as part of the glazing specifications. Failure to follow these guidelines may result in voiding of the warranty.

Setting Blocks
All laminated glass should be installed on setting blocks positioned on the lower edge at the quarter points. The setting block should have a Shore A durometer of 85 ± 5, support the entire thickness of the glass and be 0.1” long, per square foot of glazing, but not less than 4” in length. Ensure that the setting blocks are manufactured from Santoprene, Silicone, EPDM or any other material compatible with silicone and the rest of the glazing components. Pay particular attention to compatibility when the laminated glass contains a polycarbonate.

Clearances
Adequate clearances must be maintained to prevent glass damage or breakage as a result of glass-to-metal contact. A minimum of a 1/8” face clearance should be maintained using a cushioning material. Edge clearance should be a minimum of 1/4”; however, due to the expansion of polycarbonate, any laminate containing this material should have a 1/16” edge clearance per foot of glass length. To reduce in-service breakage, avoid excessive clamping pressures, especially on thin annealed glass, such as the low-spall glass on bullet-resistant materials.

Edge Engagement
All forced-entry and bullet resistant glass must have a minimum of a 1” edge engagement. Clearances and setting block allowances are in addition to this engagement. Any reduction in this edge engagement can cause the performance of the product to be reduced and the test certificate may no longer be applicable.

Weep System
The edges of laminated glass must not be exposed to standing water. All framing systems must be designed to accommodate a reliable weep system, as no cap seal is 100% reliable. In addition, it is extremely important that any cleaning solutions used on either face of the glass be allowed to drain out of the frame. It is the responsibility of the designer and the installer to ensure that the weep system works correctly. Do not glaze any laminated glass in a system without adequate drainage.

Sealants and Caulking
An appropriate sealant should be used to seal the glazing to the frame. Sealant and caulking manufacturers regularly change their products’ raw materials. Therefore, it is essential that the installer checks with the appropriate manufacturer for compatibility of any product, before use. This is particularly important for security glazing containing polycarbonate, as some solvents used in sealants can cause crazing and ultimate failure of the product. This warning also applies to any varnishes, primers or paints used on the framing system. These finishes should be allowed to fully dry before glazing commences.

Threat Surface
Most bullet-resistant glazing products and some forced-entry products are not symmetrical and have a threat side, attack face or impact face. All glass of this type supplied by Oldcastle BuildingEnvelope™ is shipped with a removable label specifying the impact face. This side MUST be installed toward the threat side. Failure to do this can seriously affect the ability of the product to resist the specified threat. This label should be left on until final inspection and/or sign-off occurs.
Installation Guidelines

Storage
Shipments should be scheduled so that glass is stored on the site for a maximum of 30 days. If the glass is to be stored for longer than this, it should be removed from the construction site to a controlled environment. When on the site, store crates indoors, and keep them dry. Ensure that the stored glass remains above the dew point at all times; otherwise, condensation and staining can occur. Protect the crates from exposure and possible damage from the practices of other construction trades.

Handling
Only remove the glass from the crates when it is ready to be installed. Remove glass from the front of the crate—never by sliding to the side. On security glass with exposed polycarbonate, pay particular attention to this face. Never allow glass to rest on uncushioned surfaces. When exposed polycarbonate is supplied with a protective removable sheet, this must be removed immediately after the installation. Never allow the sun to bake this protective film on to the glazing. Never allow anything to rest against the glass. DO NOT install any glass that has been damaged, however slightly. Even small cracks at the edges can ultimately “run” due to thermal expansion while in service. Oldcastle BuildingEnvelope™ does not warrant glass breakage.

Cleaning
Do not expose the edges of any laminated glass to organic solvents, acids or any cleaner containing ammonia, which can react with the plastic components. Once the glazing is installed, the glazing contractor should ensure that the glazing is protected from possible damage caused by the construction practices of other trades.

Take particular care during the initial cleaning, especially if the surfaces are severely soiled. Never attempt to remove dry deposits. NEVER use a sharp blade or scraper to remove deposits or clean the glass.

First flush with water to soften and remove as many contaminants as possible. Then use a clean squeegee to remove excess water, ensuring that abrasive deposits do not get trapped between the squeegee and the glass surface. Then use a mild nonabrasive, nonalkaline cleaner and a soft, grit-free cloth to clean the glass. Rinse immediately with water, removing excess water with a squeegee.

For routine cleaning, a mild soap or detergent, with lukewarm water, can be used with a clean, grit-free cloth. Dry the surface immediately and never allow metallic or hard objects, such as razor blades or scrapers, to come into contact with the glass.

Cleaning Exposed Polycarbonate
All exposed polycarbonate has a mar-resistant coating; however, extra care must be taken to avoid scratching or other damage. Do not use any abrasive cleaners or solvents. Wash with a mild detergent and lukewarm water, using a clean, grit-free cloth. Dry the surface immediately and never allow metallic or hard objects, such as razor blades or scrapers, to come into contact with the glass.

Fresh paint, grease and smeared glazing compounds can be removed using isopropyl alcohol. Afterward, wash with warm water and a mild detergent, as noted above.
decorative glass

Sell Sheet

i-Glass™

Montage®
Now you can print just about any image on glass.
With i-Glass, Oldcastle BuildingEnvelope has taken decorative glass to the next level. Now architects and designers can print directly on heat-treated, monolithic, laminated and insulating glass. Oldcastle BuildingEnvelope employs a new, screenless technology which offers the ability to print complex designs and multiple colors for truly one-of-a-kind custom looks.

**Limitless Possibilities**

**Specifications**

- **Applications:** Interior, Exterior Glass
- **Minimum size:** 12" x 12"" 
- **Maximum size:** 96" x 144" 
- **Overall Dimensions:** 207" x 256" x 52" 
- **Glass Thickness Range:** 1/8" - 1/2" 
- **Print Resolution:** 360 dpi 
- **File Formats:** PDF, PS, AI, EPS, TIFF, BMP and JPEG

**For More Information**

For more information, call your local sales representative or email iglass@oldcastlebe.com.

**Here’s How It Works**

1. **File preparation**
   - Email file(s) to your local sales representative

2. **Digital Printing**
   - Using our exclusive printing technology, we print your image directly to glass

3. **Drying**
   - The image on the glass is dried by radiant forced air

4. **Tempering and Firing**
   - Finally, the glass is sent to our tempering furnace

Specifications

- **Applications:** Interior, Exterior Glass
- **Minimum size:** 12" x 12" 
- **Maximum size:** 96" x 144" 
- **Overall Dimensions:** 207" x 256" x 52" 
- **Glass Thickness Range:** 1/8" - 1/2" 
- **Print Resolution:** 360 dpi 
- **File Formats:** PDF, PS, AI, EPS, TIFF, BMP and JPEG

**For More Information**

For more information, call your local sales representative or email iglass@oldcastlebe.com.
Decorative Glass: i-Glass™

Introduction

i-Glass™ utilizes a new digital printing technology that provides architects, designers and owners the ability to create custom graphics and artistic designs that are applied directly to the surface of glass.

Description

i-Glass™ is manufactured using a digital printing process in which ceramic inks are applied directly to the surface of glass. Unlike traditional silk-screened glass technology, i-Glass™ printing allows multiple colors to be applied simultaneously in a single printing session to create a broad range of design possibilities.

Capabilities

Image resolution up to 360 dpi, dependent upon the electronic file provided, the application and the final size of the printed image.

The glass substrate must be heat-treated; therefore, a printed image can only be applied to one surface of the glass. If more than one printed surface is required, laminating or insulating multiple lites of printed i-Glass™ is suggested.

Thickness:
The thickness range for monolithic glass is from 1/8” to 1/2”.

Typically, laminated glass may range from 5/16” to 1” in thickness and insulating glass units may range from 5/8” to 2” in thickness.

Size:
The size of the printed glass can range from a minimum of 12”x12” up to a maximum of 96”x144”.

Contact your sales representative for specific details regarding capabilities for your project.

Applications

i-Glass™ can be used as a single lite, as part of a laminated product, or as part of an insulating glass unit, creating a wide range of interior and exterior applications.

Characteristics

Heat-treated glass (fully tempered or heat-strengthened) complies with the quality and strength requirements of ASTM C1036 and C1048.

Decorative Glass: i-Glass™

**Inspection Guidelines**

View i-Glass™ from a distance of 6’ (1.8 m) under natural daylight conditions. Pinholes and point blemishes larger than 1/16” (1.6 mm) are not allowed if noticeable from a distance of 10’ (3 m) or greater.

Printed patterns and graphics may be located up to 1/16” (1.6 mm) off parallel from the locating glass edge, which should be identified on the customer’s engineering or shop drawings. Due to glass dimension and squareness tolerances, printed patterns may be up to 1/8” (3 mm) off parallel from the edges other than the locating glass edge. A maximum variation of +/- 1/32” (0.8 mm) in dot, line or hole location is acceptable.

**Additional Important Information**

**Specifications**

A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

**Visit Us on the Web**

Log on to www.oldcastlebe.com for project photos, product colors, general inquiries and project assistance.

To view performance data on a wide range of glass make-ups, or to build your own product specification, log on to www.oldcastlebe.com and choose GlasSelect®.

**Contact Us**

For any additional information, including details, technical data, specifications, technical assistance and samples, call 1-866-OLDCASTLE (653-2278).
Decorative Glass: Montage®

Introduction

Montage® Visual Effects Glass is a totally new concept in glazing. Montage® provides architects, designers and owners the ability to create unique custom effects by combining at least two of our standard designs and technologies.

Montage® allows you to mix and match textured pattern glass, silk-screened glass, and colored laminated glass into your very own vision. Each effect can stand alone or be utilized as components to create other products, such as insulating glass units.

Description

Montage® Visual Effects Glass products are manufactured by combining two or more core components. The combinations of these components create unique optical features. Montage® products are offered in monolithic (single lite), insulating glass units, laminated glass and laminated insulating glass.

The core components consist of traditional Oldcastle BuildingEnvelope™ products and processes like:

- Tempered Glass
- Insulating Glass
- Spandrel Glass
- Laminated Glass
- Glass Entrance Systems

The decorative components consist of highly advanced and systematized manufacturing processes like:

- Silk-Screened Glass
- Textured Pattern Glass
- Colored Laminated Glass

Blending one or more decorative components with one or more core components results in an almost limitless range of visual possibilities.

Capabilities

Thickness:
The thickness for monolithic, laminated and insulating glass products will typically range from 5/32" to 1-5/8".

Size:
Minimum: 12" x 12"  
Maximum: 72" x 120" Some items could be produced at larger sizes.

Additional capabilities information is available for the core products under the corresponding section of this Binder: Insulating Glass, Section 11D; Heat-Treated Glass, Section 11E; Laminated Glass, Section 11F; Silk-Screened Glass, Section 11H; Spandrel Glass, Section 11I; 11J; Glass Entrance Systems, Section 11L.
Decorative Glass: Montage®

Applications

Oldcastle BuildingEnvelope™ offers a variety of silk-screened decorative glass products to satisfy a wide range of applications. Light frit colors and certain pattern designs can cause enhanced brightness when viewed from indoors under certain daylight and background sky conditions, while dark frit colors will tend to reduce glare.

Applications include transparent and translucent silk-screened glass for interior applications, including glass doors, partitions, handrails, glass ceilings, bathrooms, elevator walls, shower enclosures, court walls for racket sports and sneeze guards for food service.

1. Partitions
2. Entrance Doors
3. Shower Doors
4. Handrails
5. Elevator Cabs
6. Glass Floors
7. Stair Treads
8. Ceilings
9. Countertops and Backsplashes
10. Exterior Canopies
11. Exterior Spandrel
12. Exterior Decorative Fins
13. Display Cases

Characteristics

Most heat-treated Montage® glass is not permanently marked with a logo unless it is specifically requested at the time of placing an order. The design professional is responsible for specifying the use of a logo as required to meet the governing building codes. Heat-treated glass (fully tempered or heat-strengthened) complies with ASTM Standards C1036 and C1048, and tempered glass meets ANSI Z97.1 and CPSC 16 CFR 1201 safety glazing standard. Tempered silk-screened decorative glass supplied in Canada complies with CAN/CGSB-12.1-M90.

The color and opacity of the ceramic frit may vary slightly due to paint thickness and glass substrate variations.

Screened patterns may be located up to 1/16" (1.6 mm) off parallel from the locating glass edge, which should be identified on the customer’s engineering or shop drawings. Due to glass dimension and squareness tolerances, printed patterns may be up to 1/8" (3 mm) off parallel from the edges other than the locating glass edge. A maximum variation of +/- 1/32" (0.8 mm) in dot, line or hole location is acceptable. Dots of any diameter up to 1/8" (3 mm) may be missing, up to a maximum of two in one location. Patterns covering the entire glass surface will require a 3/8" (10 mm) border at the edge. A 1/8" (3 mm) border can be obtained for structural glazing applications, but must be specified on the purchase order. A print image of a 1/32" (0.8 mm) indefinite border is acceptable.

Inspection Guidelines

View Montage® glass from a distance of 6' (1.8 m) under natural daylight conditions. Pinholes larger than 1/16" (1.6 mm) are not allowed if noticeable from a distance of 10' (3 m) or greater. On close viewing, small “sawtooth” edges are characteristic of and acceptable in the screen printing process. The color and opacity of the ceramic frit may vary slightly due to paint thickness and glass substrate variations.

Screened patterns may be located up to 1/16" (1.6 mm) off parallel from the locating glass edge, which should be identified on the customer’s engineering or shop drawings. Due to glass dimension and squareness tolerances, printed patterns may be up to 1/8" (3 mm) off parallel from the edges other than the locating glass edge. A maximum variation of +/- 1/32" (0.8 mm) in dot, line or hole location is acceptable. Dots of any diameter up to 1/8" (3 mm) may be missing, up to a maximum of two in one location. Patterns covering the entire glass surface will require a 3/8" (10 mm) border at the edge. A 1/8" (3 mm) border can be obtained for structural glazing applications, but must be specified on the purchase order. A print image of a 1/32" (0.8 mm) indefinite border is acceptable.
Decorative Glass: Montage®

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

Contact Us
For any additional information, including details, technical data, specifications, technical assistance and samples, call 1-866-OLDCASTLE (653-2278).

Visit Us on the Web
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Decorative Glass: Montage®
Textured Patterned Glass

Introduction
Montage® offers architects and designers a unique variety of textured patterns from bold geometrics and modern randoms to subtle motifs, even natural configurations. Below is a small sampling of the textures we offer. Glass has never been so versatile.

Description
When one or more of the rollers in the rolled glass process has a textured surface, patterned glass is produced. This glass is usually available in thicknesses of 1/8” (3 mm) to 3/16” (5 mm); however, a very limited number of patterns are available in thicknesses up to 3/8” (10 mm). Colors may also be available, but are extremely limited. Patterned glass is also called figured glass or obscure glass because the pattern of the rollers reproduced on the glass surface obscures the details of the objects viewed through the glass. The degree of obscurity depends upon both the pattern design and depth. Patterned glass surfaces produce diffuse reflections, as opposed to the specular reflections which occur with float glass. Patterned glass diffuses transmitted light and spreads it in many directions to produce a translucent effect, as opposed to the transparent effect produced by float glass. Patterned glass does not provide complete privacy. Some patterned glasses cannot be heat-treated because of the variations in glass thickness and/or the depth of the pattern.

Capabilities

<table>
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<tr>
<th>Thickness:</th>
<th>5/32” - 3/8”</th>
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</thead>
</table>
| Size:      | Minimum: 12” x 12”  
Maximum: 80” x 94” Some additional sizes may be available. |

Applications

1. Partitions  
2. Entrance Doors  
3. Shower Doors  
4. Handrails  
5. Elevator Cabs  
6. Glass Floors  
7. Stair Treads  
8. Ceilings  
9. Countertops and Backsplashes  
10. Exterior Canopies  
11. Exterior Spandrel Applications  
12. Exterior Decorative Fins  
13. Display Cases

Characteristics

See Heat-Treated, Section 11E, for Characteristics of Heat-Treated Decorative Glass.
Decorative Glass: Montage®
Textured Patterned Glass

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

Contact Us
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To view performance data on a wide range of glass make-ups, or to build your own product specification, log on to www.oldcastlebe.com and choose GlasSelect®.

Decorative Glass: Silk-screened Glass

See following Section: Silk-Screened Glass
silk-screened glass

Sell Sheet

Product Information
Figge Art Museum
Davenport, Iowa
Architect: David Chipperfield Architects
Silk-screened glass has a wide range of standard, decorative and custom applications including:

- All-Glass Entrances
- Interior Partitions
- Signage
- Skylights
- Storefronts
- Exterior Window Walls
- Commercial Fixed and Operable Windows
- Canopies

Oldcastle BuildingEnvelope™ silk-screened products offer building designers and architects endless possibilities. From subtle aesthetics to bold designs for interior and exterior applications. Silk-screened glass is offered monolithically, in insulating glass units or as laminated glass, providing beauty, safety and functionality.
Silk-screened Glass

Introduction

Oldcastle BuildingEnvelope™ provides today’s design professional with a family of glass products that create that distinctive look—from refreshingly new exterior cladding designs to exciting interior applications. Oldcastle BuildingEnvelope™ silk-screened decorative glass is available in a palette of colors and patterns, allowing the glass to become a critical design element that is not only functional, but also aesthetically important. Silk-screened glass can provide a truly unique architectural statement. The versatile nature of this product allows it to be produced in many colors, thereby making decorative glass an attractive product choice for owners, architects and designers who seek to attain unique features in the structures they create or refine.

Silk-screened glass can be specified for both exterior and interior applications. When used on building exteriors, the painted surface must be protected from direct contact with the environment and is normally found in an insulating glass unit. Combining silk-screened glass with clear, tinted, Low-E, or reflective glass, can control light transmittance, reduce solar heat gain and provide a desired level of privacy.

Silk-screened decorative glass is fabricated by transferring images or geometric designs to a glass surface. By using the same basic technology as in spandrel glass, the ceramic frit is applied to the glass through a fine mesh screen containing a standard or custom design. More durable than acid-etched or sandblasted surfaces, silk-screened glass is less susceptible to staining, easier to clean and always heat-treated to withstand thermal and/or mechanical stress.

Whether designing for interior or exterior applications, privacy or openness, silk-screened glass is attractive, easy to clean and “more resistant to graffiti” than most building materials. Laminated silk-screened glass can also be used in skylight and canopy applications since it has a significant influence on natural light entering the area. By incorporating silk-screened glass into an insulating glass unit, its aesthetic and performance characteristics are enhanced.

Description

Available in one-piece orders or high-volume runs, silk-screened decorative glass is custom-made by transferring a silk-screen image to the glass and then processing it through a horizontal tempering furnace. Each individual lite is screen-printed with the desired pattern and ceramic enamel frit color. The ceramic frit can be silk-screened onto the glass substrate in one of three common standard patterns—dots, lines, holes—or in a full-coverage application. Additionally, other standard and custom patterns can be easily duplicated on a range of glass substrates. Depending on the pattern and the color, the glass lite can be made transparent, translucent or opaque. With a wide range of glass substrate and frit color options, the silk-screen process gives designers exceptional creative flexibility.

For a list of available glass products/colors, go to the Glass Options Tab, Section 11C.
Silk-screened Glass

**Capabilities**

**Thickness:** 1/8" through 1/2".

**Size**
Maximum size is generally 72" x 120".
Minimum size is 12" x 12".

The maximum glass size will vary with glass thickness and equipment capabilities.

**Colors**
Oldcastle BuildingEnvelope™ offers ceramic enamel frit in all standard colors as well as simulated sandblast and simulated acid-etched. Custom colors may be utilized to create a unique appearance. Designers can choose from a wide range of glass substrates as well as silk-screened patterns to achieve that special look.

**Standard Silk-screened Patterns**

- **Dots** – 40% coverage; 1/8" dots staggered on 1/4" centers
- **Lines** – 50% coverage; 1/8" lines on 1/4" centers
- **Holes** – 60% coverage; 1/8" holes staggered on 1/4" centers

**Custom Silk-screened Pattern Examples**

**Custom Capabilities:** For design assistance with custom silk-screened options, call 1-866-OLDCASTLE(653-2278) or log on to www.oldcastlebe.com.
#2 Standard Dot Pattern - 40% Coverage - White Frit

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#2 Standard Line Pattern - 50% Coverage - White Frit

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#2 Standard Hole Pattern - 60% Coverage - White Frit

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For additional information concerning performance, strength or application guidelines see page 10.
Silk-screened Glass: Laminated Glass

### #2 Standard Dot Pattern - 40% Coverage - White Frit

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### #2 Standard Line Pattern - 50% Coverage - White Frit

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### #2 Standard Hole Pattern - 60% Coverage - White Frit

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For additional information concerning performance, strength or application guidelines see page 10.
Silk-screened Glass: Insulating Glass Unit

### #2 Standard Dot Pattern - 40% Coverage - White Frit

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<th>Solar Trans %</th>
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### #2 Standard Line Pattern - 50% Coverage - White Frit

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### #2 Standard Hole Pattern - 60% Coverage - White Frit

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For additional information concerning performance, strength or application guidelines see page 10.
Silk-screened Glass

Capabilities (continued)

Silk-screened Glass Performance Notes
Values are typical for Oldcastle BuildingEnvelope™ products at the time of testing. Data will vary due to manufacturing tolerances as well as glass and ceramic frit variations. All data are Center of Glass (COG) values.

The optical properties for total solar and the visible spectrum were measured following the ASTM E1084 and ASTM E972 standards, respectively for the white frit coating at 100% coverage on 1/4” clear glass.

Total solar and visible optical properties for a 40%, 50% and 60% frit coating coverage were calculated following standard ASHRAE methodology. The solar heat gain coefficient (SHGC) and U-Values were calculated using the LBNL’s Window 5.2 program. The environmental conditions used for the calculations are NFRC 100-2001.

Applications

Oldcastle BuildingEnvelope™ offers a variety of silk-screened decorative glass products to satisfy a wide range of applications. Light frit colors and certain pattern designs can cause enhanced brightness when viewed from indoors under certain daylight and background sky conditions, while dark frit colors will tend to reduce glare. Applications include transparent and translucent silk-screened glass for interior applications, including glass doors, partitions, handrails, glass ceilings, floors, bathrooms, elevator walls, shower enclosures, court walls for racket sports and sneeze guards for food service, curtain walls, canopies and skylights.

See the Glass Selector Tab for some typical applications.

Insulating Glass
When used in an insulating glass (IG) unit, silk-screened decorative glass provides an attractive, easily cleaned building component. The silk-screened pattern can be applied to the #2, #3 or #4 surface of an insulating glass unit to provide the desired aesthetic and performance characteristics. For optimum solar performance, the silk-screened pattern should be applied to the #2 surface. Some glass types may not be available with a second surface frit application. Applications with the silk-screened pattern on the #3 or #4 surface will result in an increase in solar absorption on the interior lite and a higher shading coefficient.

Laminated Glass
When incorporated into laminated glass make-ups, silk-screened decorative glass can be used in interior partitions, handrails, doors, glass art, canopies and skylights. For exterior applications, the silk-screened pattern can be applied to the #2, #3 or #4 surface of a laminated glass assembly providing an element of safety in addition to desirable aesthetics and performance levels. For interior applications, the silk-screened pattern can be applied to the #1, #2, #3 or #4 surface of a laminated glass assembly.

Design Considerations
The correct choice of silk-screened decorative glass for a particular application requires the careful consideration of a number of different properties: color and appearance, thermal and acoustic insulation, strength, deflection under design load and meeting code or safety requirements. Other properties such as flatness and ease of cleaning, which can make silk-screened decorative glass the material-of-choice, may also need to be considered.

See the Glass Selector Tab, Section 11B, for some typical applications.
Silk-screened Glass

**Characteristics**

Most heat-treated silk-screened glass is not permanently marked with a logo unless it is specifically requested at the time of placing an order. The design professional is responsible for specifying the use of a logo as required to meet the governing building codes. Heat-treated glass (fully tempered or heat-strengthened) complies with ASTM Standards C1036 and C1048. Tempered glass meets ANSI Z97.1 and CPSC 16 CFR 1201 safety glazing standards. Tempered silk-screened decorative glass supplied in Canada complies with CAN/CGSB-12.1-M90.

**Moiré Effect**

Moiré is an optical phenomenon that appears as a circular or wavy pattern that may occur with some silk-screened glass conditions. Moiré is formed when two regularly spaced patterns overlap but are not aligned.

While moiré may be difficult to predict, the following will increase the probability of it to occur:

- Fine line patterns
- Dots and holes spaced too closely together
- A silk-screened pattern applied to two or more glass surfaces
- Silk-screened patterns combined with a highly reflective glass
- Large insulating units with less than a 2:1 ratio of width to length

Although these guidelines will help, Oldcastle BuildingEnvelope™ recommends full size mock-ups be evaluated when considering silk-screened glass for your project. The mock-up should be viewed under a variety of light and temperature conditions.

**Inspection Guidelines**

Interior Applications:
Inspect at a distance of 1M (39”), a viewing angle of 90 degrees to the surface being inspected, under incandescent lighting conditions.

Exterior Applications:
Inspect in transmission at a distance of 3M (10 feet), a viewing angle of 90 degrees to the surface being inspected, under indirect daylight conditions, against a uniform background.

The following quality guidelines are to be used for the evaluation of silk-screened decorative architectural glass products when viewed per the inspection guidelines listed above:

- Scattered pinholes and/or fisheyes are allowable
- Screen marks are not allowable
- Slight mottling is allowable within the normal viewing area
- Opaque particles are not allowable within the normal viewing area, but are allowable outside the normal viewing area
- Slight variations in color uniformity are allowable

The ‘Normal Viewing Area’ is defined as the central 80% of the total area of an individual lite.

Oldcastle BuildingEnvelope™ does not recommend the use of silk-screened decorative glass in backlit applications.

The following criteria also apply:

- On close viewing, ‘sawtooth’ edges are acceptable in the screen printing process
- A maximum variation of +/- 1/32” (0.8 mm) is acceptable in dot, line or hole location
- Screened patterns may be located up to 1/16” (1.6 mm) off parallel from the locating glass edge. (Locating glass edge must be identified on the PO)
- Due to glass dimension and squareness tolerances, printed patterns may be up to 1/8” (3 mm) off parallel from the edges other than the locating glass edge
- Patterns covering the entire glass surface will require a 1/8” (3 mm) or less border at the edge
Characteristics (continued)

- For structural silicone glazing applications, the pattern may extend to +/- 1/32” or less but must be specified on the order
- A print image of a 1/32” (0.8 mm) indefinite border is acceptable
- A 1/8” (3 mm) border can be obtained for structural glazing applications. (Structural glazing applications must be specified on the PO)

Additional Important Information

Specifications:
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

Silk-screen Charts
Contact Oldcastle BuildingEnvelope™ at 1-866-OLDCASTLE (653-2278) for samples or additional information concerning performance, strength, deflection, thermal stress or application guidelines. GlasSelect® calculates center of glass performance data using the Lawrence Berkeley National Laboratory (LBNL) Window 5.2 program (version 5.2.17) with Environmental Conditions set at NFRC 100-2001. Gas Library ID#1 (Air) is used for Insulating Glass units with air. Gas Library ID#9 (10% Air/90% Argon) is used for Insulating Glass units with argon. Monolithic glass data is from the following sources: 1. LBNL International Glazing Database (IGDB) version 15.0; 2. Vendor supplied spectral data files. Laminated glass data is from the following sources: 1. LBNL International Glazing Database (IGDB) version 15.0; 2. LBNL Optics 5 (version 5.1 Maintenance Pack 2); 3. Vendor supplied spectral data files; 4. Vendor supplied data.

Contact Us
For any additional information, including details, technical data, specifications, technical assistance and samples, call 1-866-OLDCASTLE (653-2278).

Visit Us on the Web
Log on to www.oldcastlebe.com for project photos, product colors, general inquiries and project assistance.

To view performance data on a wide range of glass make-ups, or to build your own product specification, log on to www.oldcastlebe.com and choose GlasSelect®.
Offered monolithically, in insulating units or as laminated glass, spandrel glass is typically specified for building nonvision areas to mask construction materials. Even refurbished buildings, cladded in a combination of vision and spandrel glass, can appear to be constructed entirely of glass. Color samples are shown below. Black and white are also available, as well as an array of custom colors.

Due to the limitations of the printing process, colors above may vary. Consult factory for actual color samples.

Spandrel Applications

Spandrel glass applications range from functional to decorative:

- Masking structural components while maintaining a consistent glass look
- Custom Color Applications
- Nonvision Areas
- Curtain Walls
- Storefronts
- Wall Cladding

Note: Applications in which light may pass through the glass must be reviewed prior to fabrication.
Spandrel Glass

Introduction

Oldcastle BuildingEnvelope™ provides today’s design professional with a family of glass products that create that distinctive look, from refreshing new exterior cladding designs to exciting interior applications. Oldcastle BuildingEnvelope™ spandrel glass is available in a palette of colors, allowing the glass to become a critical design element that is not only functional, but also aesthetically important. Many buildings are cladded in a combination of vision and spandrel glass, giving them an all glass appearance. Even refurbished buildings, with little or no actual vision glass, can provide expansive glass areas through the use of spandrel glass. The versatile nature of this product allows it to be produced in many colors, which makes opaque glass an attractive product choice for owners, architects and designers who seek to attain unique features in the structures they create or refine. Spandrel glass is an opaque, painted glass, traditionally used in non-vision areas of a building to mask construction materials. The paint, a ceramic frit or an elastomeric silicone, is applied directly to the glass surface by utilizing modern coating technology.

Designed for non-vision areas, spandrel glass should be glazed against a dark uniform background, void of light. Spandrel glass is normally heat-strengthened to withstand higher temperatures associated with these areas of the building’s facade to reduce the risk of fallout and minimize the possibility of spontaneous breakage. Spandrel glass can be tempered to meet safety glazing requirements for hazardous locations.

Description

Ceramic Frit Spandrel
Available in a variety of colors to harmonize or contrast with the vision area, the ceramic frit is applied to the #2 surface of monolithic glass by using a horizontal roller-coating process. Ceramic enamel frits contain finely ground glass mixed with inorganic pigments to produce a desired color. The coated glass is then heated to about 1,150°F, fusing the frit to the glass surface, which produces a ceramic coating almost as hard and tough as the glass itself. A fired ceramic frit is durable and resists scratching, chipping, peeling, fading and chemical attacks.

OPACI-COAT-300® Silicone Paint Spandrel
OPACI-COAT-300® silicone paint is a water-based, elastomeric coating that provides optimal glass opacification. Applied without heat during the final stage of the spandrel fabrication process, OPACI-COAT-300® can be used with equal effectiveness on annealed glass (interior only) or heat-treated glass. OPACI-COAT-300® creates a rubber-like film when applied to glass, and, when specified, may satisfy criteria for fallout protection without the need for taping or the application of scrim films.

For a list of available glass products/colors, go to the Glass Options Tab, Section 11C.
Spandrel Glass

**Capabilities**

<table>
<thead>
<tr>
<th>Size:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum size on 1/4&quot; glass (1)</td>
</tr>
<tr>
<td>Minimum size on 1/4&quot; glass</td>
</tr>
</tbody>
</table>

(1) Represents typical standard size limitations; please review larger and smaller size requirements with Oldcastle BuildingEnvelope™.

**Available Colors for Ceramic Frit**

Standard ceramic frit colors include white, Solargray®, Solarbronze®, warm gray, black, Solex®, Ford Blue, lava bronze, and New EverGreen™. Additional industry standard colors are available along with a variety of custom color options. For additional information, log on to www.oldcastlebe.com.

**Available Colors for OPACI-COAT-300®**

Standard OPACI-COAT-300® colors include Harmony Gray, Harmony Bronze, Harmony Solex®, Harmony Blue, Harmony EverGreen™; warm gray, black and lava bronze. Additional industry standard colors are available along with a variety of custom color options. For additional information, log on to www.oldcastlebe.com.

**Applications**

Spandrel glass can be installed monolithically, using insulated metal back-pans, but is more often found as a component of an insulating glass unit. Reflective spandrel glass units are widely used when a uniform all-glass look is desired for the building exterior. Typical applications include commercial fixed windows, curtain walls, storefronts and wall cladding. Spandrel glass is traditionally an opaque material not intended for use in vision areas. Glazing conditions, such as in transoms and partitions, where the glass can be viewed in transmission, should be avoided.

See the Glass Selector Tab, Section 11B, for some common applications.

Variable sky conditions may influence the perception of glass color and appearance. When viewing glass from the outside, the dominant visual characteristic is the visible light reflectance. Overcast (gray) skies result in a greater visual disparity between vision and spandrel areas. This is due to the relative transparency of the vision glass, resulting in the perception of depth in the vision areas. By contrast, the opaque spandrel glass tends to look two-dimensional.

**Curtain Walls**

Curtain wall construction typically includes both vision glazing and spandrel glazing. The spandrel area often complements the vision area in terms of exterior appearance. This is relatively easy to achieve when low-light transmitting (or highly reflective) glass types are used. These glass types provide the least contrast between vision and spandrel areas under a variety of lighting conditions. Glass with high light transmission or low reflectance typically provides greater contrast between vision and spandrel areas.

**Spandrel and Low-E Glass**

Applying spandrel coatings to a Low Emissivity (Low-E) glass is not recommended. If applied directly onto the Low-E coating, it will negate the effectiveness of the Low-E coating. If applied on the opposite side, the Low-E coating may be damaged during the tempering process. For vision IG units with a Low-E coating on the inboard lite, it is standard practice to replace the Low-E coated glass with clear glass for the spandrel IG units.

For a ceramic frit spandrel IG unit that has the Low-E coating on the #2 surface, the spandrel coating is typically applied to the #4 surface. In some circumstances, it can be applied to the #3 surface. For a ceramic frit spandrel IG unit with the Low-E coating on the #3 surface, the spandrel coating can be on the #2 surface, or the Low-E inboard lite can be replaced with clear glass and the ceramic frit spandrel coating placed on the #3 or #4 surface.
Spandrel Glass

Applications (continued)

Oldcastle BuildingEnvelope™ requires using OPACI-COAT-300® spandrel paint on the #4 surface of an IG unit that has a Low-E coating on the #2 surface.

For an OPACI-COAT-300® spandrel IG unit with the Low-E coating on the #3 surface of the vision unit, the Low-E inboard lite can be replaced with clear glass with the OPACI-COAT-300® spandrel coating on the #4 surface.

As always, full-size mock-ups should be viewed prior to the final design decision.

Spandrel With Insulation

Many companies throughout the glass industry have long studied the subject of exterior spandrel glass and its accompanying use with building insulations.

It has been suggested that the best possible method of using spandrel glass with insulation is to have an air gap between the two materials. Any glass, if installed improperly, can become stained or mottled from moisture when it is allowed to remain in contact with the glass for long periods of time. Airborne contaminants can also be present before and during the time of installation. When this moisture blends with alkaline materials, staining potential is increased if moisture is trapped between the insulation and the coated surface of the spandrel glass. Thermal breakage can also be influenced by the use of insulation. On darker colors the heat buildup can be significant. If insulation should be improperly applied, an uneven distribution of heat can occur, resulting in hot and cold spots.

Reflective Glass Products

The use of insulation in direct contact with reflective surfaces is not recommended. Manufacturers of reflective glass products recommend a minimum air gap of 1" to 2" (26 mm to 51 mm) when the coated surface is in the #2 position. This recommendation applies to both sputter/vacuum deposited (soft coat) and pyrolytic coated (hard coat) reflective glass products.

See the Glass Selector Tab, Section 11B, for some typical applications.

Characteristics

Installed Appearance

Standard industry practice advises against the use of spandrel glass in vision areas. Spandrel glass is designed to be glazed against a uniform dark background and should not be used in transoms, partitions, or other areas where it can be viewed in transmission. Applications in which light may pass through the glass must be reviewed prior to fabrication.

Quality

Pinholes, roller marks and opaque particles are permissible in ceramic enamel spandrel glass.

Visual Characteristics

Greater contrast between vision and spandrel areas occurs when using tinted (uncoated) glass or high-transmission Low-E coatings on clear substrates. Under these conditions, insulating glass spandrel units (shadowbox IG units) can provide the illusion of depth and approximate the look of the vision glass more closely. Keeping both the vision and the spandrel glass construction similar (the same exterior glass color, coating, etc.) can minimize the contrast under various lighting conditions. Oldcastle BuildingEnvelope™ suggests specifying a neutral colored opaque spandrel (a ceramic frit or silicone paint) on the #4 surface of the IG for this application.
Spandrel Glass

Additional Important Information

Specifications
A sample Section 08 81 00 Specification for North America can be found in Section 11M of this binder titled: Sample Architectural Glass Specifications.

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Potomac Yards
Arlington, Virginia
Architect: Cooper Carry
Exclusive structural glass options that provide extraordinary possibilities

Below are our four primary structural glass systems. Custom options are also available.

**Technical Assistance**
Oldcastle BuildingEnvelope™ has extensive experience in the design of structural glass systems. We offer custom design and engineering capabilities for all structural glass applications for your design development needs.

**Engineering**
Oldcastle BuildingEnvelope™ provides complete engineering and shop drawings for our structural glass systems as a complete package to our customers. All of our engineers are state licensed with extensive knowledge of glass structures.

**Finwall®**
Finwall® is an exclusive structural wall system with glass panels comprising the facade and vertical glass mullions to structurally resist wind load and seismic forces. Finwall® is free from visual obstructions, limiting the need for metal framing to the perimeter and creating a seemingly floating glass facade.

**Stackwall®**
Stackwall® is an exclusive structural wall system with glass panels comprising the facade and vertical glass mullions to structurally resist wind load and seismic forces. Stackwall® is free from visual obstructions, limiting the need for metal framing to the perimeter and creating a seemingly floating glass facade. Oldcastle BuildingEnvelope™ Stackwall® can be engineered to integrate with Finwall®.

**Point Supported Systems**
Point supported canopies and facades are comprised of stainless steel spider fittings and laminated glass to resist wind load and snow load requirements. Glass attachment fittings are designed to flex when the glass is underloading to reduce stresses in the glass at the fitting connection. Spider fittings are typically bolted to a steel backup structure.

**Steel**
Oldcastle BuildingEnvelope™ can engineer and provide the steel backup structure for most point supported applications. Backup steel can consist of standard pipe and tube members to custom truss systems. Steel can be shop primed, painted or powder coated. Oldcastle BuildingEnvelope™ can review steel requirements for each project to determine feasibility.

**Glass**
Oldcastle BuildingEnvelope™ can incorporate insulated glass with or without Low-E, laminated glass or monolithic glass.

**All-Glass Doors**
Oldcastle BuildingEnvelope™ can incorporate all-glass entrance systems into our structural wall systems. Door types and configurations may vary.

**Cable Net/Truss Systems**
Cable Net and Cable Truss walls are unique in their design and application. These systems require review in the early stages of design to determine the proper structural requirements of the building steel. Cable Net and Cable Truss systems can integrate spider fitting or patch plate fittings.
Part 1. General

Summary
Section Includes:
Glass, glazing and connections for the structural glazing system, in accordance with the contract documents. Oldcastle BuildingEnvelope™ Architectural Systems Stackwall®/Structural Glass Wall Systems will be the basis of design for this application.

Related Sections:
Section 07 90 00–Joint Protection
Section 08 81 00–Glass Glazing

Quality Assurance
System Sole Source Responsibility:
Glazing Material and System Design: Glass, glazing, system design and accessories are the sole responsibilities of the structural glass wall provider.

Installation Sole Source Responsibility:
Provide installation by glazing contractor acceptable to glass wall system supplier.
1. The installer of the structural glass system is responsible for supplying and erecting the complete structural glazing system, coordinating and maintaining tolerances between the structure and glazing system with individual suppliers and manufacturers, and the installation of the glazing system.

Safety Glass
Where safety glass is indicated or required by authorities having jurisdiction, provide the types of products that comply with ANSI Z97.1 and 16 CFR 1201 Category II.

System Description
Design Requirements
1. Design windload: ___________ PSF positive and negative
2. Seismic zone
3. Live load deflection of supporting structure (if any)

Structural glazing system:
1. Fittings are designed to give a (single-point fixed) or (flush) appearance to the outward surface of the glazing system. Attachment fittings to be “spider” type (see pages 10-14) or conventional patch system assemblies (see page 20).
2. The design of the structural fittings is the sole responsibility of Oldcastle BuildingEnvelope™.
3. All connection members are to be designed to prevent high-stress concentration at the hole positions and must cope with:
   a. negative and positive wind loading
   b. seismic loads
   c. thermal movement
   d. construction tolerances
   e. live load and dead load movements
4. All connection assemblies for the glass facade must be designed to incorporate a durable, flexible disc/pads, to accommodate hole sizes in fixing members which allow for thermal movement and glass manufacturing tolerances.

Submittals
Submit the following in accordance with Sections 08 44 26 and 08 44 33:
1. Shop drawings: shop drawings shall clearly indicate material and methods, indicate coordination with other trades and bear the signed approval of the glazing system manufacturer and the glazing system installer, as well as the stamp of a licensed professional engineer registered in the State of ________.
2. Product data: material description and installation instructions for tapes, compounds, gaskets and other materials.
3. Samples: submit samples of glass and glazing materials required for the project. Samples of glass shall be 12” x 12”; samples of sealants or gaskets shall be 12” long. Submit samples of fixing hardware assemblies, complete with the glass, bolt and accessories.
4. Calculations: submit calculations proving the structural glazing system’s performance and compliance with specified loads, with the stamp of a licensed professional engineer registered in the State of ________.
5. Test reports: Submit test reports from an independent laboratory certifying that the structural glass components are applicable to the design. The components must be similar in the type, material and design shown on the architect’s drawings, utilizing (flush countersunk) or (countersunk, external disc), bolted attachments through the glass or conventional patch system assemblies. If test reports are not available, proposed assemblies will be tested.

Warranty

Manufacturer Warranty
1. Provide a five-year warranty for the design and materials supplied by the system provider. Provide written requirements for notification of the manufacturer and terms for maintaining warranty provisions.

Installer Warranty
1. Warrant the installation for a period of five years for installation and repairs of failures. Provide written requirements for notification of the installer and terms for maintaining warranty provisions. Do not contradict the requirements of the contract documents.
2. The warranties submitted under this section shall not deprive the owner of other rights or remedies that the owner may have under other provisions of the contract documents and the laws of governing jurisdictions, and are in addition to and run concurrently with other warranties made by the contractor under requirements of the contract documents.

Part 2. Products

Materials

Structural Glass (Wall) (Canopy) System
The system will be designed to have custom attachment plates and fasteners whereby the facade glass will fasten to the structural support system as depicted in the architectural drawings.

The basis of this specification is the Stackwall®/Structural Glass Wall System as engineered and manufactured by Oldcastle BuildingEnvelope™.

Glass
All glass must be fully tempered (monolithic), (laminated) (insulating) glass. Overall thickness of the facade glass is to be determined by the structural glass wall system provider in accordance with specifications and drawings. Laminated glass is to be produced using laid-in-place interlayer bonded via an autoclave heat and pressure process. Minimum interlayer thickness is to be 0.060” (poured or cast resin laminates will not be permitted.)

All glass must be horizontally tempered, eliminating tong marks. All edges will be ground flat with a frosted appearance unless otherwise noted. All edgework, holes and notches in the tempered glass panels will be completed before tempering and will comply with the requirements stated below:

1. ASTM C1036 Standard Specification for Flat Glass
2. ASTM C1048 Standard Specification For Heat-Treated Flat Glass
3. ASTM C1172 Standard Specification for Laminated Architectural Flat Glass
4. Safety glazing requirements as defined in ANSI Z97.1 and CPSC 16CFR1201
5. Glass strength:
   a. Wind Loading
      - Vertical~1/1,000
      - Sloped~1/1,000
   b. Thermal stress
      - Design factor, 2.5 (8/1,000)
   c. Deflection
      - Deflection must be limited to prevent disengagement from framing members and to ensure conditions well within the criteria defined above.
Stackwall/Structural Glass Wall Systems and Canopies

Specifications (continued)

Finishes
All exposed surfaces will be free of scratches and other serious blemishes.
Rail, channel and pan cover finishes will be (select one of the following):
- For extruded aluminum, an Architectural Class II clear anodic coating conforming with Aluminum Association standards.
- An Architectural Class I color anodic coating, conforming with Aluminum Association standards. Color: Dark Bronze.
- A fluoropolymer paint coating conforming with the requirements of AAMA605.2. Color will be (Specify):
  - Stainless Steel clad using an alloy 304 finished as follows (specify one): Polish or Satin.
  - Brass/Bronze clad finished (samples required) as follows (specify one): Polish or Satin.

Fittings
1. Conventional patch system assemblies are for walls only. (See finishes section from this guide specification.) “Spider” type attachment fittings are for walls and canopies, and are predominately manufactured from Stainless Steel Grade 316. (Select type of fittings(s) from this section.)
2. The subcontractor will demonstrate to the architect’s satisfaction that the stresses induced in the glass by these fittings are compatible with the strength of the glass and the needs of the performance section of this specification.
3. The finish of all fittings will be as called for on the architect’s drawings.
4. Attachment plates shall be designed to the architect’s specification. The design shall be shown by the subcontractor to be compatible with the performance specification in all respects.
4.1 Attachment plates shall provide a tolerance capability which will cope with the full range of movements shown on top right:
   a. Thermal movements occurring as a result of differential coefficients of thermal expansion within the range specified. The components used within the system will noiselessly withstand all thermal movements without any buckling, distortion, cracking, failure of joint seals or undue stress on the glass or fixing assemblies.
   b. Deflection of edge beams due to loading applied after the erection of the cladding to the magnitude specified.
   c. Maximum side sway of the structure due to wind load occurring to the magnitude specified or seismic movement to the degree specified.
   d. Deflection due to self-weight of the structural glass system.
   e. Inward and outward movements due to the design wind loads specified.
5. Exterior countersunk discs, flush countersunk bolts and articulated swivel bolts will be machine finished; socket head bolt will be with hexagonal shank, stainless steel grade 316, or conventional patch system assemblies (for walls).
6. Bushings will be UV-resistant nylon.
7. Gaskets will be fully vulcanized fiber, neoprene or precured silicone.

Part 3. Execution

Examination
Examine surfaces receiving the work. Verify dimensions of in-place and subsequent construction. Follow the recommendations of GANA (Glass Association of North America) as to inspection procedures. Do not begin work until unsatisfactory conditions have been corrected. Installation of work will constitute acceptance of the related construction.

Preparation
Preinstallation review: the representatives of the glass system provider, the architectural exposed-structural-steel fabricator and erector, the sealant manufacturer, the glazing installer, the architect’s representative and the owner’s representative shall review the glazing procedure and schedule, including the method of delivering and handling...
Specifications (continued)

glass, and installing glazing materials. The chemical compatibility of all glazing materials and framing sealants with each other and with like materials used in glass fabrication will be established.

**Installation of Glass**
1. Install in accordance with the glass system provider's requirements and the shop drawings.
2. Employ only experienced glaziers who have had previous experience with the materials and systems being applied. Use tools and equipment recommended by the manufacturer.
3. Plate-to-plate joints of glass are to be sealed with silicone sealant. Joint dimensions will be designed to be compatible with sealant properties and live load movement of the structure.
4. Bolt torque: Torque bolts to torques specified on shop drawings using a calibrated tool. Lock torque bolts into position to prevent back-off. Reset calibrations regularly to ensure an accurate torque.
5. Clean glazing connectors receiving glazing materials of deleterious substances that might impair the work. Remove protective coatings that might fail in adhesion or interfere with bond of sealants. Comply with the manufacturer's instructions for final wiping of surfaces immediately before the application of primer and glazing sealants. Wipe metal surfaces with an appropriate cleaning agent.
6. Inspect each unit of glass immediately before installation. Glass that has significant impact damage at edges, scratches, abrasion of faces or any other evidence of damage will not be installed.
7. Sealants: Prime surfaces are to receive glazing sealants where required, in accordance with the manufacturer's recommendations, using recommended primers.
8. Locate setting blocks, if required by the drawings, at the quarter points of the sill, but no closer than 6 inches to corners of the glass. Use blocks of proper sizes to support the glass in accordance with the manufacturer's recommendations.
9. Provide spacers to separate the glass from attachment plates.
10. Set the glass in a manner that produces the greatest possible degree of uniformity in appearance. Face all glass which has a dissimilar face with matching faces in the same direction.
11. Use masking tape or other suitable protection to limit the coverage of glazing materials on the surfaces intended for sealants.
12. Tool the exposed surfaces of glazing materials.
13. Clean excess sealant from the glass and support members immediately after the application, using solvents or cleaners recommended by the manufacturers.

**Curing, Protection and Cleaning**
1. Cure sealants in accordance with the manufacturer's instructions to attain maximum durability and adhesion to glass.
2. Clean all surfaces after the installation, leaving all in a clean and workmanlike manner.
3. Final cleaning and protection after installation is the responsibility of others.
Stackwall/Structural Glass Wall Systems and Canopies

Capabilities

**Point-Supported Canopies**

Point-supported canopies are commonly used as features at entrances to offices, stores and residential properties. They are defined as overhead glazing where the laminated glass is supported by fasteners that pass through holes in the glass and that cannot be offered in annealed laminated glass due to high stresses. The support structure can be either above or below the glass. This type of design is specifically excluded from ASTM E1300 Standard Practice for Determining the Load Resistance of Glass in Buildings and needs careful, specific engineering design. Oldcastle BuildingEnvelope™ regularly supplies this type of glass but insists that a thorough engineering design should be completed.

Oldcastle BuildingEnvelope™ offers the following design guidelines for point-supported glass:

1. The laminated glass in these applications is typically designed as a nonenclosed structure as the wind load acts both as an uplift on the upper surface and a pressure on the lower surface. Adding this wind load to the snow load and dead load can result in very large loads. Assuming that a high wind will blow considerable amounts of snow off the canopy, it is standard practice to use a design load calculated as the greater of: wind load + 1/2 snow load, or 1/2 wind load + snow load.

2. The maximum stress on point-supported canopies may not be at the point of maximum bending moment. The holes and fasteners often create large local stresses that must be accounted for. Fasteners must therefore have a flexible capability so that local loads do not develop as a result of deflections.

3. Deflection is often the limiting design criterion on these types of applications. If one is designing for strength, a safety factor of 5 should be used.

4. It is extremely important that the holes are sized to give adequate clearance from fasteners. It is common in laminated glass to experience a small amount of slippage between the two lites, and therefore, extra clearance is often used to avoid any problems.
To select what type of wall best fits your needs, follow these instructions:

1. Select your support condition (see page 9).
2. Select the look you want:
   A. Spider attachments (see pages 10-14).
   B. Patch system assemblies (see page 20).
Stackwall®/Structural Glass Wall Systems and Canopies: Sample Elevations

What support condition does your project require?

- Structural Steel
- Cantilevered Glass Fins
- Full Height Glass Fins
- Truss System

(See fitting options)
Stainless Steel Fitting: OG-445/4

FOR USE IN THESE SUPPORT CONDITIONS:
(See page 9.)

- Attaches to a glass mullion or a steel tab bracket
- Suitable for canopy applications
- Available with laminated glass
- Contact Oldcastle BuildingEnvelope™ for insulating glass applications

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Stainless Steel Fitting: OG-445/2

FOR USE IN THESE SUPPORT CONDITIONS:
(See page 9.)

STRUCTURAL STEEL
CANTILEVERED GLASS FINS
FULL-HEIGHT GLASS FINS
- Attaches to a glass mullion or a steel tab bracket
- Suitable for canopy applications
- Available with laminated glass
- Contact Oldcastle BuildingEnvelope™ for insulating glass applications

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.

TOP VIEW

FRONT VIEW

SIDE VIEW
Stainless Steel Fitting: OG-445/2x2

For use in these support conditions:
(See page 9.)

Structural Steel
Cantilevered Glass Fins
Full-Height Glass Fins

- Attaches to a glass mullion or a steel tab bracket
- Suitable for canopy applications
- Available with laminated glass
- Contact Oldcastle BuildingEnvelope™ for insulating glass applications

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.

Oldcastle BuildingEnvelope™ Engineering your creativity™
Stainless Steel Fitting: OG-446/4

FOR USE IN THESE SUPPORT CONDITIONS:
(See page 9.)

- Attaches to steel rod coupling on tension truss or steel supports
- Suitable for canopy applications
- Available with laminated glass
- Contact Oldcastle BuildingEnvelope™ for insulating glass applications

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Stainless Steel Fitting: OG-446/2

FOR USE IN THESE SUPPORT CONDITIONS:
(See page 9.)

<table>
<thead>
<tr>
<th>STRUCTURAL STEEL TRUSS SYSTEM</th>
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</thead>
<tbody>
<tr>
<td>- Attaches to steel rod coupling on tension truss or steel supports</td>
</tr>
<tr>
<td>- Suitable for canopy applications</td>
</tr>
<tr>
<td>- Available with laminated glass</td>
</tr>
<tr>
<td>- Contact Oldcastle BuildingEnvelope™ for insulating glass applications</td>
</tr>
</tbody>
</table>

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Fin Connections: Fin in Shoe

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Fin Connections: Cantilevered Fin

Structural steel supports must be capable of resisting a mainplate and fin reaction as required. Steel supplied by others.

Notes:
- Drawings not to scale.
- All dimensions for reference only. Actual values based on project design and conditions.
Sill Conditions: Exposed Sill and Embedded Sill

*Note:* Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Sill Conditions: Exposed Sill with Fin

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Sill Conditions: Embedded Sill with Fin

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Splice Plates with Cover Pans

FOR USE IN THESE SUPPORT CONDITIONS:
(See page 9.)

STRUCTURAL STEEL
CANTILEVERED GLASS FINS
FULL-HEIGHT GLASS FINS
- Attaches to a glass mullion or a steel tab bracket
- Available with laminated glass
- Contact Oldcastle BuildingEnvelope™ for insulating glass applications

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Splice Plates with Spider Fitting for Insulating Glass

FOR USE IN THESE SUPPORT CONDITIONS:
(See page 8.)

- STRUCTURAL STEEL
- CANTILEVERED GLASS FINS
- FULL-HEIGHT GLASS FINS
- Attaches to a glass mullion or a steel tab bracket
- Available with laminated glass

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.

AGA 445/4 SPIDER FITTING, BOBE

STAINLESS STEEL COVERS, BOBE

(2) 3/8" THICK ALUMINUM SPLICE PLATES WITH FRICTION PADS AND 5/8 GRADE 8 BOLTS W/N, FW, BOBE

3/4" CLEAR TEMPERED GLASS FIN, BOBE

CONTINUOUS STRUCTURAL SILICONE, BOBE

CONTINUOUS ROD AND SILICONE WEATHERSEAL, BCG

1-1/4" CLEAR TEMPERED I.G. MAINPLATES, BOBE

GLASS SIZE 3/16" GLASS SIZE

21-1/4" FIN (NTS)
Custom Options: Contact Sheet

For all custom concepts, please call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.
Finwall® System

Specifications

Part 1. General

Description of Work
1. Complete structural glazing system: tempered monolithic, laminated or insulating glass main plates; glass stiffeners; glass entrance doors (where applicable); metal framing for doors (where applicable); metal support members for perimeter of system; metal fasteners and sealants.
2. Labor and equipment, and services necessary to install all the work of this section as shown on the approved shop drawings, as specified, and as required by job conditions.

Related Work Specified Elsewhere
1. Structural steel
2. Perimeter caulking
3. Curtain wall systems

Quality Assurance and Performance
1. General - The manufacturer will design and fabricate the Finwall® or IG Finwall® in accordance with the manufacturer’s established practices and as shown on the approved shop drawings.
2. Installation must be performed by an installation company approved by Oldcastle BuildingEnvelope™ and in accordance with the Oldcastle BuildingEnvelope™ erection and glazing instructions.
3. Structural performance: A test report will be submitted that provides the basis for the structural calculations. For earthquake-prone areas, the Finwall® system will be designed to allow for lateral racking for seismic requirements. Test reports by an independent testing laboratory which show results of tests of structural performance, in accordance with ASTM E330, that have been made for substantially identical systems, will be submitted as required by architect.
4. There will be no uncontrollable air or water infiltration through the assembly when tested in accordance with ASTM E331.
5. System will provide for live loads imposed by the operation of doors. Doors will comply with applicable handicap and fire codes.

Submittals
1. Submit shop drawings including elevation drawings, sections and details at no less than a 1/4" scale, showing glass types and thicknesses, metal types and thicknesses, joining details, anchorage fastening and sealing methods, metal finishes, door hardware, glazing sealants, setting blocks, shims and spacers.
2. Submit substantiating engineering calculations and test reports by state-licensed engineer.
3. Submit samples as requested
   a. Glazing materials
   b. Metal components and finishes

Warranty
1. Provide a two-year warranty, cosigned by manufacturer and the installer.
2. Warranty: Cover the complete system for failure to meet specified requirements, including materials and installation costs. Insulating glass units will be warranted for a period of five years.

Part 2. Products

Manufacturer
The structural glass wall system will be Finwall®, as manufactured by Oldcastle BuildingEnvelope™.

Main Plate Insulating Glass
Will be constructed using fully tempered glass in accordance with ASTM C1048. The thickness of the glass lites for the insulating units will be either 3/8" or 1/4" thick. Glass or coating color will be selected by the architect. The insulating glass will be dual sealed with polyisobutylene primary seal and a silicone secondary seal with an aluminum spacer. The insulating glass unit will be certified by the IGCC to a Class CBA rating.

Monolithic or Laminated glass may also be used; see Glass section on page 4.
Finwall® System

Specifications (continued)

**Finishes**
All exposed surfaces will be free of scratches and other serious blemishes.
Rail, channel and pan cover finishes will be (select one of the following):

- For extruded aluminum, an Architectural Class II clear anodic coating conforming with Aluminum Association standards.
- An Architectural Class I color anodic coating, conforming with Aluminum Association standards. Color: Dark Bronze.
- A fluoropolymer paint coating conforming with the requirements of AAMA605.2. Color will be (Specify):
  - Stainless Steel clad using an alloy 304 finished as follows (specify one): Polish or Satin.
  - Brass/Bronze clad finished (samples required) as follows (specify one): Polish or Satin.

**Stabilizers**
Will be 3/4" fully tempered glass in accordance with ASTM C1048. Stabilizer end blocks will be designed so that the shear load is not transferred through the insulating glass main plate.

**Perimeter Glazing Channels**
Will be 6063-T5 aluminum alloy meeting ASTM B221, matching the profile on the approved shop drawings; size is as required by the insulating glass thickness and glazing requirements.

**Sealants**
Structural glazing joints must be glazed with an approved structural glazing sealant, such as GE Ultraglaze 4000, Dow Corning 795 or 995. Perimeter weather seal will be a silicone weather seal product, such as GE Silglaze™ or Dow Corning 790.

**Setting Blocks**
Will be silicone-compatible material, as shown on shop drawings.

---

**Part 3. Execution**

**Examination**
Examine surfaces receiving the work. Verify dimensions of in-place and subsequent construction. Follow the recommendations of GANA (Glass Association of North America) as to inspection procedures. Do not begin work until unsatisfactory conditions have been corrected. Installation of work will constitute acceptance of the related construction.

**Preparation**
Pre-installation review: The representatives of the glass system provider, the architectural exposed-structural-steel fabricator and erector, the sealant manufacturer, the glazing installer, the architect’s representative and the owner’s representative shall review the glazing procedure and schedule, including the method of delivering and handling glass, and installing glazing materials. The chemical compatibility of all glazing materials and framing sealants with each other and with like materials used in glass fabrication will be established.

**Installation of Glass**
1. Install in accordance with the glass system provider’s requirements and the shop drawings.
2. Employ only experienced glaziers who have had previous experience with the materials and systems being applied. Use tools and equipment recommended by the manufacturer.
3. Plate-to-plate joints of glass are to be sealed with silicone sealant. Joint dimensions will be designed to be compatible with sealant properties and live load movement of the structure.
4. Bolt torque: Torque bolts to torques specified on shop drawings using a calibrated tool. Lock torque bolts into position to prevent back-off. Reset calibrations regularly to ensure an accurate torque.
5. Clean glazing connectors receiving glazing materials of deleterious substances that might impair the work. Remove protective coatings that might fail in adhesion or interfere with bond of sealants. Comply with the manufacturer’s instructions for final wiping of surfaces immediately before the application of primer and glazing sealants. Wipe metal surfaces with an appropriate cleaning agent.

6. Inspect each unit of glass immediately before installation. Glass that has significant impact damage at edges, scratches, abrasion of faces or any other evidence of damage will not be installed.

7. Sealants: Prime surfaces are to receive glazing sealants where required, in accordance with the manufacturer’s recommendations, using recommended primers.

8. Locate setting blocks, if required by the drawings, at the quarter points of the sill, but no closer than 6 inches to corners of the glass. Use blocks of proper sizes to support the glass in accordance with the manufacturer’s recommendations.

9. Provide spacers to separate the glass from attachment plates.

10. Set the glass in a manner that produces the greatest possible degree of uniformity in appearance. Face all glass, which has a dissimilar face with matching faces in the same direction.

11. Use masking tape or other suitable protection to limit the coverage of glazing materials on the surfaces intended for sealants.

12. Tool the exposed surfaces of glazing materials.

13. Clean excess sealant from the glass and support members immediately after the application, using solvents or cleaners recommended by the manufacturers.

Curing, Protection and Cleaning

1. Cure sealants in accordance with the manufacturer’s instructions to attain maximum durability and adhesion to glass.

2. Clean all surfaces after the installation, leaving all in a clean and workmanlike manner.

3. Final cleaning and protection after installation are the responsibilities of others.
Finwall® System Sample Elevations

ROUGH OPENING

MODULAR DIMENSION

TEMPERED MONOLITHIC, LAMINATED OR INSULATING GLASS UNITS

3/4" TEMPERED GLASS, TYPICAL
Finwall® System: Isometric View

3/4” TEMPERED GLASS, TYPICAL

TEMPERED MONOLITHIC, LAMINATED OR INSULATING GLASS UNITS
Finwall® System: Head and Sill Details

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions. As used herein, Oldcastle refers to Oldcastle BuildingEnvelope™.
Finwall® System: Fin Detail

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions. As used herein, Oldcastle refers to Oldcastle BuildingEnvelope™.
Finwall® System: Isometric Detail

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions. As used herein, Oldcastle refers to Oldcastle BuildingEnvelope™
glass entrance systems

Sell Sheet

Product Information

All-Glass Entrance Systems

Bottom-Rolling and Top-Hung Sliding Doors

Hardware
Glass Entrance Systems Applications

Glass Entrance Systems are used in a wide range of applications including:

- Malls
- Hotels
- Office Buildings
- Interior Store Entrances
- Airports
- Banks
- Museums
- Sports Arenas

Oldcastle BuildingEnvelope™ glass entrance systems are all-glass portals engineered to allow designers the extraordinary flexibility they need to convey the visual impact they desire.

Oldcastle BuildingEnvelope™ entrance systems can employ swinging or sliding doors, as well as stacking or bifold panels.
All-Glass Entrance Systems: Door Style/Swing

Introduction
Many rail variations are available with Oldcastle BuildingEnvelope™ tempered glass entry doors. They can be used with corner patches only, with continuous rails only or in combinations of the two. The sketches shown here illustrate some of the many possibilities.

Door Sizes
Doors up to 10’ high can be fabricated to your specifications and requirements. (See Table 3, page 13, for the recommended maximum height for your specific application.)

Glass Thickness: 3/8”, 1/2”, 5/8” or 3/4”

Pivot Distance
Typical pivot distance is 2-5/8” from the end of a door or 2-3/4” from the edge of a jamb. Check with the factory for special applications.

Edgework
All exposed glass edges will be polished. Flat polish is standard edgework for Oldcastle BuildingEnvelope™.

Door Styles

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>TYPE “P”</td>
</tr>
<tr>
<td>BP</td>
<td>TYPE “BP”</td>
</tr>
<tr>
<td>A</td>
<td>TYPE “A”</td>
</tr>
<tr>
<td>F</td>
<td>TYPE “F”</td>
</tr>
</tbody>
</table>

Door Swing Chart

- Please specify door swing by number.
- Interior and exterior swing options are shown.

Oldcastle BuildingEnvelope™ Engineering your creativity™
All-Glass Door and Sidelite Systems:
Specifications

Part 1. General

Description
Work included: furnish all necessary materials, labor and equipment for the complete installation of tempered glass swing doors, as shown on drawings and specified herein.

Work not included: structural support, interior closures, trim.

Quality Assurance
Drawings and specifications are based upon door style (select from page 3), as manufactured by Oldcastle BuildingEnvelope™ and Oldcastle Architectural Systems (“Oldcastle”). Whenever substitutes are to be considered, supporting technical literature, samples, drawings and performance data must be submitted ten days prior to making the bid in order to make a valid comparison of the product involved.

Part 2. Products

Rails
Top and bottom rails will be selected from the options provided in this section. Rail sections will be of extruded aluminum of 6063-T5 alloy and dry-glazed. Dry-glazed rail may be a pressure assembly utilizing a fitted EPDM gasket, or mechanical rail assemblies utilizing torqued fasteners and gaskets to affix glass to rail. Dry-glazed rails use precision-fit end caps in the finish to match the rail.

Glass
Glass will be (one of the following):

- 3/8” and 1/2” thick, fully tempered, clear, gray, bronze, or low iron.
- 5/8” and 3/4” thick, fully tempered, clear or low iron.
- Glass will conform to requirements set forth by ASTM Specifications C1036 and C1048 for fabrication and tempering. All exposed edges will be flat-polished to a reflective appearance similar to the glass surface.

Finishes
All exposed surfaces will be free of scratches and other serious blemishes.

Rail finishes will be (Select one of the following):

- For extruded aluminum, an Architectural Class II clear anodic coating conforming with Aluminum Association standards.
- A fluoropolymer paint coating conforming with the requirements of AAMA605.2. Color will be (Specify):
  - Stainless Steel clad using an alloy 304 finished as follows (specify one): polish or satin.
  - Brass/Bronze clad finished (samples required) as follows (specify one): polish or satin.

Hardware

Hardware for tempered glass swing doors will be furnished by the glass door supplier. Hardware will be the glass manufacturer’s standard as follows:

1. Handles: (see page 42)  
2. Pivots: (see pages 39-40)  
3. Door Closers: (see page 38)  
4. Locking Hardware: (see pages 20,40,41)  
   or  
   Exit Devices: (see page 41)  

For all above, specify manufacturer, model, style, type, finish, etc. as appropriate.

To ensure single-source responsibility and timely coordination, Oldcastle BuildingEnvelope™ recommends the use of hardware offerings in this section. The hardware has been selected on proven performance. Custom hardware provided outside the scope of this product line will be provided as required but will extend the manufacturing lead times. For custom hardware
All-Glass Door and Sidelite Systems: Specifications (continued)

applications, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.

If lock cylinders for doors are to be master-keyed, it is suggested that cylinders be included under the “Finish Hardware” section of specifications.

Part 3. Execution

Installation

Doors will be installed by qualified installers in a workmanlike manner in accordance with industry standards. All items under this specification will be set in correct locations as shown in the details and will be level, square and plumb.
All-Glass Entrance Systems: Rail Profiles

**Rail Profile Dimensions**

**Standard:**
- 1-3/4" x 3-3/8", 3-5/8" square
 **Option:**
- 1-3/4" x 6" square
 **ADA-Compliant:**
- 1-3/4" x 3-5/8" and 4" tapered
- 1-3/4" x 10" square

- Rail assemblies are dry-glazed. Dry-glazed rails utilize pressure-fitted gasket or mechanically fastened.
- Rails supplied with standard precision applied end caps.
- Custom rail heights available by special order.
- For available rail height dimensions, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.

**Brite Vue® Door Rail**

- Precision applied end caps
- Optional taper
- Gasket
- Mechanical assembly
- Side mount grip system
- Bottom mount wedge system
- Pressure assembly

**Note:** Drawings not to scale
All-Glass Entrance Systems:
Micro Stile Door

Details and Weathering Options

FOR OTHER STILE DIMENSIONS, CALL 1-866-OLDCASTLE (653-2278), OR LOG ON TO WWW.OLDCASTLEBE.COM.

FORMED WEATHER CHANNEL

3/4" PVC WEATHER CHANNEL

1/2" PVC WEATHER CHANNEL

ADHESIVE-BACK WEATHER PILE

For availability, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.

Note: Drawings not to scale
All-Glass Entrance Systems: Sidelite Applications

**Introduction**

Sidelites and other fixed glass may have rails at the top and bottom, or at the bottom only, to match the doors. To maintain even alignment with the rail of the adjacent door, a track/saddle of various heights is installed under the sidelite rail. The track/saddle must be anchored to the structure at the ceiling and floor. Additional anchoring of the rail to this track may also be required.

Sidelites with rails are available in two types: factory-applied rails (individual panel only) and field-glazed rails (individual or multiple panels).

See Table 1 and 2 on pages 11 and 12 that are reprinted from the GANA Tempering Division *Engineering Standards Manual* for additional information regarding height and thickness recommendations for fully tempered interior butt-glazed fixed panels.
All-Glass Entrance Systems: Finishes

Oldcastle BuildingEnvelope™ products can be supplied in various metals and finishes. The following are finishes available for Oldcastle BuildingEnvelope™ products.

### Anodized

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>AA(1)</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>AA-C22A31</td>
<td>II</td>
</tr>
<tr>
<td>Black</td>
<td>AA-C22A41</td>
<td>I</td>
</tr>
<tr>
<td>Dark Bronze</td>
<td>AA-C22A42</td>
<td>I</td>
</tr>
</tbody>
</table>

### Stainless Steel

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Number</th>
<th>BHMA(2) Code</th>
<th>USA Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polish</td>
<td>8</td>
<td>629</td>
<td>US32</td>
</tr>
<tr>
<td>Satin</td>
<td>4</td>
<td>630</td>
<td>US32D</td>
</tr>
</tbody>
</table>

### Brass

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>AA(1) Finish</th>
<th>BHMA(2) Code</th>
<th>USA Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polish</td>
<td>M21</td>
<td>605</td>
<td>US3</td>
</tr>
<tr>
<td>Satin</td>
<td>M32</td>
<td>606</td>
<td>US4</td>
</tr>
</tbody>
</table>

### Bronze

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>BHMA(2) Code</th>
<th>USA Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polish</td>
<td>611</td>
<td>US9</td>
</tr>
<tr>
<td>Satin</td>
<td>612</td>
<td>US10</td>
</tr>
</tbody>
</table>

### Paint

Oldcastle BuildingEnvelope™ products are available in painted finishes. Please call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com for availability.

**Important:**

Brass/Bronze finishes are all copper alloys. To insure proper selection, please specify using the alloy designations of the Copper Development Association (CDA). 220–Commercial Bronze (BHMA 611 or 612). 260–Brass 280–Muntz (Architectural Bronze).

---

(1) AA - Aluminum Association  
(2) BHMA - Builders Hardware Manufacturers Association
All-Glass Entrance Systems: Metal Finish Maintenance

**Maintenance Recommendations for Oldcastle BuildingEnvelope™ Tempered Glass and Architectural Products**

**Glass**
Tempered glass should be cleaned with a concentrated foam spray cleaner and wiped with a clean, dry cloth. Such foam cleaners can be used as often as necessary. Liquid solutions should not be used because of their tendency to splash or run. Liquid solutions can be very damaging to any exposed metal finishes on or near the glass.

**Polished Stainless Steel (Alloy 304)**
Polished stainless steel finishes should be cleaned with a concentrated foam spray cleaner (such as Hi-Sheen by Sommer and Macca Industries) and wiped with a clean dry cloth. Such foam cleaners can be used as often as necessary. Liquid solutions may cloud or scratch polished stainless steel finishes.

**Satin Stainless Steel (Brushed) (Alloy 304)**
Satin-polished stainless steel finishes should be wiped clean with a mild soap and water solution, rinsed with clean water and wiped with a clean, dry cloth for occasional smudges.

For periodic maintenance, satin stainless steel can be rubbed with an abrasive pad (such as a #9650 general purpose rubbing pad by 3M). The finish should always be rubbed in the same direction as the grain texture.

**Polished Brass (or Bronze) (Alloy 280/260 or 220)**
Polished brass should be cleaned periodically (when it begins to tarnish) with a brass polishing cream that uses low level abrasives (such as Brasso). The liquid or cream polish should be rubbed on with a clean dry cloth with strokes going back and forth in one direction only, either horizontally or vertically. Allow the polish to dry to a chalky finish before buffing off with a clean dry cloth in the same direction. Do not use circular motions when polishing. If the brass is heavily stained or tarnished, it may be cleaned by the following method: one ounce of oxalic acid diluted into one pint of lukewarm water. This solution is used for the cleaning, bleaching and removing of stains. If a stain is hard to remove, use #4 pumice with the acid mixture. After cleaning and removal of stains, re-polish with “Noxon Metal Polish,” manufactured by Boyle of Midway, New York. The acid can usually be purchased through chemical supply houses or even pharmacies. The “Noxon Metal Polish” can be obtained from janitorial supply houses or homeowners’ hardware supply houses. The pure acid, and even the diluted acid, can cause skin burns, so caution should be used when handling the material, and rubber gloves should be worn.

**Satin Brass (or Bronze) (Brushed) (Alloy 280/260 or 220)**
Satin, brass finishes should be cleaned by rubbing an abrasive pad (such as a #9650 general purpose rubbing pad by 3M). The finish should always be rubbed in the same direction as the grain texture.

**Satin, Oxidized and Oil Rubbed/Statuary Bronze (Alloy 280/260 or 220)**
Satin oxidized can be cleaned periodically by gently wiping with a mild soap and water solution, rinsing with clean water, wiping off the excess and allowing it to dry naturally.

**Finishes Coated with Clear Baked Enamel or Clear Lacquer**
Finishes coated with clear baked enamel or clear lacquer coating can be cleaned periodically by gently wiping with a mild soap and water liquid solution, rinsed with clean water and wiped dry with a clean, dry cloth.

**Anodized Aluminum (Alloy 6063-T5)**
Anodized aluminum finishes that are finished with a brushed or grainy texture should be cleaned periodically with a semi-abrasive liquid solution (such as Ajax or Comet), rinsed with clean water and wiped with a clean dry cloth. The finish should always be rubbed in the same direction as the grain texture.
All-Glass Entrance Systems:
GANA Recommendations for Fully Tempered Interior Butt-Glazed, Fixed-Glass Panels

Introduction

The fixed panels of interior glass partitions, mounted or restrained on only two sides (top and bottom), require special design considerations:

Glass held only on two sides is much more flexible than glass supported on all four sides. If the glass is too thin, small fluctuations of interior air pressure can cause the glass to tremble or shimmer. People pushing or leaning on glass that is too thin will noticeably deflect the glass. As the unsupported span or height of the glass panels increases, the glass thickness must also increase to maintain a reasonable stiffness.

Table 1 below shows the recommended minimum thickness of fully tempered glass for various glass heights used in interior butt-glazed, fixed-glass panels.

<table>
<thead>
<tr>
<th>Unsupported span from top to bottom of glass: ft (m)</th>
<th>Recommended minimum thickness of FULLY TEMPERED Glass: inches (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 5 (1.5)</td>
<td>1/4 (6)</td>
</tr>
<tr>
<td>Over 5 (1.5) up to 8 (2.4)</td>
<td>3/8 (10)</td>
</tr>
<tr>
<td>Over 8 (2.4) up to 10 (3.0)</td>
<td>1/2 (12)</td>
</tr>
<tr>
<td>Over 10 (3.0) up to 12 (3.6)</td>
<td>5/8 (16)</td>
</tr>
<tr>
<td>Over 12 (3.6) up to 14 (4.2)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td>Over 14 (4.2) up to 16 (4.8)</td>
<td>7/8 (22)</td>
</tr>
<tr>
<td>Over 16 (4.8) up to 18 (5.5)</td>
<td>1 (25)</td>
</tr>
<tr>
<td>Over 18 (5.5)</td>
<td>Not Recommended</td>
</tr>
</tbody>
</table>

Cautions

The following cautions are not addressed in any way by Table 1 above.

IBC’s model National Building Code, Section 2403.4, states, regarding interior glazed areas: “Where interior glazing is installed adjacent to a walking surface, the differential deflection of two adjacent unsupported sides shall not be greater than the thickness of the panels when a force of 50 pounds per linear foot is applied horizontally to one panel at any point up to 42 inches above the walking surface.”

Thicknesses shown in Table 1 above WILL NOT MEET the IBC code for adjacent panels not linked together by adequate silicone or permanent clips. Table 2, on the following page, shows the recommended minimum thickness of fully tempered glass required to meet the IBC code for panels that are not linked together to prevent differential deflection greater than the panel thickness.

Silicone joints or permanently clipping adjacent panels do not add to the structural strength or rigidity of the assembly and do not permit the reduction of the recommended thickness shown in Table 1 above.

All-Glass Entrance Systems:
GANA Recommendations for Fully Tempered
Interior Butt-Glazed, Fixed-Glass Panels

Cautions (continued)

Open narrow joints between butt-glazed glass panels may catch or pinch fingers. The best preventive is to avoid open joints by filling them with silicone. An alternative is to install permanent clamps approximately every four feet to couple the adjoining panels together to prevent relative movement between panels. The gap between panels with unfilled joints should be such that fingers cannot be inserted and trapped.

Table 2

Recommended Minimum Thickness for Fully Tempered Glass to Meet IBC Requirements (Section 2403.4) for Interior Partitions

<table>
<thead>
<tr>
<th>Distance from Walking Surface to the Bottom Edge of Glass: inches (mm)</th>
<th>Panel Height: ft (m)</th>
<th>Minimum Recommended Fully Tempered Glass Thickness: inches (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (0)</td>
<td>7 (2.1)</td>
<td>5/8 (16)</td>
</tr>
<tr>
<td>6 (152)</td>
<td>8 (2.4)</td>
<td>5/8 (16)</td>
</tr>
<tr>
<td>12 (305)</td>
<td>9 (2.7)</td>
<td>5/8 (16)</td>
</tr>
<tr>
<td>18 (457)</td>
<td>10 (3.0)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td>24 (609)</td>
<td>11 (3.3)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td></td>
<td>12 (3.6)</td>
<td>3/4 (19)</td>
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<tr>
<td></td>
<td>13 (3.9)</td>
<td>7/8 (22)</td>
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<td></td>
<td>18 (5.4)</td>
<td>1 (25)</td>
</tr>
</tbody>
</table>

For further information, please refer to Glass Association of North America, Engineering Standards Manual.
All-Glass Entrance Systems:
GANA Recommendations for Fully Tempered Interior Butt-Glazed, Fixed-Glass Panels

**Interior Applications**

Heavy glass doors are becoming increasingly popular for interior applications. Although wind load is not a consideration, other types of structural loading may limit the size of interior doors. Interior, fully tempered glass sidelite panels are not always sealed. See Appendix I of the GANA Tempered Glass Engineering Standards Manual for additional information regarding height and thickness recommendations for fully tempered interior, butt-glazed glass panels. Traffic volume for interior applications needs to be considered, as with exterior applications. Interior doors are often locked in both the open and closed position, eliminating the need for closers. Structural design of fully tempered all-glass interior entrance systems is discussed in detail in the GANA 1999 Fully Tempered Heavy Glass Door and Entrance Systems Design Guide.

**Door Size Limitations**

Door sizes need to be limited due to glass flexibility and hardware limitations. Closers and pivots have weight limitations. Doors that are too wide are difficult to control in windy conditions and may exceed hardware limits. Larger doors may be used when locked open or infrequently used. Full rails, top and bottom, are recommended for larger door sizes. (See Table 3.)

**Types of Glass**

Glass in fully tempered heavy glass doors and entrances is clear or tinted monolithic, fully tempered float glass complying with standards defined in ASTM C1036 and C1048. Typical heavy clear float glass thicknesses used include 3/8" (10 mm); 1/2" (12 mm); and 3/4" (19 mm). Tinted (gray and bronze) heavy float glass thicknesses used include 3/8" (10 mm) and 1/2" (12 mm).

The exposed vertical edges of the glass are ground and polished prior to tempering the glass. Holes for handles and patch fittings must be drilled in the glass prior to tempering. The diameter of these holes is usually slightly larger than the thickness of the glass. See ASTM C1048 for glass fabrication guidelines.

**Table 3: Recommended Maximum Interior or Exterior Swinging Door Sizes**

<table>
<thead>
<tr>
<th>Fully Tempered Glass</th>
<th>Patch Fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass Thickness: inches (mm)</td>
<td>3/8 (10)</td>
</tr>
<tr>
<td>Glass Weight: lbs/ft²</td>
<td>5</td>
</tr>
<tr>
<td>Width: inches (mm)</td>
<td>36 (914)</td>
</tr>
<tr>
<td>Height: inches (mm)</td>
<td>84 (2130)</td>
</tr>
<tr>
<td>Glass Weight: lbs/ft²</td>
<td>105</td>
</tr>
<tr>
<td>Concealed Overhead Closer</td>
<td>36 (914)</td>
</tr>
<tr>
<td>Floor Closer</td>
<td>84 (2130)</td>
</tr>
<tr>
<td>Glass Weight: lbs/ft²</td>
<td>105</td>
</tr>
</tbody>
</table>

For special applications, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlbe.com.
all-glass entrance systems

Specifications

Door Styles

Fitting Designations

Fitting

Fitting and Design Information/Hardware

GANA Fin Usage Recommendations

See “Entrances” section 6, page 5 for additional “All Glass” products
All-Glass Entrance Systems: Specifications

Part 1. General

Description
Work included: furnish all necessary materials, labor and equipment for the complete installation of the All-Glass Entrance System as shown on drawings and specified herein.

Work not included: structural support, interior closures, trim.

Quality Assurance
Drawings and specifications are based upon door style, (select from page 17) as manufactured by Oldcastle BuildingEnvelope™. Whenever substitutes are to be considered, supporting technical literature, samples, drawings and performance data must be submitted ten days prior to the bid in order to make a valid comparison of the product involved.

Part 2. Products

Fittings
Top and bottom fittings will be of cast structural alloys with formed cover plates to match desired finish. All assembly connections will have stainless steel threaded inserts or utilize roll thread fasteners. All assemblies will be constructed of high-density, hardened aluminum castings capable of achieving maximum clamping force.

Glass
Glass will be (Specify one of the following):
- 3/8” and 1/2” thick, fully tempered, clear, gray, bronze, or low iron.
- 5/8” and 3/4” thick, fully tempered, clear or low iron.
- Glass will conform to requirements set forth by ASTM Specifications C1036 and C1048 for fabrication and tempering. All exposed edges will be flat-polished to a reflective appearance similar to the glass surface.

The glass adjacent to or above the door, along with that of the door, must be supplied by the entrance manufacturer to ensure a proper fit and alignment. It is highly recommended that the entrance manufacturer supply all-glass for the entire all-glass opening to ensure a uniform color match of the glass.

Finishes
All exposed surfaces will be free of scratches and other serious blemishes. Rail, channel and pan cover finishes will be (Select one of the following):
- For extruded aluminum, an Architectural Class II clear anodic coating conforming with Aluminum Association standards.
- A fluoropolymer paint coating conforming with the requirements of AAMA605.2. Color will be (Specify):
- Stainless Steel clad using an alloy 304 finished as follows (specify one): polish or satin.
- Brass/Bronze clad finished (samples required) as follows (specify one): polish or satin.

Hardware
Due to the necessary interaction of entrance components, it is imperative that all hardware be supplied and/or coordinated by the entrance manufacturer.

Hardware for the All-Glass Entrance System will be furnished by the entrance supplier. Where practical, all hardware fittings will be installed at the factory before the shipment will be made. Hardware will be the entrance manufacturer’s standard, as follows:
1. Top corner patch (see page 18)
2. Bottom corner patch (see page 18) or full rail (see page 6).
All-Glass Entrance Systems:
Specifications (continued)

3. Transom and sidelite patches based on entrance design (see pages 17-21).
4. Patch locks (see page 20) or bottom rail lock, if rail (see page 38).
5. Pivots (see pages 21 and 38) and/or door closers (see page 36).
6. Handles (see page 40).
7. Exit devices (see page 41).

For all above, specify manufacturer, model, style, type, finish, etc. as appropriate.

If lock cylinders are to be master keyed, it is suggested that cylinders be included under the “Finish Hardware” section of the specifications.

Part 3. Execution

Installation
Doors will be installed by qualified installers in a workmanlike manner in accordance with industry standards. All items under this specification will be set in correct locations as shown in the details and will be level, square and plumb.
All-Glass Entrance Systems:
Entrance Configurations/Fitting Designations

Door Styles:
The above Entrance Configurations will accommodate door styles A, F and BP (shown at left).

*For specification information for BP style doors, and for 3/4” glass, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.
All-Glass Entrance Systems:
Fittings

**OBE-42410 Top Corner Patch with Pivot Housing**

**Function**
Provides housing for a top-pivot or closer spindle block assembly.

**Specifications**
- Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel.
- Cover plates can be removed from both sides for installation. Pressure-applied to 3/8", 1/2", 5/8" or 3/4" glass.

**OBE-41410 Bottom Corner Patch with Pivot and Closer Housing**

**Function**
Provides housing for a bottom-pivot assembly or floor closer spindle.

**Specifications**
- Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel.
- Cover plates can be removed from both sides for installation. Pressure-applied to 3/8", 1/2", 5/8" or 3/4" glass.

**OBE-44010 Transom/Sidelite Pivot Patch**

**Function**
Supports transom glass off of the adjacent sidelite and provides a top pivot pin for door.

**Specifications**
- Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel.
- Cover plates can be removed from both sides for installation. Pressure-applied to 1/2", 5/8" or 3/4" glass.

**OBE-43410 Transom to Wall Pivot Patch**

**Function**
Supports transom glass off of the adjacent jamb and provides a top pivot pin for door.

**Specifications**
- Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel.
- Cover plates can be removed from both sides for installation. Pressure-applied to 1/2", 5/8" or 3/4" glass.
All-Glass Entrance Systems: Fittings

**OBE-47710 Transom Double Pivot Patch**

**Function**
Provides top pivots off of the glass transom for a pair of doors that pivot at the center of opening.

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 1/2", 5/8" or 3/4" glass.

**OBE-44610 Transom/Sidelite Patch with Door Stop**

**Function**
Supports transom glass off of the adjacent sidelite and provides a door stop for a single door.

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 1/2", 5/8" or 3/4" glass.

**OBE-47210 Transom Door Stop Patch**

**Function**
Provides a door stop for a pair of doors with a glass transom above.

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 1/2", 5/8" or 3/4" glass.

**OBE-46500 180° Connector Patch**

**Function**
Stabilizes lite off of the adjacent lite and secures lite above or below.

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 1/2", 5/8" or 3/4" glass.
All-Glass Entrance Systems:

**Fittings**

**OBE-16500 Bottom Lock Patch with Dead Bolt**

**Functions**
Provides a bottom lock with a dead bolt (11/16" long).

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 3/8", 1/2", 5/8" or 3/4" glass.

**OBE-16300 Patch Lock with Dead Bolt**

**Functions**
Provides a center lock with a dead bolt (11/16" long). Can also be used as bottom lock.

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 3/8", 1/2", 5/8" or 3/4" glass.

**OBE-16400 Center Lock Strike**

**Functions**
Provides a strike for OBE-16300, a center lock application.

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 3/8", 1/2", 5/8" or 3/4" glass.

**OBE-461XX Stabilizer Fin Bracket**

**Functions**
Attaches the glass stabilizing fin to a transom/sidelite pivot patch.

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 1/2" or 3/4" glass.

**Fitting Options:** Part no. OBE-46150 for 1/2" glass; OBE-46153 for 3/4" glass.
All-Glass Entrance Systems:
Fittings and Design Information/Door Hardware

OBE-360 Top Pivot

**Function**
Provides a top pivot pin for surface mounting.

**Specifications**
Constructed of a solid stainless steel pin welded to a solid stainless steel plate; cover plates are of stainless steel or brass.

OBE-11500 Bottom Pivot

**Function**
Provides a height-adjustable bottom pivot.

**Specifications**
Constructed of solid stainless steel or brass plate with a roller bearing assembly. Adjustable from 1/4” to 1/2”.

OBE-46700 Transom or Sidelite to Wall Bracket

**Function**
Supports a transom or a sidelite off of an adjacent structure.

**Specifications**
Constructed of cast structural alloys; cover plates are formed aluminum, brass or stainless steel. Cover plates can be removed from both sides for installation. Pressure-applied to 3/8”, 1/2”, 5/8” or 3/4” glass.
All-Glass Entrance Systems:
GANA Reference Material

**Fully Tempered Glass Transoms**

Fully tempered glass transoms are those fixed glass panels immediately above the door opening, and often span between the top of the doors and the finished ceiling. These fully tempered glass transoms can be incorporated into the glass entrance using patch fittings or other transom support methods. Large-size glass transoms using patch fittings may require mechanical fastening to the ceiling structure, based on weight, size and other design considerations. (See pages 23-26.)

**Fully Tempered Glass Stabilizer Fins**

With all glass transoms and sidelites, perpendicular, fully tempered heavy glass mullions, sometimes called fins, may be mounted from the ceiling to the bottom of the transom to reduce the amount of deflection of the glass entrance. The fin must be mechanically fastened and anchored to the overhead load-carrying structure. Suspended ceilings do not provide an adequate structure for the attachment of stabilizer fins. Typically these glass fins are made using 1/2" (12 mm) or 3/4" (19 mm) thick fully tempered glass. See pages 23-26 for structural design criteria for the design and use of glass stabilizer fins.

![Figure 19. Fully Tempered Glass Stabilizer Fins](image)

**Structural Design of Interior Glass Entrance Systems**

One of the primary purposes of this design guide is to ensure that the designer has considered the structural limitations of the glass and metal fittings, so that the fully tempered entrance system will function satisfactorily and safely. Fully tempered all-glass entrance systems using patch fittings were originally designed in Europe and were used in both interior and exterior installations. Interior glass is not subject to uniform wind loading; other loading criteria had to be developed.

Many interior entrances are designed with the glass panels supported at the head and sill only and without additional mullions or other lateral support. Because the glass panels of interior glass entrances and partitions are mounted or restrained on only two sides (top and bottom), they require special design considerations. Glass held only on two sides is much more flexible than glass supported on all four sides. If the glass is too thin, small fluctuations of interior air pressure, or the operation of a door can cause the glass to tremble or shimmer. Persons pushing or leaning on glass that is too thin will noticeably deflect the glass. As the unsupported span of height of the glass panels increases, the glass thickness must also
be increased to maintain a reasonable stiffness. In this design guide we have separated the design considerations into two-sided support and three-sided support. Uniform horizontal pressures or other interior loading criteria are not clearly defined in most building codes. The International Building Code (IBC) limits the differential deflection of two adjacent unsupported sides of the interior glass panels. The recommended minimum thickness of fully tempered glass required to meet the International Building Code (IBC) for adjacent panels that are NOT linked together to prevent differential deflection is shown in Table 2 of Section 11 of the GANA Tempered Glass Engineering Standards Manual. By permanently clipping adjacent panels or siliconing the joints of adjacent panels, the thickness limits shown in Table 1 (Section 11 of the GANA Tempered Glass Engineering Standards Manual) can be used.

**Two-Sided Support**

Based upon the recommendations shown in Table 1 of the GANA Tempered Glass Engineering Standards Manual, the maximum height of heavy glass sidelite panels is as shown below in Figure 20.

<table>
<thead>
<tr>
<th>Glass Thickness: inches (mm)</th>
<th>Maximum Height: inches (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 (10)</td>
<td>96 (2438)</td>
</tr>
<tr>
<td>1/2 (12)</td>
<td>120 (3048)</td>
</tr>
<tr>
<td>3/4 (19)</td>
<td>168 (4267)</td>
</tr>
</tbody>
</table>

Figure 20. *Interior Entrance Size when Supported at Head and Sill*
Most fully tempered all-glass interior entrance systems are designed using 1/2" (12 mm) thick fully tempered glass; the following design examples are for 1/2" (12 mm) thick fully tempered glass. The structural loading criteria used for two-sided supported panels in this design guide were developed using the force developed by the weight of the glass doors being opened 90° to the plane of the entrance as the primary design load for these interior applications. This load is often greater than the 0.25-0.5 kPa (5 to 10 PSF) interior design load often stated in building codes. When a sidelite is located adjacent to a door, this sidelite is often required to support the weight of an operating glass door. If this sidelite is too narrow, it doesn’t have sufficient strength to support the weight of the door without deflecting (flexing) to the point where the toe of the door will drag on the floor as it is opened. The chart in Figure 21 is furnished using common door sizes. This chart is constructed so that if the glass door toe deflects downward more than 1/4" (6 mm) due to the weight of the door, the sidelite is too flexible. If this occurs, the design must be changed either by securing the jamb of the sidelite to provide three-sided support or by adding fully tempered stabilizer fins.

In order to determine if fins are (or are not) required for an interior glass entrance system with two-sided support, the door width and transom height must be known. See “T” (transom height) and “W” (sidelite width) in Figure 20. The maximum height for 1/2" (12 mm) glass is 120” (3 m), as shown in Figure 20, and must not be exceeded. As can be seen in the chart, the minimum width for a sidelite that must support the weight of the door is 12” (305 mm). Use “T” and “W” in the chart below (Figure 21) to establish a reference point. If this reference point is below the door width line in the chart, fins are not required. If this point is above the line, fins are required to provide additional lateral stability for the entrance.

**Figure 21.**
Fin Requirement Chart for Doors and Transoms with Two-Sided Support for Interior Glass Entrance Systems
All-Glass Entrance Systems:
GANA Reference Material

Three-Sided Support

Often an interior glass entrance can be supported structurally at the jambs, as well as at the head and sill, as shown in Figure 22. Three-sided support is obtained with the addition of structural members on the vertical edges of the sidelites adjacent to the doors. If the glass sidelite is structurally supported on three sides, it will deflect much less than when it is supported only at the top and bottom. Narrower sidelites are stiffer because they are also supported at the jambs. It is also possible to provide a structurally supported edge for a sidelite by making a 90° corner so that the perpendicular sidelite becomes a full-height structural stabilizer for the adjacent sidelite. Structural silicone is often used to connect the glass corner to provide structural adequacy, but 90° patch fittings and clamps can also be used to stabilize the corners.

If the sum of the height of the transom “A” plus the width of the sidelite “B” is 72” (1,830 mm) or less, the stabilizer fins are not required. \( A + B < 72" \) \( [1,830 \text{ mm}] \), fins are not required. The traditional method of analyzing the requirement for structural glass stabilizer fins was developed in Europe more than 20 years ago. The European method of determining fin requirements is more conservative than this formula, because it was used for both interior and exterior openings with low-wind-load design. The European formula that has been used is that if \( A + B < 48" \) \( (1,200 \text{ mm}) \), fins are not required.

If the entrance is to be used heavily or additional stability is desired, a more conservative formula could be used, so that fins would be required for smaller openings. Conversely, in applications (such as interior malls) when the doors are locked, open all-day stabilizers may not be needed because of the limited use of the doors. The design professional must consider glass strength and deflection for both two- and three-sided glass support using this analysis to determine glass fin requirements.
All-Glass Entrance Systems:
GANA Reference Material

Stabilizer Fins
In most interior applications a 12" (305 mm)-deep 1/2" (12 mm) glass mullion is adequate for transom/fin heights of up to 24" (610 mm). If the transom/fin height is greater than 24" (610 mm), the fin width at the top will need to increase, as shown on Figure 23. The top of the stabilizer fin must be securely fastened to a rigid structure at the top of the assembly, usually by means of back-to-back metal angles clamped to the fin using gaskets and through bolts. Two bolts are sufficient for fins up to 36" (1 m) high, but three or more bolts will be required for higher and deeper stabilizer fins.

Even with glass stabilizer fins, the recommended maximum height limit for 1/2" (12 mm) fully tempered glass is 168" (4.2 m) for three-sided, supported interior applications, and even less for exterior applications depending on the wind load. Fully tempered glass transoms using patch fittings may also require a mechanical fastening to the ceiling structure due to the weight of the glass transom.

Figure 23.
Fin Stabilizer Width/Depth Chart
bottom-rolling and top-hung sliding doors

Bottom-Rolling Specifications

Bottom-Rolling Details

Rail Profiles

Top-Hung Sliding Specifications

Top-Hung Sliding Door Section

Top-Hung Sliding 90° Stack Area

Top-Hung Sliding Parallel Stack Area

Top-Hung Sliding Roller Unit
Bottom-Rolling and Top-Hung Sliding Glass Doors: Bottom-Rolling Specifications

Specifications

Part 1. General

Description
Work included: furnish all necessary materials, labor and equipment for the complete installation of bottom-rolling sliding doors, as shown on drawings and specified herein.

Work not included: structural support, interior closures, trim.

Quality Assurance
Drawings and specifications are based upon the door style, as manufactured by Oldcastle BuildingEnvelope™. Whenever substitutes are to be considered, supporting technical literature, samples, drawings and performance data must be submitted ten days prior to a bid in order to make a valid comparison of the product involved.

Part 2. Products

Rails
Top and bottom rails will be selected from rail profiles provided in this section. Rail sections will be of extruded aluminum of 6063-T5 alloy and dry-glazed. Dry-glazed rail may be a pressure assembly utilizing a fitted EPDM gasket, or mechanical rail assemblies utilizing torqued fasteners and gaskets to affix glass to rail. Dry-glazed rails use precision-fit end caps in the finish to match the rail.

Glass
Glass will be specified from one of the following:
- 3/8” and 1/2” thick, fully tempered, clear, gray, bronze or low iron.
- 5/8” and 3/4” thick, fully tempered, clear or low iron.
- Glass will conform to requirements set forth by ASTM Specifications C1036 and C1048 for fabrication and tempering. All exposed edges will be flat-polished with arris to a reflective appearance similar to the glass surface.

Finishes
All exposed surfaces will be free of scratches and other serious blemishes.
Rail finishes will be (Select one of the following):
- For extruded aluminum, an architectural Class II clear anodic coating conforming with Aluminum Association standards.
- A fluoropolymer paint coating conforming with the requirements of AAMA605.2. Color will be:
  - Stainless Steel clad using an alloy 304 finished as follows (specify one): polish or satin.
  - Brass/Bronze clad-finished (samples required) as follows (specify one): polish or satin.

Hardware
Hardware for the bottom-rolling sliding doors will be furnished by the sliding glass door supplier. Where practical, all hardware fittings will be installed at the factory before the shipment is made. Hardware will consist of the following: LLO5 straddle bolt lock mounted in the bottom rail and factory-installed tandem roller with a 3/4” height adjustment. Head and sill track will be of solid aluminum extrusion, alloy 6063-T5 and anodized or clad to match door rails.
Bottom-Rolling and Top-Hung Sliding Glass Doors: Bottom-Rolling Specifications

Specifications (continued)

Part 3. Execution

Installation
Doors will be installed by qualified installers in a workmanlike manner in accordance with industry standards. All items under this specification will be set in correct locations, as shown in the details, and will be level, square and plumb.
Bottom-rolling sliding doors are adaptable to single- or multiple-track installations. They can utilize any of the standard Oldcastle BuildingEnvelope™ rails and finishes but must be P-style doors with continuous top and bottom rails. Depending upon the rail style, they can use 3/8" and 1/2" clear, gray or bronze glass 5/8" or 3/4" clear or low iron glass.

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
**Bottom-Rolling and Top-Hung Sliding Doors: Rail Profiles**

### Rail Profile Dimensions

**Standard:**
- 1-3/4" x 3-3/8", 3-5/8", 4"

**Option:**
- 1-3/4" x 6" square

**ADA-Compliant:**
- 1-3/4" x 3-5/8" and 4" tapered
- 1-3/4" x 10" square

- Rail assemblies are provided in wet- or dry-glazed rails. Dry-glazed rails utilize pressure-fitted gasket or are mechanically fastened.
- Custom rail heights available by special order.
- Rails are supplied with standard precision applied end caps.

For other rail height dimensions, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.

**Brite Vue® Door Rail**

- Precision applied end caps
- Optional taper
- Gasket
- Mechanical assembly
- Side mount grip system
- Bottom mount wedge system
- Pressure assembly
- Full extrusion for cladding support

**Note:** Drawings not to scale
Bottom-Rolling and Top-Hung Sliding Doors:
Top-Hung Sliding Specifications

Specifications

Part 1. General

Description
Work included: furnish all necessary materials, labor and equipment for the complete installation of top-hung sliding doors, as shown on drawings and specified herein.

Work not included: structural support, interior closures, trim.

Quality Assurance
Drawings and specifications are based upon door style for top-hung sliding doors, as manufactured by Oldcastle BuildingEnvelope™ (“Oldcastle”). Whenever substitutes are to be considered, supporting technical literature, samples, drawings and performance data must be submitted ten days prior to a bid in order to make a valid comparison of the product involved.

Part 2. Products

Rails
Top and bottom rails will be selected from rail profiles provided in this section. Rail sections will be of extruded aluminum of 6063-T5 alloy and dry-glazed. Dry-glazed rail may be a pressure assembly utilizing a fitted EPDM gasket, or mechanical rail assemblies utilizing torqued fasteners and gaskets to affix glass to rail. All rails use precision-fit end caps in the finish to match the rail.

Glass
Glass will be (Specify one of the following):
- 3/8” and 1/2” thick, fully tempered, clear, gray, bronze or low iron.
- 5/8” and 3/4” thick, fully tempered, clear or low iron.
- Glass will conform to requirements set forth by ASTM Specifications C1036 and C1048 for fabrication and tempering. All exposed edges will be flat-polished with arris to a reflective appearance similar to the glass surface.

Part 2. Products

Finishes
All exposed surfaces will be free of scratches and other serious blemishes.

Rail finishes will be (Select one of the following):
- For extruded aluminum, an Architectural Class II clear anodic coating conforming with Aluminum Association standards.
- A fluoropolymer paint coating conforming with the requirements of AAMA605.2. Color will be:
  - Stainless Steel clad using an alloy 304 finished as follows (specify one): polish or satin.
  - Brass/Bronze clad finished (samples required) as follows (specify one): polish or satin.

Hardware
Hardware for the top-hung sliding doors will be furnished by the rolling door supplier. Where practical, all hardware fittings will be installed at the factory before the shipment is made.

Part 3. Execution

Installation
Doors will be installed by qualified installers in a workmanlike manner in accordance with industry standards. All items under this specification will be set in correct locations, as shown in the details, and will be level, square and plumb.
Bottom-Rolling and Top-Hung Sliding Doors:
Top-Hung Sliding Door Section

Pictured here is a vertical section of our 90° and parallel stacking system.

Detail shown is for reference only. Dimensions may vary. For specific applications, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.

Note: Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.

SECTION VIEW AT HEAD

SECTION VIEW AT SILL

Note:

Drawings not to scale. All dimensions for reference only. Actual values based on project design and conditions.
Bottom-Rolling and Top-Hung Sliding Doors: Top-Hung Sliding 90° Stack Area

90° Stacking Door System

PICTURED HERE IS A PLAN VIEW OF A 90° STACKING SYSTEM IN THE CLOSED POSITION.

PICTURED HERE IS A PLAN VIEW OF A 90° STACKING SYSTEM IN THE OPEN OR "PARKED" POSITION.
Bottom-Rolling and Top-Hung Sliding Doors:
Top-Hung Sliding Parallel Stack Area

Parallel Stacking Door System

PICTURED HERE IS A PLAN VIEW OF A PARALLEL STACKING SYSTEM IN THE CLOSED POSITION.

PICTURED HERE IS A PLAN VIEW OF A PARALLEL STACKING SYSTEM IN THE OPEN OR “PARKED” POSITION.
Bottom-Rolling and Top-Hung Sliding Doors:
Top-Hung Sliding Roller Unit

Roller Unit/Suspension System

Stainless steel top rollers utilize the highest-quality roller bearings, permitting quiet, easy manipulation of the panels. The roller is adjustable.

Note: structural condition at the head must be adequate to support the full weight of the track system and tempered glass doors.

Note: Detail shown is for reference only. For specific applications, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlbe.com.
hardware

- Closers
- Center-Hung Pivots
- Offset Pivots / Standard Locks
- Electric Locks
- Pulls
- Panic Devices
- Entrance Components
Floor Closer

**Function**
Provides a hydraulically controlled, center-pivoted, single- or double-acting door operation or an offset-pivoted, single-acting operation.

**Operation**
Includes door-centering adjustment to simplify door alignment. One-screw adjustment of latching speed. Available with extended spindles from the factory for heavy-duty reliability.

**Specifications**
Maximum door size and weight:
(See Table 3, page 13 for further size limitations.)

- 90° or 105°
- Hold-open or no-hold-open available.

Backcheck is available, subject to ADA Code restrictions. Check with local code authorities.

For specific applications, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.

Overhead Closer

**Function**
Provides a hydraulically controlled, center-pivoted, single- or double-acting door operation.

**Operation**
Built-in mechanical backcheck offers a cushioning action prior to contact with positive stop. Closing and latching speeds are individually adjustable.

**Specifications**
Maximum door size and weight:
(See Table 3, page 13 for further size limitations.)

- 90° or 105°
- Hold-open or no-hold-open available.

Backcheck is available, subject to ADA Code restrictions. Check with local code authorities.

For specific applications, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com.
Hardware: Center-Hung Pivots

**Top-Pivot Walking Beam**

**Function**
Provides top pivot for center-pivoted, all-glass doors.

![Top-Pivot Walking Beam](image1)

**Bottom-Pivot-Floor or Threshold**

**Function**
Provides an adjustable bottom pivot for center-pivoted, all-glass doors.

![Bottom-Pivot-Floor or Threshold](image2)

**OBE-11500 Bottom Pivot**

**Function**
Provides a height-adjustable bottom pivot for all-glass doors that need a larger clearance due to special finished floor conditions.

![OBE-11500 Bottom Pivot](image3)
**Top Offset Pivot**

**Function**
Provides a top-pivot for full-rail all-glass doors or full-framed clad doors.

**Finishes**

**Bottom Offset Pivot Arm**

**Function**
Provides a bottom pivot for full-rail all-glass doors or full-framed clad doors when offset floor pivots or floor closers are used.

**Finishes**

For specific hardware details, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlembe.com.

**LL05 Bottom Rail Lock with Round Bolt**

**Function**
Provides security on entrance doors. Locks may be activated with cylinders and/or thumb turns. Locks can have cylinder guards and/or lock indicators. Cylinders and/or thumb turns may be changed without removing the doors.

**Finishes**
Cylinders can be finished to match rails.

**Specifications**
A solid brass body construction with a steel pin in the bolt. A round bolt with a 1-3/32" straight throw.

Cylinder guards and exit indicators are optional.
Hardware: Electric Locks

Shearlock

Totally concealed and mortise-mounted, this electro-magnetic lock has a substantial holding force, yet releases immediately when the lock magnet is turned off. Can be controlled by a variety of sources including door switches, remote control consoles, card readers and cypher-locking systems.

Remote control accessories are supplied by others.

The lock must be securely fastened to maintain the holding force.

Electric Strike

Provides entrance security control on doors with panic devices. Electric latch strikes are header-mounted.

For use with tempered glass swing doors or full-framed clad doors.

May require a 2" x 6" header.

Encasement may be used with a 2" x 4" header.

Electric Deadbolt

Electro-mechanical deadbolt is concealed and overhead-mounted only.

(Other security devices are available, call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com).
Hardware: Handles
(Typical handles shown below; others are available upon request.)

**OBE-3 Back-to-Back “C” Pulls**

**OBE-3OS Offset Back-to-Back Pull**

**OBE-5 Back-to-Back Circular Pull**

**OBE-8 Push-Pull**

*Note: Drawings not to scale*
Hardware: Exit Devices

CR Laurence, PA100 Panic Device

Function
Provides emergency egress for a single door or pairs of tempered glass doors. Mechanically fastens into doorstop/strike at the head. Can be used in conjunction with the Folger Adam 310-1 electric strike for entrance security control.

Finishes

Specifications
Maximum interior door height:
- 1/2" glass: 102"
- 3/4" glass: 108"
Door is shown with an PA100 exit device with an “A” type exterior handle.

Other Panic Device Hardware options are available upon request; call 1-866-OLDCASTLE (653-2278.)

Electronic Exit Device

Function
Provides entrance security control for a single door or pairs of tempered glass doors using a touch-sensitive handle. The door is secured by electromagnetic locks, using either surface-mounted maglocks or concealed shearlocks. When the interior bar is touched, a relay in the sensor is tripped, releasing the lock.

Finishes

Specifications
The door is shown with a horizontal exterior pull handle. A full-width top rail must be used.

Other options are available upon request; call 1-866-OLDCASTLE (653-2278.)
Locks

Most fully tempered heavy glass doors are secured using a dead bolt lock with standard-keyed cylinders and/or thumb turns. Locks can be mounted into a door rail or a patch fitting. Locks are typically mounted on the bottom of the door, with the bolts engaging a strike plate or threshold. If a round throw bolt is used, a covered "dustproof" strike may be used to prevent dirt accumulation in the strike area.

Occasionally, it is desirable to locate the lock in the jamb of the opening. In order to accomplish this, a center lock housing is mounted on the door at the handle height to accommodate the lock. The strike plate is mounted on an adjacent sidelite or metal door jamb. Electric locks and strikes, both drop bolt and magnetic, may be used. Exit devices can be installed in all fully tempered heavy glass doors, engaging in the top, bottom and/or jamb of the opening.

Handles

A variety of shapes and styles of handles may be used on fully tempered heavy glass doors. The most common are 1” (25 mm) diameter metal pull handles, attached through holes in the glass. These pull handles can be either vertical or horizontal, straight or offset. Handles are available to match the metal finish on the door or they can be made of wood, plastic or a contrasting metal finish. These handles are typically made by "finish hardware" manufacturers and can be supplied either by the glass door manufacturer or by the finish hardware supplier. Holes for the handles must be drilled in the glass prior to tempering. Because of the hole pattern or size, not all handles can be mounted to heavy fully tempered glass. Designers should consult with the glass door manufacturer or hardware supplier as to the suitability of a particular handle for mounting onto heavy fully tempered glass.

See the figures below for the commonly used heavy glass door pull-handle configurations.

Note: Drawings not to scale
sample architectural
glass specifications
Architectural Glazing Specifications

Section 08 81 00 - Glass Glazing

Part 1 General

1.01 Summary
A. Section Includes: glass, including heat-treated glass, insulating glass units, silk-screened glass, spandrel glass, laminated glass, glass-clad polycarbonate and fire-rated glass.

B. Related Sections
1. Drawings, General and Supplementary Conditions of the Contract, Division 1, and the following Specification Sections, apply to this section.
2. Section 08 40 00 – Entrances, Storefronts and Curtain Wall
3. Section 08 41 00 – Entrances and Storefronts
4. Section 08 42 00 – Entrances
5. Section 08 43 00 – Storefronts
6. Section 08 44 00 – Curtain Walls and Glazed Assemblies
7. Section 08 50 00 – Windows
8. Sections 08 60 00 – Roof Windows and Skylights

1.02 References
(Note: Delete all reference standards that are not actually required and add any additional standards required by the municipality and/or state where the project is located. The Contracting Requirements of Division 1, Section 01 42 00 – References, may establish the edition date of standards not otherwise indicated. Division 1 may include full names and addresses of the organizations whose standards are referenced.)

A. United States
8. ASTM E1300–Standard Practice for Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load.

B. Canada
1. CAN/CGSB-12.1–M–Tempered or Laminated Safety Glass.
2. CAN/CGSB-12.2–M–Flat, Clear Sheet Glass.
3. CAN/CGSB-12.3–M–Flat, Clear Float Glass.
5. CAN/CGSB-12.8–M–Insulating Glass Units.
6. CAN/CGSB-12.9–M–Spandrel Glass.
Architectural Glazing Specifications

**Section 08 81 00 - Glass Glazing** (USA and Canada) (continued)

7. CAN/CGSB-12.10-M–Light and Heat Reflecting Glass.

C. United States and Canada
1. GANA Glazing Manual; Glass Association of North America.
2. GANA Sealant Manual; Glass Association of North America.
5. GANA/GTA 89-1-6–Specification for Environmental Durability of Fully Tempered or Heat-Strengthened Spandrel Glass with Applied Opacifiers.
12. UL752–Standard for Bullet-Resisting Equipment.

1.03 Definitions
A. Sealed Insulating Glass Unit Surfaces and Coating Orientation:
1. Surface 1–Exterior surface of outer pane (surface facing outdoors of outboard lite).
2. Surface 2–Interior surface of outer pane (surface facing indoors of outboard lite).
4. Surface 4–Room side surface of inner pane (surface facing indoors of inboard lite).

B. Performance Characteristics
1. Center of Glass–Performance values that take only the center portion of a glass make-up into account and not the framing members. Customarily found in manufacturer’s catalogs and Oldcastle BuildingEnvelope™ GlasSelect® and used in 08 81 00 architectural specifications.
2. Glass thermal and optical performance properties will be based on data and calculations from the current LBNL Window 5.2 computer program.
3. Fenestration Performance–Performance values that take into account the total fenestration (center of glass and framing members). Normally identified with building energy codes such as ASHRAE-IESNA 90.1 and the IECC. These values can also be tested and certified by the National Fenestration Rating Council (NFRC).

1.04 System Description
A. Design Requirements
1. Provide glazing systems capable of withstanding normal thermal movements, wind loads and impact loads, without failure, including loss due to defective manufacture, fabrication and installation; deterioration of glazing materials; and other defects in construction.
2. Provide glass products in the thicknesses and strengths (annealed or heat-treated) required to meet or exceed the following criteria based on project loads and in-service conditions per ASTM E1300.
   a. Minimum thickness of annealed or heat-treated glass products is selected, so the worst-case probability of failure does not exceed the following:
1) 8 lites per 1,000 for glass installed vertically or not over 15 degrees from the vertical plane and under wind action.
2) 1 lite per 1,000 for glass installed 15 degrees or more from the vertical plane and under action of wind and/or snow.

1.05 Submittals
A. Submit 12-inch (305 mm) square samples of each type of glass indicated (except clear monolithic glass products), and 12-inch (305 mm) long samples of each color required (except black) for each type of sealant or gasket exposed to view.

B. Submit the manufacturer’s product data sheet and glazing instructions.

C. Glazing contractor will obtain compatibility and adhesion test reports from the sealant manufacturer, indicating that glazing materials were tested for compatibility and adhesion with glazing sealant, as well as other glazing materials including insulating units.

D. Glazing contractor will provide test reports showing that the glass meets the requirements of any security test reports specified on drawings.

1.06 Quality Assurance
A. Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this section or referenced standards.
   1. GANA Publications
   2. AAMA Publications
   3. IGMA/IGMAC Publications

B. Safety glass products in the USA are to comply with CPSC 16 CFR Part 1201.

C. Safety glass products in Canada are to comply with the testing requirements of CAN/CGSB-12.1–M, Type 1 for Laminated Glass and Type 2 for Tempered Glass.

   1. Provide safety glass permanently marked with the company name or logo and CAN/CGSB-12.1–M if the product meets categories 1 and 2, or mark as CAN/CGSB-12.1–M–1 if the product meets the requirements of Category 1 only.

D. Insulating Glass products are to be permanently marked either on spacers or at least one insulating unit component with an appropriate certification label of the inspecting and testing agency indicated below:
   1. USA–Insulating Glass Certification Council (IGCC)
   2. Canada–Insulating Glass Manufacturers Alliance (IGMA) or Insulating Glass Manufacturers Association of Canada (IGMAC)

E. Single-source fabrication responsibility: All glass fabricated for each type will be processed and supplied by a single fabricator.

1.07 Delivery, Storage and Handling
A. Comply with the manufacturer’s instructions for receiving, handling, storing and protecting glass and glazing materials.

B. Delivery: Deliver materials in the manufacturer’s original, unopened, undamaged containers, with identification labels intact.

C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

D. Exercise exceptional care to prevent edge damage to glass, and damage/deterioration to coating on glass.
ARCHITECTURAL GLAZING SPECIFICATIONS

SECTION 08 81 00 - GLASS GLAZING (USA and Canada) (continued)

Part 2. Products

2.01 Manufacturers
1. Oldcastle BuildingEnvelope™;
   “Manufacturer” is used in this section to refer to a firm that produces primary glass, or fabricated glass, defined in the referenced standards.

2. Guardian Industries
3. Pilkington
4. PPG Industries

2.02 Materials

A. Monolithic Float Glass
   1. Glass Type:
   2. Glass Tint:
   3. Nominal Thickness:
   4. Glass Strength: (Annealed, Heat-Strengthened, Tempered)
   5. Coating Orientation: (NA, Surface #___)
   6. Performance Characteristics (Center of Glass)
      a. Visible Transmittance:____%
      b. Visible Reflectance:____%
      c. Winter U-Factor (U-Value):____
      d. Shading Coefficient (SC):____
      e. Solar Heat Gain Coefficient (SHGC):____
   
   (Note: Repeat items from subparagraphs 1 thru 6 for each monolithic float glass product used.)

B. 5-year warranty from the date of manufacture for laminated glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting and maintaining practices contrary to the glass manufacturer’s published instructions.

D. Provide a written 5-year warranty from the date of manufacture for glass-clad polycarbonate. Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting and maintaining practices contrary to the glass manufacturer’s published instructions.

E. Where insulating glass units will be exposed to substantial altitude changes, comply with the insulating glass fabricator’s recommendations of venting and sealing.

1.08 Project/Site Conditions

A. Environmental requirements: Installation of glass products at ambient air temperature below 40°F (4.4°C) is prohibited.

B. Field Measurements: When the construction schedule permits, verify field measurements with drawing dimensions prior to fabrication of glass products.

1.09 Warranty

A. Provide a written 10-year limited warranty from the date of manufacture for insulating glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting and maintaining practices contrary to the glass manufacturer’s published instructions.

B. Provide a written minimum 5-year warranty from the date of manufacture for ceramic frit silk-screened, ceramic frit spandrel glass or OPACI-COAT-300® spandrel glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting and maintaining practices contrary to glass manufacturer’s published instructions.

C. Provide a written 5-year warranty from the date of manufacture for laminated glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting and maintaining practices contrary to the glass manufacturer’s published instructions.

D. Provide a written 5-year warranty from the date of manufacture for glass-clad polycarbonate. Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting and maintaining practices contrary to the glass manufacturer’s published instructions.

7. USA Requirements:
   a. Annealed float glass will comply with ASTM C1036, Type I, Class 1 (clear), Class 2 (tinted), Quality Q3.

   b. Heat-Strengthened float glass will comply with ASTM C1048, Type I, Class 1 (clear), Class 2 (tinted), Quality Q3, Kind HS.
c. Tempered float glass will comply with ASTM C1048, Type I, Class 1 (clear), Class 2 (tinted), Quality Q3, Kind FT.

8. Canadian Requirements:
   a. Annealed float glass will comply with CAN/CGSB-12.3-M, Glazing Quality.
   b. Tinted annealed float glass will comply with CAN/CGSB-12.4–M.
   c. Tempered float glass will comply with CAN/CGSB-12.1–M, Class B-Float Glass, Type 2-Tempered Glass.

9. Glass will be annealed, heat-strengthened or tempered as required by codes and specified on drawings.

10. Glass will be heat-treated by the horizontal (roller hearth) process with inherent roller wave distortion parallel to the bottom edge of the glass, as installed when specified.

B. Monolithic Fire-Rated Glass
1. Glass Type:
2. Nominal Thickness:
3. Framing: [Hollow Metal (HM) or Wood (W)]
4. Glazing System:
5. Rating: (Nonrated, UL __ minute (NH), UL __ minute, other)
6. USA Requirements:
   a. Wired glass will comply with ASTM C1036, Type II, Class 1 (clear), Quality Q6, Form 1 (Wired Glass, polished both sides), Mesh 1 (M1-Diamond) or Mesh 2 (M2-Square).
   b. Nonwired, fire-rated laminated glass will comply with ASTM C1172.
7. Canadian Requirements:
   a. Wire glass will comply with CAN/CGSB-12.11–M, Type 1, Style 1 (Diamond) or Style 3 (Square).
   b. None specified for nonwire, fire-rated laminated glass.
8. Fire rating level is to be as required by codes and specified on drawings.

C. Sealed Insulating Glass (IG) Units
1. Insulating Glass Unit Make-up
   a. Outboard Lite
      1) Glass Type:
      2) Glass Tint:
      3) Nominal Thickness:
   b. Spacer
      1) Spacer Material: (Aluminum, Stainless Steel, Other Warm Edge)
      2) Spacer Color: (Anodized, Black, Bronze, Champagne, etc.)
      3) Nominal Thickness: (1/2", etc.)
      4) Gas Content: (Air or 90% Argon)
   c. Inboard Lite
      1) Glass Type:
      2) Glass Tint:
      3) Nominal Thickness:
      4) Glass Strength: (Annealed, Heat-Strengthened, Tempered)
      5) Coating Orientation: (NA, Surface #___)

2. Performance Characteristics
   (Center of Glass)
   (Note: Verify that the glass type and thickness specified matches the Performance Characteristics listed below.)
   a. Visible Transmittance:____%
   b. Visible Reflectance:____%
   c. Winter U-Factor (U-Value):____
   d. Shading Coefficient (SC):____
   e. Solar Heat Gain Coefficient (SHGC):____

(Repeat items from subparagraphs 1 and 2 for each type of insulating glass unit.)

3. Provide sealed IG units with dehydrated airspace, dual sealed with a primary seal of polyisobutylene (PIB) and a secondary seal of silicone or an organic sealant, depending on the application.

4. USA Requirements:
   a. Insulating glass units are certified through the Insulating Glass Certification Council (IGCC) to ASTM E2188, E2189 and E2190.
Architectural Glazing Specifications

Section 08 81 00 - Glass Glazing (USA and Canada) (continued)

5. Canadian Requirements:
   a. Insulating glass units are certified through
      the Insulating Glass Manufacturers
      Association of Canada (IGMAC) to
      CAN/CGSB-12.8-M, or to the Insulating
      Glass Manufacturers Alliance (IGMA)
      Certification Program for ASTM E2188,
      E2189 and E2190.

D. Monolithic Ceramic Frit Silk-screened Glass

(Note: For Ceramic Frit Silk-screened Glass in an
Insulating Glass Unit, use the format for Sealed
Insulating Glass (IG) Units, substituting this section
for the lite (outboard or inboard) that is to be
silk-screened.)

1. Glass Type:
2. Glass Tint:
3. Nominal Thickness:
4. Glass Strength: (Heat-Strengthened,
   Tempered)
5. Silk-screen Orientation: (Surface #___)
6. Silk-screen Pattern:
7. Ceramic Frit Color: As selected by the
   architect from manufacturer’s standard
   color selection.

8. USA Requirements:
   a. Heat-treated glass with ceramic
      coating complying with ASTM C1048,
      Condition B (spandrel glass, one surface
      ceramic-coated), Type I (transparent
      glass, flat), Quality Q3 (glazing select)
      and comply with other requirements
      as specified.
   b. GANA/GTA 66-9-20, Specification for
      Heat-Strengthened or Fully Tempered
      Ceramic Enameled Spandrel Glass for
      Use in Building Window/Curtain Walls
      and Other Architectural Applications.

9. Canadian Requirements:
   a. Heat-treated glass with ceramic coating
      complying with CAN/CGSB-12.9-M, Class
      A-Float Glass, Type 1-Tempered
      or Type 2-Heat-Strengthened.

F. Monolithic OPACI-COAT-300®
   Spandrel Glass

(Note: For OPACI-COAT-300® Spandrel Glass in
an Insulating Glass Unit, use the format for Sealed
Insulating Glass (IG) Units substituting this section
for the lite (outboard or inboard) that is to have the
OPACI-COAT-300® Spandrel.)
1. Glass Type:
2. Glass Tint:
3. Nominal Thickness:
4. Glass Strength: (Heat-Strengthened, Tempered)
5. Coating Orientation: (NA, Surface #___)
6. Spandrel Orientation: (Surface #___)

7. OPACI-COAT-300® Color: As selected by the architect from the manufacturer’s standard color selection.

8. USA Requirements:
   a. Heat-treated glass with elastomeric coating complying with ASTM C1048, Condition C (other coated glass), Type I (transparent glass, flat), Quality Q3 (glazing select) and with other requirements as specified.
   b. GANA/GTA 89-1-31, “Specification for Environmental Durability of Fully Tempered or Heat-Strengthened Spandrel Glass with Applied Opacifiers,” and comply with other requirements as specified.

9. Canadian Requirements:
   a. None specified.

G. Monolithic Two-Ply (two lites of glass)
Laminated Glass

(Note: For Two-Ply Laminated Glass in an Insulating Glass Unit, use the format for Sealed Insulating Glass (IG) Units, substituting this section for the lite (outboard or inboard) that is to be Two-Ply Laminated. For specifications on other laminated glass make-ups, please call 1-866-OLDCASTLE (653-2278) or log on to www.oldcastlebe.com and click on “Project Assistance” and enter your request.

1. Laminated Glass Make-up
   a. Outer Ply
      1) Glass Type:
      2) Glass Tint:
      3) Nominal Thickness:
      4) Glass Strength: (Annealed, Heat-Strengthened, Tempered)
   b. Inner Ply
      1) Glass Type:
      2) Glass Tint:
      3) Nominal Thickness:
      4) Glass Strength: (Annealed, Heat-Strengthened, Tempered)
   5) Coating Orientation: (NA, Surface #___)

2. Performance Characteristics
   (Center of Glass)

   a. Visible Transmittance:___%
   b. Visible Reflectance:___%
   c. Winter U-Factor (U-Value):___
   d. Shading Coefficient (SC):___
   e. Solar Heat Gain Coefficient (SHGC):___

3. Laminated glass products are to be fabricated in an autoclave with heat, plus pressure, free of foreign substances and air pockets.

4. Interlayer material: Extruded Sheet Interlayer.

5. USA Requirements:
   a. Glass is to comply with ASTM C1172 and with other requirements as specified (UL, NIJ, WMFL, HP White, ASTM F 1233, etc.).

6. Canadian Requirements:
   a. Laminated glass complying with CAN/CGSB 12.1–M, Type 1-Laminated Glass, Class B-Float Glass and with other requirements as specified (UL, NIJ, WMFL, HP White, ASTM F 1233, etc.).

H. Glass-Clad Polycarbonate

1. Laminated Glass-Clad Polycarbonate products are to be fabricated in an autoclave with heat, plus pressure, free of foreign substances and air pockets.
Architectural Glazing Specifications

Section 08 81 00 - Glass Glazing (USA and Canada) (continued)

2. Interlayer Material: Optical Aliphatic Ether Polyurethane Sheet.
3. Polycarbonate Sheet is to be extruded and UV stabilized.
4. Glass is to comply with ASTM C1349 Standard Specification for Architectural Flat Glass-Clad Polycarbonate and with other requirements as specified (UL, NIJ, WMFL, HP White, ASTM F 1233, etc.).

I. Glazing Products
1. Select appropriate glazing sealants, tapes, gaskets and other glazing materials of proven compatibility with other materials that they contact. These include glass products, insulating glass unit seals and glazing channel substrates under installation and service conditions, as demonstrated by testing and field experience.

Part 3 Execution

3.01 Examination
A. Site Verification and Conditions
1. Verify that site conditions are acceptable for installation of the glass.
2. Verify that openings for glazing are correctly sized and within tolerance.
3. Verify that a functioning weep system is present.
4. Verify that the minimum required face and edge clearances are being followed.
5. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.02 Preparation
A. Protection
1. Handle and store products according to the manufacturers’ recommendations.

B. Surface Preparation
1. Clean and prepare glazing channels and other framing members to receive glass.
2. Remove coatings and other harmful materials that will hinder glass and glazing installation required to comply with performance criteria specified.

3.03 Installation
A. Install products using the recommendations of manufacturers of glass, sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those in the GANA Glazing Manual.

B. Verify that the Insulating Glass (IG) Unit’s secondary seal is compatible with glazing sealants.

C. Install glass in prepared glazing channels and other framing members.

D. Install setting blocks in rabbets, as recommended by referenced glazing standards in GANA and IGMA Glazing Guidelines.

E. Provide a bite on glass, a minimum edge and face clearances and glazing material tolerances recommended by GANA.

F. Provide weep system as recommended by GANA Glazing Manual.

G. Set glass lites in each series with a uniform pattern, draw, bow and similar characteristics.

H. Distribute the weight of the glass unit along the edge rather than at the corner.
I. Comply with the manufacturer’s and referenced industry recommendations on expansion joints and anchors, accommodating thermal movement, glass openings, use of setting blocks, edge, face and bite clearances, use of glass spacers, edge blocks and installation of weep systems.

J. Protect glass from edge damage during handling and installation.

K. Prevent glass from contact with contaminating substances that result from construction operations, such as weld spatter, fireproofing or plaster.

L. Remove and replace glass that is broken, chipped, cracked or damaged in any way.

3.04 Cleaning

A. Clean excess sealant or compound from glass and framing members immediately after application, using solvents or cleaners recommended by manufacturers.

B. Glass is to be cleaned according to:
   1. GANA Glass Informational Bulletin GANA 01-0300–Proper Procedures for Cleaning Architectural Glass Products.
   2. GANA Glass Informational Bulletin GANA TD-02-0402–Heat-Treated Glass Surfaces Are Different.

C. Do not use scrapers or other metal tools to clean glass.

End of Section