



GLASS DESIGN HANDBOOK

Top Considerations for Glass Selection & Specification

In addition to the important considerations of aesthetics and energy related performance characteristics of glass products, it is critical that attention be given to other design considerations. This should be done by the appropriate design professional as early in the design cycle as possible.

Surface Orientation

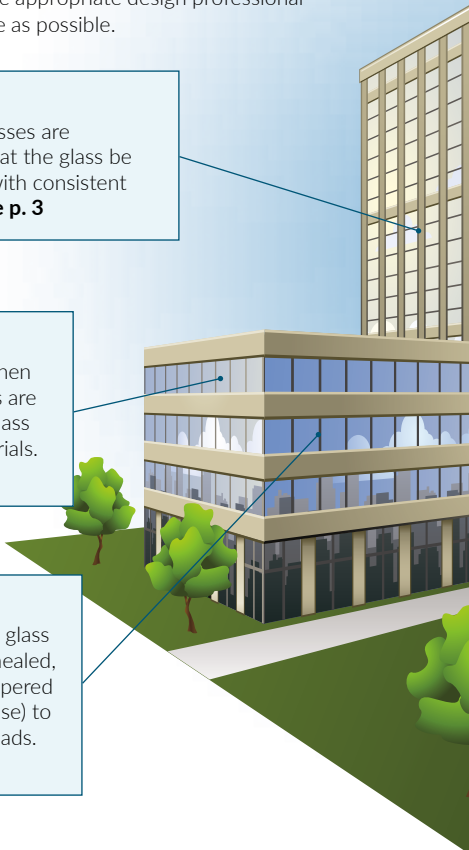
When darker tinted glasses are specified, it is critical that the glass be fabricated and glazed with consistent surface orientation. **See p. 3**

Color Shift

Color shift can occur when some coatings and tints are incorporated into the glass design with other materials. **See p. 4**

Wind & Snow Loads

Specify the appropriate glass thickness and type (annealed, heat strengthened, tempered or a combination of these) to resist wind and snow loads. **See p. 3**





Safety

Appropriate safety glazing materials, such as tempered or laminated glass, must be specified where required by code or application. **See p. 3**

Thermal Stress

Strengthened glass (heat strengthened or tempered) may be required to resist thermally induced stresses. These stresses are caused by a number of design factors. **See p. 5**

Aesthetics & Mock-Up

Many glass products can be used with other materials for improved performance and aesthetics. **See p. 7**

Energy & Sustainable Design

For more than 70 years, Vitro has been a leader in the advancement of glass technology designed to enhance comfort and save energy. **See p. 5-6**

Acclaimed Applications

Some of the world's most sustainable buildings utilize low-e glass products by Vitro, including 24 AIA Committee on the Environment (COTE) winners since 2008, three Certified Living Buildings, 11 Net Zero Energy Certified Projects and dozens of LEED® Platinum buildings.

A. Bullitt Center

2015 AIA Committee on the Environment (COTE) Top Ten Green Buildings

B. David L. Lawrence Convention Center

LEED® Platinum Certified

C. The Tower at PNC Plaza

LEED® Platinum Certified



Vitro Architectural Glass: A Culture of Sustainability

Environmentally Progressive Products

High-performance low-e coated glasses and ecologically friendly solutions from Vitro help reduce energy costs and support environmental responsibility, including:

- **Solarban**[®] solar control family of low-e glasses
- **Starphire**[®] and **Acuity**[™] low-iron glasses
- **Sungate**[®] passive low-e glasses

Sustainability Documentation

Throughout its history, Vitro Architectural Glass has raised the bar by becoming the first glass manufacturer in the worldwide and North American markets to certify critical sustainability documentation – such as **Environmental Product Declarations** (EPDs) and **Cradle to Cradle**[™] Certification – for its entire collection of architectural glasses. Get sustainability documentation and more at vitroglazings.com/sustainability.

LEED[®] Support

Get guidance on earning LEED[®] credits through glass selections with the Vitro Glass Guide to LEED[®] at vitroglazings.com/leed.



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Glass Design Guidelines

In addition to specifying glass for its aesthetic and energy related performance, specifiers and design professionals must consider and account for several factors as early as possible in the design/specification process.

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Safety

Appropriate safety glazing materials, such as tempered or laminated glass, must be specified where required by code or when dictated by design judgment based on the intended application. For additional information on heat-treated glass, review **TD-138: “Heat-Treated Glass for Architectural Glazing.”**

Wind & Snow Loads

The appropriate glass thickness and type (annealed, heat strengthened, tempered or a combination of these) must be specified to withstand the design wind and/or snow loads for the application. The current industry-accepted procedure for determining the uniform load resistance of glass is **ASTM E1300: “Standard Practice for Determining Load Resistance of Glass in Buildings.”** Review Vitro Technical Document **TD-134: “Designing Glass to Resist Wind and Snow Loads,”** in the Technical Documents section of the Vitro Architectural Glass website, for a brief tutorial on the use of ASTM E1300. A digital calculation tool for the ASTM E1300 procedure also is available for purchase from the Standards Design Group, Inc. (StandardsDesign.com) and on the Vitro website for *Vitro Certified™* Network members.

Surface Orientation

When darker-tinted glasses are specified, the glass must be fabricated and glazed with consistent surface orientation to achieve a uniform appearance. For additional information, review **TD-122: “Surface Orientation of Low Light Transmittance Glasses.”**

Color Shift

Responsible design professionals must consider how the combination of materials in a glazing unit will impact the transmitted and reflective color of the glass, as well as its transmitted and reflective clarity. A transmitted and reflective color shift may result when various coatings and tints, such as a low-e coating, opacifier coating, tinted or low-iron glass, interlayer material or other design alternatives, are incorporated into the glass design. Combining clear or low-iron glass with light colored opacifier coatings or interlayers will make such appearance disparities especially evident. Additional information on color consistency and uniformity considerations is available in **TD-155: “Solarban® Color Uniformity.”**

To achieve color consistency, Vitro recommends maintaining consistent glass product constructions throughout a project, and viewing a full-size mock-up with all design components at the job site with all interested parties.

Evaluating Color in Samples & Mock-Ups

Glass color is a blend of transmitted and reflected color influenced by light source, the glass's properties and coatings, interior and exterior lighting conditions, viewing angles and differences in observer perception. The absence of interior walls and shades during construction also may affect perception of glass color.

Viewing samples against a white surface overly emphasizes transmitted color, while a dark background emphasizes reflected color. Glass installed on buildings includes components of each blended together.

Glass samples should be evaluated in natural daylight since artificial light may emit wavelengths that can skew perception of glass color.

Perceived glass color can be influenced by sample size (referred to as field size metamerism failure). The color of a 12" x 12" sample may not appear the same as a 4' x 10' glazed unit of the identical glass.

Thermal Stress

Strengthened glass (heat strengthened or tempered) may be required to withstand thermally induced stresses in specified applications. Such stresses are caused by a number of design factors, including glass type, shading patterns, indoor shading devices and others, which can and do lead to glass breakage if not properly accounted for during the specification process.

Thermally induced glass breakage is recognized and well understood in the glass industry. Vitro provides procedures to help design professionals evaluate such risks and specify strengthened glass, when required.

For additional information, review **TD-109: “Thermal Stress Update.”** Vitro also offers a thermal stress analysis program at technicalresources.vitroglazings.com/ThermalStress.

Energy & Sustainable Design

Since introducing the world's first energy-efficient glass more than 70 years ago, Vitro has been a global leader in advancing glass technology to enhance comfort and save energy. *Solarban*[®] and *Sungate*[®] low-e glasses by Vitro Glass, along with the Vitro line of “spectrally selective” tints, can significantly lower energy costs and associated carbon emissions, as well as initial HVAC capital equipment costs.

As the first U.S. glass manufacturer to receive *Cradle to Cradle*[™] Certification for its entire product line, Vitro has demonstrated a commitment to environmentally responsible, sustainable design that is unique to the glass industry. *Cradle to Cradle*[™] Certification signifies a commitment to designing and manufacturing products that not only enhance energy efficiency, but also limit a product's total impact on the environment – from raw material acquisition, through manufacturing and the building lifecycle, to final recycling and/or disposal.

Vitro is also the first North American manufacturer to publish third-party verified Environmental Product Declarations (EPDs) for its Flat Glass and Processed Glass products, which also offers the ability to earn LEED® points in the Materials & Resources credit category. EPDs, *Cradle to Cradle™* documentation and more are available at vitroglazings.com/sustainability.

Vitro low-e glasses allow design professionals to meet or even exceed energy code requirements. While many codes reference whole-unit fenestration data, all published Vitro performance data represents center of glass measurements.

Inclusion of Materials in IGU Airspaces

Any material to be utilized inside a hermetically sealed airspace, such as grids (muntins), clips, films, blinds, paints and other coatings, must be tested and approved for such use by that material manufacturer. The compatibility of the material with sealants, as well as the potential release of volatiles into the airspace, must be verified. The inclusion of materials in IGU airspaces raises several concerns, including the following:

- The materials may outgas volatiles that then condense on the glass and/or coated glass surface within the airspace. In addition to causing aesthetic issues, the volatiles may cause coating degradation. Coating degradation or color change caused by volatiles will void any applicable warranty.
- Damage to the low-emissivity (low-e) coating likely will result should any physical contact occur between a material located inside the airspace of the IGU and the low-e coating.
- Materials located inside the airspace of an IGU often have a negative impact on the thermal performance of the IGU by weakening its insulating value (U-value).

- Materials that may cause localized rise in glass temperatures have the potential to increase glass breakage due to thermal stress. In addition, while uniform elevated temperatures may not have an immediate effect on the glass, they can reduce the overall durability/longevity of the hermetic seal of the IGU.

Accordingly, Vitro strongly recommends that careful consideration be given to these issues prior to incorporating materials inside the hermetically sealed airspace. The burden of proof regarding compatibility or fitness for use of any material lies with the manufacturer of that material.

Aesthetics & Mock-Up

Vitro offers a broad selection of glass products such as clear, ultra-clear and tinted glasses that can be used as standalone products for their own inherent beauty and performance, or combined in IGUs to create deeper and richer hues, enhanced daylighting and improved performance. Many additional aesthetic, environmentally friendly and energy-control solutions can be achieved by including a Vitro high-performance glass coating, such as a visibly reflective coating or one of Vitro's many non-reflective, solar control low-e coatings, in a building design.

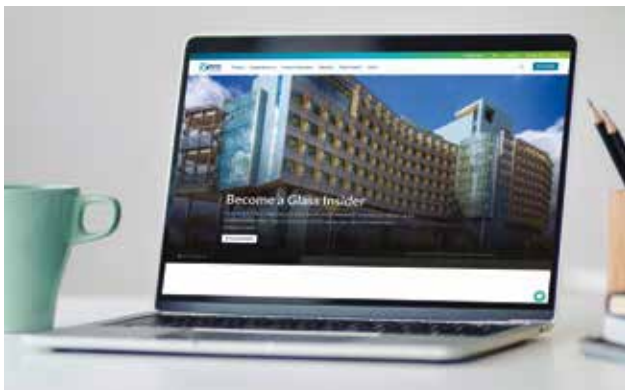
The ultimate glass solution for any project marries the desired aesthetic to enhance the building façade with design considerations related to performance, safety, wind/snow loads, thermal stress and other design considerations. Reduction of transmitted sound into and within buildings is also often an important design consideration. For additional information, review **TD-135: "Glass Acoustical Performance."**

Once all design considerations have been appropriately addressed, Vitro strongly recommends viewing a full-size mock-up early on in the project—under actual or simulated finished building and project site location conditions—prior to making final design decisions.

Additional Information & Project Support

For additional technical information about architectural glass issues, applications and usage guidelines, please visit vitroglazings.com and review the Vitro Architectural Glass Technical Documents found in the Technical Information section.

Vitro Architectural Services and our National Architectural Managers are standing by to assist you. Reach the Architectural Services team by calling 1-855-VTRO-GLS (1-855-887-6457) or emailing architecturalglass@vitro.com. When you need product selection assistance from a technical expert, bidding support or logistics expertise to satisfy tight deadlines, your region's National Architectural Manager can help you achieve project success. Find your region's National Architectural Manager at vitroglazings.com/rep.



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Glass Design Resources



Vitro Architectural Glass (formerly PPG Glass) offers two of the industry's most comprehensive portals for glass research, product selection and specification.

Tools & Resources tools.vitroglazings.com

Explore our suite of specification and product selection tools.

- Use **Search** to explore Vitro's extensive selection of products.
- Use **Construct** to simplify the process of specifying Vitro and even competitive glass products by generating thermal and optical performance data featuring password-free access to International Glazing Database (IGDB) data.
- Browse our **Project Gallery** to view completed projects.
- **Order a sample** to see the amazing aesthetics for yourself.

Vitro Glass Education Center glassed.vitroglazings.com

Designed to deliver technical information in an accessible, engaging format, the **Vitro Glass Education Center** features short videos, illustrations and articles that address the key challenges facing today's design and building professionals.



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