Product Availability
All Zeledyne Versalux® products are readily available and can be field fabricated by regional independent fabricators to reduce lead times and minimize construction delays.

As with any glass product manufactured with a coating, it is recommended that a mock-up be viewed by the design professional and building owner prior to final product selection. All Zeledyne Float Glass types meet manufacturing tolerances within applicable provisions of ASTM C 1036-2001 Standard Specification For Flat Glass.

It should be noted that all warranty statements disclaim any Zeledyne liability for breakage, replacement costs, and incidental, special, or consequential damages.

Tempering Considerations
Blue, green, grey, and bronze tinted glass have heat-absorbing characteristics and retain heat as part of the absorption process. Zeledyne Versalux reflective glass, with the coating on the second surface of heat-absorbing glass, absorbs increased amounts of solar energy and may require heat-strengthening or tempering to reduce the possibility of thermal breakage.

Uniform Load Data
Design professionals should review and adhere to all applicable national, state, and local building codes and regulations when selecting glass design load factors.

Chart A
Glass supported on four sides (Uniform Load kPa)
Uniform Load/Glass Strength Tables

Charts A and C may be used to determine the adequacy of a glass substrate of the indicated thicknesses to withstand a uniform static load for a 60 second duration. The wind load buildings are exposed to is neither static nor uniform. It is the design professional’s responsibility to translate a project’s specified wind or design loads into uniform static loads of a 60 second duration equivalent.

Four-Side Support

Chart A may be used to determine maximum permissible annealed glass sizes at Indicated Design Loads expressed in Uniform Pounds Per Sq. Ft. for 1/4” (6.0mm) thick glass. This four-side support chart is based on glass supported on all four sides, a design factor of 2.5, and a probability of failure rate of 8 lites per 1,000.

Example: Glass Size: 65” x 90”
- Locate the 90” line on the horizontal scale.
- Determine the location of the 65” dimension between the 60” and 70” lines on the vertical scale.
- Locate the intersection of a vertical line emanating from the 90” location on the horizontal scale and a horizontal line drawn from the location of 65” on the vertical scale.
- Draw a line from the 0 point at the junction of the horizontal and vertical scales until it intersects the previously determined point (between the 20 lb. and the 25 lb. lines.)
- Interpolate the point between the 20 lb. and 25 lb. lines.
- Maximum load example lite of glass will withstand with probability of failure rate of 8 lites per 1,000 is 22 PSF.

The dotted lines on the chart indicate points at which center of glass deflection will be 3/4” or greater. Strength of glass charts for additional thicknesses of glass may be found in ASTM E 1300 - 94 Standard Practice for Determining the Maximum Thickness and Type of Glass to Resist a Specified Load. ASTM E 1300-94 is available from the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

Four-Side Support

Assuming annealed monolithic glass to have a factor of 1, the multiplying factors shown in Chart B may be used to determine the approximate uniform load strength of further fabricated glass.*

Multiplying factors should not be used in combination, nor should they be used with the two-side support chart.

Heat strengthened and fully tempered glass will withstand greater uniform loads than annealed glass. Deflection characteristics, however, are the same for identical thicknesses of annealed, heat strengthened, or annealed substrates.

National and local building codes and regulations for wind load and safety requirements set forth the minimums that must be met, but do not necessarily represent the most current product availability for wind load factors.

GANA (Glass Association of North America) “Glazing Manual, 2004 edition/ASCE Standard 7-95” and many other publications offer insight into the many facets constituting design load.

### Chart B

<table>
<thead>
<tr>
<th>GLASS TYPE</th>
<th>MULTIPLYING FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monolithic Fully Tempered</td>
<td>4.0</td>
</tr>
<tr>
<td>Monolithic Heat Strengthened</td>
<td>2.0</td>
</tr>
<tr>
<td>Insulated Glass (Both Lites Fully Tempered)</td>
<td>7.2</td>
</tr>
<tr>
<td>Insulated Glass (Both Lites Heat Strengthened)</td>
<td>3.6</td>
</tr>
<tr>
<td>Insulated Glass (Both Lites Annealed)</td>
<td>1.8</td>
</tr>
</tbody>
</table>

* Center of glass deflection under specified loads must additionally be considered in selection proper glass thicknesses and types. Data for laminated glass products may be located in ASTM E 1300 - 94.

* All lites must be identical thickness of annealed lite.
Two-Side Support

Glazing that is framed or otherwise supported on only two opposite horizontal (sill and head) sides must be considered separately from four-side supported glazing in determining the correct glass thickness to meet the specified uniform load. For this condition, glass strength is dependent only on the glass thickness and the length of the unsupported span. For two-sided support conditions, only monolithic annealed or tempered glass should be used. Using tempered glass in lieu of annealed glass of the same thickness increases the allowable unsupported span by a factor of two.**

The proper glass thickness to meet the desired uniform load for a given unsupported span can be selected by referring to the two-side support graph.

Glass deflection under wind loading is more pronounced with two-side supported glass. A glass thickness that is sufficient to meet a given uniform load may exhibit deflection that is aesthetically unacceptable or psychologically bothersome to building occupants. Deflection can be reduced only by increasing the thickness for a given size lite of glass.

** Applications using this factor must be closely evaluated to ensure anticipated center of glass deflection at the specified design load is limited to an acceptable degree.

Thermal Stresses

When glass is exposed to sunlight, solar energy is absorbed, causing the glass temperature to rise. The rate at which glass temperature rises is dependent on the type and thickness of glass used. If the glass is not properly thermally isolated from the glass-framing system, or if it is glazed directly into a high heat capacity material such as concrete, the temperature of the glass edges may be significantly lower than that of the center portion of the glass.

Glass, like most materials, expands with increased temperature levels. The hotter center portion of the glass expands more than the cooler glass edges, creating thermally-induced stresses at the glass edges. Thermal stresses are normally greatest at the center of each edge, diminishing toward the corners.

Higher thermal stress may cause glass breakage unless proper cutting and glazing practices are followed. Proper design of the glazing system (reference Glazing Guidelines on Page 24) can reduce thermal and mechanical stresses. The ability of Versalux® products to resist breakage, due to both thermal and mechanical stresses, depends to a great degree on the edge strength of the glass. Clean-cut edges provide the greatest possible strength in glazed, tinted or reflective glass.

Under abnormal conditions where thermal stress increases breakage risk, resistance to thermal stress of a lite of glass can be increased by heat treating the substrate (heat strengthened or fully tempered). Heat treating also improves the glass product’s ability to withstand higher uniform loads (refer to uniform load data above). Although heat treating the glass increases its strength, it does not alter
its deflection characteristics. Annealed, heat strengthened, and fully tempered substrates of the same thickness size will deflect under load at the same rate.

The thickness of a glass substrate may have to be increased for a given uniform load to limit center line deflection to an acceptable degree. Fully tempered glass, on occasion, can experience spontaneous breakage due to melting inclusions which can occur during the glass making process. Although the risk of spontaneous breakage is remote, architects and design professionals should consider other alternatives if glass fallout is a concern.

**Interior Heat Traps**

A heat trap on the interior surface of the glass exists when there is inadequate air circulation to properly remove heat that can build up behind the glass. This condition can cause temperature differences within the lite of glass and subsequent thermal stresses that may not be acceptable with annealed glass.

**Spandrels:** An example of a severe heat trap condition would be the spandrel area of a building. The space behind a lite of spandrel glass is blocked off to prevent airflow between floors. The temperature in this space will continue to rise when the spandrel glass is subjected to solar loading. It is for this reason that spandrel glass is tempered to increase the resistance of the glass to thermal breakage.

**Vision Areas:** In vision areas, there is generally air movement across the inboard surface of the glass. If this air movement is restricted to a great degree, a heat trap situation similar to that created in the spandrel area can occur.

**Suspended Ceiling Soffits:** Suspended ceiling soffits must be positioned well to the room side to allow for natural convection. If the building design is such that natural convection cannot be provided, the head area should include vents that provide a minimum of one square inch of ventilation for each inch of glass width, or the glass should be heat treated (Chart D).

**Interior Shading Devices and Heat Outlets:** The positioning of interior shading devices is a very important consideration in achieving adequate air movement across the interior surface of the glass. Draperies, roller shades, or venetian blinds should be positioned away from the glass to prevent restriction of airflow. A minimum clearance of $2''$ (50mm) should be provided between the inboard glass surface and the shading device. Also, a clearance must be provided between the shading device and the glass-framing members. A minimum clearance of $1-1/2''$ (38mm) should be provided at the top and bottom of the shading device to ensure adequate air movement. (Chart D)

If these clearances cannot be provided, in the case of venetian blinds, a lockout device should be used to limit the rotation of the blinds. This lockout device acts as a positive stop to prevent the blinds from being completely closed. For horizontal venetian blinds, the
rotation of the blinds should be limited to a position of 60° off of the most closed position. For vertical blinds, the movement should be limited so that there is a 1/2” (12mm) space between the blinds when they are in the most closed position.

Care must also be exercised in the location and position of heat outlets. The outlets should be designed to direct hot air away from the inboard glass surface to prevent increasing the temperature difference between the center and the edge of the glass. When shading devices are used, the heat outlet should not be positioned between the glass and the shading device, but rather to the room side of the shading device. When buildings are located in cold climates, care should be exercised to prevent hot air from being directed toward the glass when the heating system is initially activated during periods of low temperature.

Glass that will be glazed into areas containing heat traps should be heat treated to reduce the possibility of thermally induced breakage.

Expansion Joints and Anchors
The architect or engineer should precisely define the anticipated movement of the building’s structure due to temperature changes, static loads, wind loads, and other dynamic loads.

- Window or curtain wall expansion joints and anchors should be designed so that loads due to types of building movement are not transferred to the glass framing members.
- Anchors must be designed to positively locate the glass framing while providing for the anticipated movement.
- It is very important that expansion joints not be located adjacent to the edge of an insulating glass unit.
- Expansion joints to accommodate vertical movements should be provided for each floor.
- Expansion joints to accommodate horizontal movements should be located at each vertical framing unit with a maximum spacing of 20 feet (6.1m).

**Thermal Movement:** Movement of glass framing members due to thermal expansion and contraction is a function of temperature and the thermal expansion properties of the glass-holding members. Therefore, this movement can be calculated for a specific system and it must be considered in design and erection. The system should be designed to permit erection with the expansion joints almost fully open in cold weather and nearly closed in hot weather.

**Deflection of Glass Framing Members**
The deflection of the glass framing members when subjected to design loads must not exceed the length of the unsupported span divided by 175 or 3/4” (19mm), whichever is less. The deflection of horizontal glass framing members due to the weight of the glass should be limited to prevent inadequate edge clearance and to minimize increased bite on the glass and consequently added thermal stress. A limit of 1/8” (3mm) or 25% of the design edge clearance of the glass or panel below, whichever is less, is recommended. It is also recommended that twisting or
rotation of the horizontal members due to the dead weight of the glass be limited to 1” from the horizontal plane (Chart E).

Glass Openings
The glass framing system must both structurally support and adequately cushion the glass. To prevent mechanical and thermal stresses on the glass, the framing system should provide openings that are within specified tolerances for squareness, corner offset and bow. These tolerances are listed below:

- **Squareness** - 1/8” (3mm) difference in the lengths of the diagonals.
- **Corner Offset** - 1/32” (0.8mm) maximum offset at corners.
- **Bow** - 1/16” (1.6mm) bow in a 4 ft. (1.22m) length of framing.

If variations from these tolerances are anticipated, details of the system should be submitted to a Zeledyne Glass representative for technical review. If job site conditions are found to ± outside these tolerances, corrections must be made before the openings are glazed.

Setting Blocks
Glass should be set on two identical setting blocks with a Shore A durometer hardness of 85±5.

The setting blocks should always be equidistant from the center line of the glass. The setting blocks preferably should be centered at the bottom quarter points of the glass. When the wall design does not allow the setting blocks to be positioned at the quarter points, they can be moved so that the end closest to the vertical glass edge is within a distance equal to 1/8 the glass width or 6” (152mm), whichever is greater.

Each setting block should be sized to provide 0.1” of length per square foot (27mm per square meter) of glass area, but not less than 4” (102mm) of length.

The setting block should be 1/16” (1.6mm) less than full channel width or be positively located in the glazing channel to provide proper support for the entire glass thickness at all times. The height of the setting blocks should provide the recommended nominal bite and minimum edge clearance for the glass.

When a lockstrip gasket glazing system is used, each setting block should be sized to provide 0.4” of length per square foot (109mm per square meter) of glass area, but not less than 4” (102mm) of length. The height of the setting block should be recommended by the lockstrip gasket manufacturer.

Edge, Face & Bite Clearances
The glazing system must provide adequate edge and face clearance to properly cushion the glass, to thermally and mechanically isolate the glass from the glass-framing members, and prevent glass-to-metal contact.
The glazing system must also provide a nominal bite on the glass that will provide adequate glass retention without excessive glass coverage. Excessive glass coverage can increase thermal stresses at the glass edge. Clearances and bite recommended for Zeledyne’s architectural glass products are shown in Chart F. (Note: Unshimmed glazing tapes should not be used.)

**Glass Spacers**

Face clearance for the glass should be provided by a continuous gasket or spacer of neoprene or an equivalent material. The use of intermittent shims should be discouraged. The Shore A durometer hardness of the continuous spacer will be determined by the practical requirements of the glazing system. In a wet-seal system, a low durometer material may be used to position the glass in the glazing channel and provide a backup for the sealant. In a tape glazing system, a high durometer material may be used to apply adequate pressure to a preshimmed glazing tape.

**Edge Blocks**

Glass should be centered both vertically and horizontally in the opening. The glass must be free to “float” in the opening to prevent movement in the glass-framing members from being transmitted directly to the glass and creating mechanical stresses. For large lites or insulating glass units, edge blocks should be used to prevent lateral “walking” of the glass. This “walking” occurs due to relative movement between the glass and the frame caused by the different thermal expansion and contraction characteristics of the materials. The edge blocks should be a minimum of 3” (76mm) in length. The blocks should be placed in the vertical channel width. They should be made of 55±5 Shore A durometer hardness neoprene and should be sized to provide a nominal 1/8” (3mm) clearance between the block and the edge of the glass.

**Weep Systems**

The glazing system must be designed to prevent the accumulation of moisture in the glazing channel for prolonged periods. The weep system should incorporate enough weep holes to ensure adequate drainage. When the weep system consists of weep holes at the sill in a location that can be wetted by driven rain, the holes should be equivalent to three 3/8” (9.5mm) diameter holes. One hole should be located at the center of the sill and one at each end between the jamb and setting block. When a lockstrip gasket system is used,
an adequate weep system and auxiliary sealant around the entire periphery, or a combination of both, must be used.

**Glass Handling, Cleaning & Maintenance**

Care must be exercised in the handling and glazing of glass to prevent damage to the glass edge. The glass must not contact the glass framing member or the surrounding structure during the glazing operation. Glass edge damage can also occur when the glass is rotated or “pitched” on its corner on hard surfaces. For insulating glass units, it is recommended that a “rolling block” be used on the corner of the glass by the glazier when rotating the unit. The “rolling block” minimizes the possibility of damaging the corner of the glass by distributing the weight of the unit along the edges rather than concentrating the weight at the corner.

Versalux® glass products may be cleaned periodically using a soft, clean, grit-free cloth. To remove built-up grime and smudges, most commercial glass cleaning solutions work well. Both Versalux glass and coatings are very durable when proper cleaning techniques are employed. Glass surfaces must be protected from scratches and should not be cleaned by mechanical buffers or any metallic scraper. Detailed cleaning instructions for Versalux products are available from Zeledyne upon request.

**Watershed**

When a sealant filler is used over a gasket or glazing tape to provide a watershed, the sealant should not extend more than 1/16” (1.6mm) above the metal sight line. This sealant filler increases the effective bite on the glass, which can increase thermal stress. Building overhangs, surrounding structures, trees and shrubbery can create a variety of exterior shading patterns on glass in a building. This exterior shading can create varying degrees of thermal edge stress in the glass. The maximum thermal stress occurs when 25% or less of an individual glass lite is shaded and when the shaded area includes more than 25% of the lite’s perimeter. Generally, horizontal, vertical, and diagonal shading patterns are not as critical as shading that includes combinations of these shading patterns. Double diagonal shading that creates a pattern that is “V” shaped in nature with the center of the “V” located at the center of a glass edge is generally the most critical shading pattern.

**Chart G** shows some typical shading patterns that can be created in a building. These are labeled “Acceptable,” “Marginal,” and “Harmful.” These drawings and designations can serve as a guide to the severity of thermal stress created by various exterior shading patterns. However, if an unusual shading pattern
is anticipated, it is recommended that a representative of Zeledyne be consulted in the design stages for technical review to determine if heat-strengthening or tempering is required.

Other Factors
Heat treating for 3/16" (5mm) or heavier Zeledyne reflective glass or heat-absorbing glass should be considered to avoid breakage under the following conditions: glazing applications that induce mechanical stresses on the glass; designs requiring notches to be cut or holes to be drilled in the glass; painted signs or large labels used on the glass.

Glazing Guidelines
The following glazing guidelines are intended to assist the design professional in developing glass support systems that will minimize the possibility of glass breakage due to thermal and mechanical stresses. In addition, specifiers and users can refer to the most current glazing recommendations published by GANA, AAMA, and IGMA.

As new and unique glazing systems are developed, variations from these guidelines may be justified. In such cases, precise details of the glazing system must be submitted to a Zeledyne representative for review.

The design of a properly functioning glazing system requires consideration of the following: the glass retaining system; the method of erection; the glass type and size; the various component and erection tolerances involved.

The glazing system must adequately support and cushion the glass to minimize loads on the glass due to building movements and movement occurring due to expansion and contraction of the glass-holding members.

Sound Control
- All Versalux tinted and tinted reflective products can be laminated to achieve greater sound attenuation properties.
- Refer to GANA (Glass Association of North America) Laminating Division’s Laminated Glass Design Guide, latest edition, or contact architectural glass laminating fabricators for additional information.

GLASS

Silicon Oasis Headquarters, Dubai, UAE
Glass: 6mm VERSALLUX® BLUE 2000R
Alum. Contractor: ALICO