

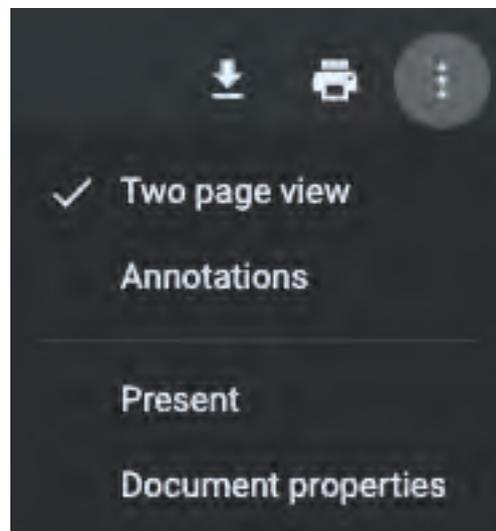
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THE 2025
NGA ANNUAL
REPORT

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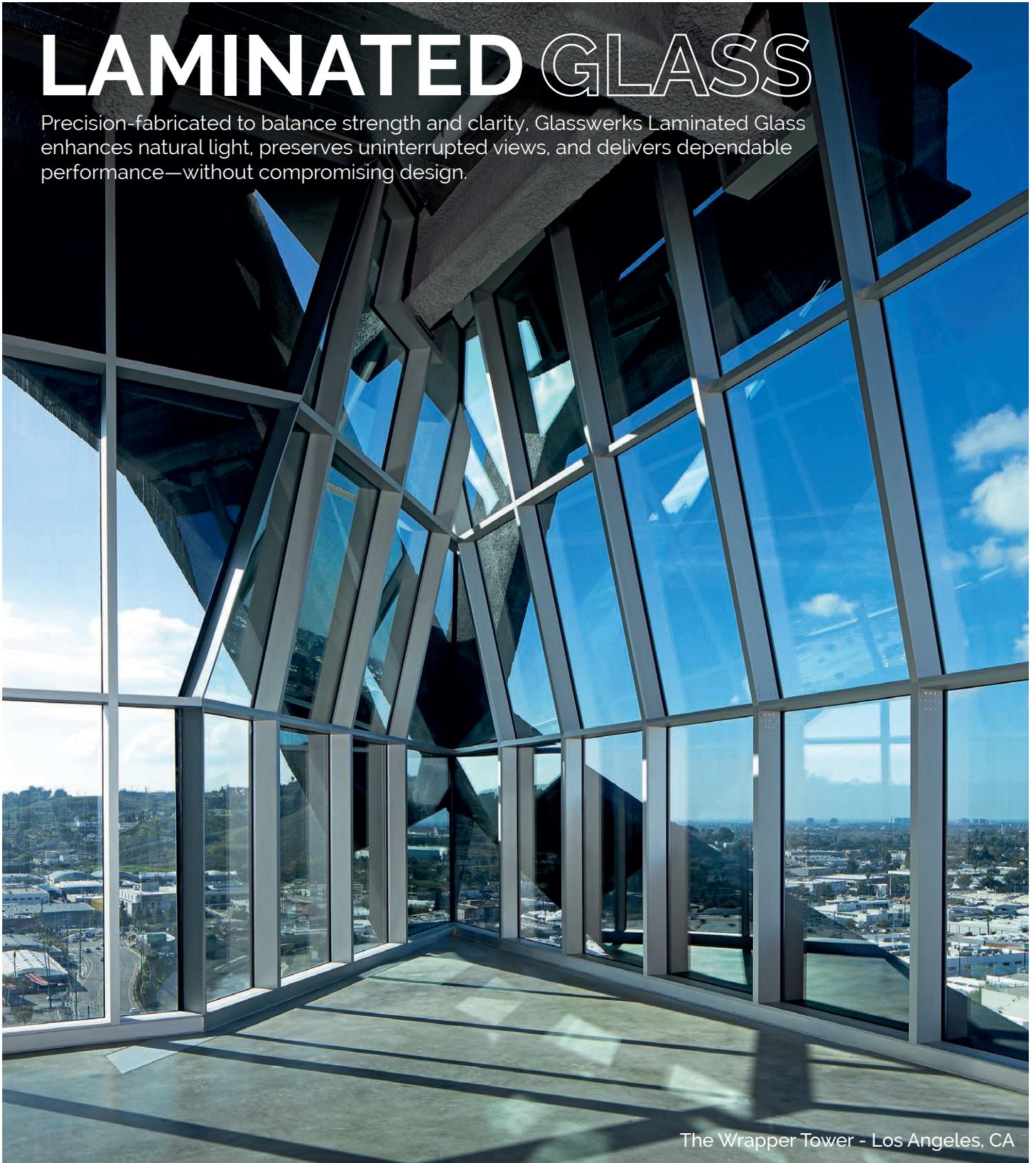
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Glass systems can offer security and life-safety without compromising occupant comfort

BY NORAH DICK

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From durability to design versatility: How steel is shaping the future of fenestration systems

BY RACHEL VITELLO

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We envision a future in which glass is the material of choice to enhance spaces where people live, play, learn, work and heal

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ON THE COVER: The recently built Baptist Health Care campus won the 2024 Glass Magazine Award for Best Protective Glazing Project. Nominated by the metal systems supplier and fabricator for the project, YKK AP America Inc., the project team went above and beyond code requirements to protect the Pensacola, Florida-based medical campus from hurricanes and tropical storms by implementing its impact-resistant and blast-mitigation systems. At completion, the facilities are rated to withstand a Category 5 hurricane and severe flooding. Photo by Chad Baumer Photography.

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Architectural Glass Recycling Turns Waste into Opportunity

BY STANLEY YEE



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EVENTS

Find comprehensive coverage of the education and insights at BEC Conference.

SUPPLY

Eugene Gerden reports on supply and demand for the Mexican glass sector.

ASSOCIATION

Learn about NGA's achievements by reading the 2025 Annual Report.

GLASSBLOG



TRENDS

2026 Colors Paint a Familiar Scene

By Tammy Schroeder, Apogee Architectural Metals



SUSTAINABILITY

LEED v5: What Do Assessment Prerequisites Mean for Fenestration?

By Brian Tobias, Tubelite



IN MEMORIAM

Carey Mobius

By Max Perilstein, Sole Source Consultants



PROJECT SHOWCASE

Achieving a modern approach to fire and life safety was one of the many goals shaping the reconstruction of Vancouver-based Eric Hamber Secondary School. Multiple fire-rated glazing systems from Technical Glass Products were installed to contribute to the school's fire- and life-safety requirements without compromising access to daylight and visual connectivity. Fire-rated glazing systems allow light from the exterior, non-rated curtain wall to filter deep into the building's interior, providing multiple light-filled common areas for students, all while also supporting compartmentation efforts and meeting code requirements for fire barriers.

Glass Magazine® (ISSN 0747-4261), Volume 76, Number 2, is published eight times annually in January/February, March, April, May/June, July, August, September/October and November/December by the National Glass Association, 344 Maple Ave. West, Unit 272, Vienna, VA 22180; 703/442-4890. There is no charge for subscriptions in the United States for individuals in the trade and/or qualified requestors. All other subscriptions will be charged \$49.95 in the U.S., and \$79.95 outside the U.S. Periodicals postage paid at Vienna, Va., and other mailing offices. POSTMASTER: Send changes of address to Glass Magazine®, Subscriptions, Box 460, Congers, NY 10920. Canada Post: Publications Mail Agreement #40612608. Canada Returns to be sent to Bleuchip International, P.O. Box 25542, London, ON N6C 6B2. For all subscription inquiries, please call 1-800-765-7514. ©2026 National Glass Association. All Rights Reserved. Printed in the U.S.A.

GLASS MAGAZINE

Published by the

NGA
NATIONAL GLASS ASSOCIATION with GARA

344 Maple Ave. West, Unit 272
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All that Glass Can Do



NORAH DICK
EDITOR

The March edition of Glass Magazine is our yearly Architect's issue. It's designed to speak directly to the architect and design community, and to highlight exactly what makes glass such a unique building material. Here are just a few reasons that glass is a powerful and dynamic part of the built environment.

Glass is secure. Security and safety remain on many people's minds, especially to protect vulnerable facilities like schools. In this year's Architect's Guide to Protective Glass on page 30, find an overview of all the protective qualities that glass can offer, from fire-rated glazing and life safety, to protection and impact-resistance. For a real-life case study, check out "Performance" on page 24, which profiles the Cathedral Church of the Redeemer in British Columbia to see how retrofit protective glazing helped to support the structure's continued safety.

Glass is sustainable. One of glass's most sustainable attributes is its infinite recyclability—it can be recycled and reused as glass as many times as needed with no loss in quality. Many in the industry are attempting to expand glass recycling efforts, including Infinite Recycled Technologies. The company recycled all the glass from last year's GlassBuild America in Orlando, diverting 14.3 tons of glass from landfill. Vice President for Sustainability and Technical Initiatives Stanley Yee outlines that process, as well as the company's other recycling ventures, on page 26 of this issue. For more on the current state of glass recycling and infrastructure, check out the Architect's Guide to the Glass Recycling Supply Chain and the Architect's Guide to Glass Sustainability, both available on GlassMagazine.com.

Glass is high-performance. Many in the architecture and design community are leading the charge on climate mitigation and reducing the environmental impact of buildings. With evolving

glass technologies like vacuum-insulating glazing and multi-cavity glazing systems—which can include triple-pane or even quad-pane insulating glass units—there are more energy-efficient options than ever before. And while embodied carbon remains a concern, so does the operational promise of glazing systems. For more on understanding the complexity of glass's environmental impact, find a critical perspective on this issue from Helen Sanders, general manager of Technoform, on page 20.

Glass is beautiful. Since it became a standard building material in the middle of the twentieth century, glass has transformed from a sturdy product to one that pushes the design envelope. This last year's Glass Magazine Award winners demonstrated that yet again, with winning projects showcasing the full spectrum of what glass can do. Taking home the Project of the Year was One River North, a mixed-development high-rise with a glass facade bisected by a "living canyon" that runs through the exterior like a river. This and other superlative projects expand the cultural imagination about how glass can help architects achieve design goals. If you have a project that features glass, please consider nominating it for a Glass Magazine Award in this year's competition.

Have glass questions? We have glass answers. If you're an architect looking to understand more about architectural glass and glazing, join us for a brand new event the NGA Glass Fabricator Conference (GFAB), to be held June 14-17 in Chicago. The event brings together leaders in glass fabrication, along with their supplier partners, to discuss what's possible with glass. The event will include a day of programming relevant to architects and designers, feature project case studies, trends in glass fabrication, and a discussion of glass in the interior. Architects will be able to earn HSW credits. Learn more at glass.org/events. ■

Nominate Your Company for the Glass Magazine Awards



Architect's Guide to the Glass Recycling Supply Chain



Architect's Guide to Glass Sustainability





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■ NEED-TO-KNOW INFORMATION FROM THE NGA



NGA MEMBER RECYCLES 28,000-PLUS POUNDS OF GLASS MATERIAL AT GLASSBUILD

GlassBuild America 2025 featured stunning displays of glass products and demonstrations of glass machinery at work. After in-booth demos and breaking down the show, there is a lot of scrap glass that could end up in landfills. In an effort to put some action behind the increased discussions around architectural glass recycling, National Glass Association member company Infinite Recycled Technologies stepped up and volunteered to collect all the scrap glass from this year's GlassBuild for recycling. Many exhibitors participated in the recycling program, delivering their scrap glass to containers provided by IRT. In total, 28,640 pounds of glass material was collected for recycling throughout the three days of the show. The company is already looking ahead to future recycling initiatives at GlassBuild 2026 in Las Vegas. ■

UPDATED: BENEFITS OF GLASS IN DAYLIGHTING APPLICATIONS

The NGA Fabricating Committee updated and published Glass Technical Paper AD01-26 Benefits of Glass in Daylighting Applications in January. A consolidation of FM04-12 (2019) Daylighting and FB53-17 (2024) Benefits of Decorative Glass in Daylighting Applications, This updated document describes the benefits of daylighting, and the role of glass in daylighting design to reduce energy consumption, improve light level control and enhance occupant comfort, with example applications using glass as part of the overall daylighting strategy. The document also includes daylighting design tools and resources. ■



Download the updated GTP

YOUR NGA MARKETING PLAYBOOK: PUBLICATIONS, EVENTS & BEYOND

Want more eyes on your company and products? Team members across NGA presented the NGA Marketing Playbook during the Thirsty Thursday webinar on January 15 to help set up members for success in the new year. Attendees learned about NGA's many marketing opportunities that amplify corporate brands and drive results. NGA staff shared strategies to get the most value from connection with the NGA by maximizing visibility across the industry, through NGA's magazines, events, member benefits and more. Watch the webinar at glass.org/webinars. ■

NEW DATES FOR INAUGURAL GLASS FABRICATOR EVENT

NGA announced new dates for its inaugural NGA Glass Fabricator Conference (GFAB™), which will now be held June 14-17, 2026, at the Radisson Blu Hotel in Chicago. Due to an unforeseen scheduling conflict within the industry calendar, we've moved the conference from April to June to ensure maximum attendance and participation from our community.

GFAB will be the must-attend industry event for glass fabricators and their supplier partners, providing can't-miss programming and networking,

including executive content for senior leaders; NGA Glass Conference track with committee meetings, advocacy initiatives and annual Fun Run; the GFAB Workshop on Glass Tempering Quality Control at nearby Skyline Design; and networking with fabrication machinery, software and supplier partners.

Registration will open in Spring 2026. Visit glass.org/GFAB for details about early-bird rates and programming highlights as they become available. ■

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**Polycrystalline
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**Monocrystalline
Solar Panel**

Example of monocrystalline and polycrystalline. To make cells for monocrystalline panels, silicon is formed into bars and cut into wafers. To make cells for polycrystalline panels, fragments of silicon are melted together to form the wafers.

GLASS IN PHOTOVOLTAICS

Among structural materials, glass has many properties that make it uniquely suited for use in the design and fabrication of solar cells, modules and arrays. All photovoltaic devices convert light energy into electrical energy through the photovoltaic effect. Common applications include in-field installations, rooftop solar, building-integrated photovoltaics, or BIPV, commercial systems, and automotive applications.

Photovoltaic applications use glass for two primary purposes: cover glass or superstrate protects the active substrate from chemical, mechanical and environmental damage, and may serve as a base for thin-film circuitry; back glass

or substrate provides structural support, protection, cosmetic appeal, and may also serve as a base for thin-film circuitry.

Types of glass

The most common composition for PV applications is soda-lime glass with low iron content to increase solar and visible-light transmittance. Borosilicate glass is also used for its excellent optical quality and resistance to thermal shock, though it is more expensive and therefore limited in application. When selecting glass, consider impact resistance, mechanical strength, distortion, fall-out resistance, breakage characteristics and thermal breakage resistance.

Annealed glass offers limited

mechanical protection and is suited to applications where cost is the driving factor rather than strength. Annealed glass refers to float glass without additional heat treatment. When broken, it fragments into large, dangerous shards and should not be used where breakage could cause injury or where prohibited by building codes. Heat-strengthened glass has a surface compression of 3,500 to 7,500 pounds per square inch (24 to 52 megapascals) and is approximately twice the mechanical strength of annealed glass of the same thickness.

Fully tempered glass has a minimum surface compression of 10,000 psi (69 MPa), with levels typically not exceeding 20,000 psi (140 MPa) to minimize internal stresses. It is approximately four times as strong as annealed glass and ruptures into numerous small fragments upon breaking, making it desirable where safety is a concern. Surface compression



Excerpted from NGA Glass Technical Paper FB39-25 Glass Properties Pertaining to Photovoltaic Applications, available for free download at glass.org/store.

of 13,000 to 15,000 psi (90 to 100 MPa) is required to meet CE-mandated mechanical strength and fragmentation requirements (EN 12150). Fully tempered glass may undergo heat soaking to force breakage of defective units before leaving the factory, reducing risk of spontaneous field failures. Tempered glass must comply with CPSC 16 CFR 1201 standard in applications where human injury may occur in the event of breakage.

Cover glass or superstrate

The electrical output of any PV device is directly proportional to its ability to collect maximum light energy, making optically clear material such as glass ideal for cover applications. Anti-reflective coatings are commonly used to increase transmission, but chemical composition, shape and surface texture of the glass are equally important. The glass should be as flat as possible and free of deformation from heat treatment processes. Uniform thickness is a factor, since variations can decrease transmittance efficiency. Thickness itself matters because longer light travel distance increases photon loss through absorption, though glass must be mechanically strong.

For soda-lime cover glass, optical clarity is improved by specifying low-iron composition. The glass must resist soiling and staining or accept coatings that provide low-maintenance or anti-reflective properties. Different PV technologies have different requirements depending on their efficiency at different wavelengths. The glass must exhibit a wide “bandpass” ability to provide a high transmittance at all wavelengths. Sometimes small prism patterns are imprinted on the

surface to gather and focus more light energy. This patterned, cast or rolled glass typically has the pattern on the #2 surface to minimize dirt buildup that diminishes module efficiency.

Mechanical strength is critical for cover glass despite its relative thinness. Cover glass faces temperature extremes, wind loads, hail impacts, heavy UV exposure, cleaning agents and caustic chemicals. Laminating and framing stresses from bonding dissimilar materials can create coefficient of thermal expansion issues resulting in costly field failures. Heat-treated glass is often specified to add strength and thermal shock resistance.

Back glass or substrate

Back glass is on the module side not facing the sun, providing structural support and sometimes decorative appeal. The glass type may be annealed, heat-strengthened or fully tempered based on strength specifications, process and cost considerations. Since transmittance is unimportant, standard soda-lime float glass can be used with tints, patterns, textures or coatings for BIPV or spandrel applications. Slight curvatures can add aesthetic appeal. While optical distortion is not an issue, edge flatness is essential for efficient laminated assembly fabrication and structural integrity.

Types of PV cells

Monocrystalline silicon cells are made from single continuous crystal structures, offering high efficiency and superior performance. They are recognizable by their uniform dark appearance and rounded edges. Polycrystalline silicon cells are made from melted-together silicon crystals through a simpler, less

NGA thanks our task group volunteers for updating this resource:
 Julia Schimmelpenninck of Eastman|Saflex; Randy Reynolds of Glass Coatings & Concepts; Jon Griggs of Guardian Glass; Vaughn Schauss of Kuraray; Jason Fisher of Oldcastle BuildingEnvelope; Kayla Natividad and Shannon Jurca of Pilkington|NSG; Richard Wright of Richard E. Wright Associates; Nicholas Koren and Soumya Haridas of Saint-Gobain; Aaron Thompson of Viracon; and Steve Marino and Michael Hammond of Vitro Architectural Glass.

expensive process, making them cost-effective though slightly less efficient. They have a distinctive blue hue and speckled appearance. Thin-film cells are created by depositing photovoltaic material layers onto substrates like glass, plastic or metal. Common types include amorphous silicon, cadmium telluride and copper indium gallium diselenide. They offer flexibility and lightweight properties ideal for BIPV and portable devices, with lower efficiency but lower production costs.

Concentrated PV uses large solar module arrays with focusing lenses or mirrors to maximize photons reaching active PV material, increasing output and lowering solar power costs by producing more electricity per cell than standard modules. ■

The most-clicked news stories on GlassMagazine.com, brought to you by **GLASS MAGAZINE WEEKLY***

GulfGuard to Open New Float Glass Line in Saudi Arabia

Saudi Guardian International Float Glass Co. (GulfGuard), a joint venture between Guardian Glass and the National Company for Glass Industries (ZOUJAJ), has announced its intention to develop a second float glass line and a second glass coater at its existing site in Jubail Industrial City, Saudi Arabia. The sputter glass coater is expected to begin operations in 2027, followed by the float glass line in 2028.

This announcement follows the signing of a Memorandum of Understanding between the joint venture partners at the U.S.–Saudi Business Forum in Washington, D.C., organized by the Saudi Ministry of Investment.

The new float line is designed to produce standard clear float glass in thicknesses ranging from 4 to 12 millimeters in jumbo dimensions (up to 6 meters in length), with the capability to manufacture Guardian UltraClear low-iron glass. The planned new advanced sputter coater will be capable of producing low-emissivity and solar control glass, including Guardian SunGuard double and triple silver high-performance coatings.

Assa Abloy Acquires Sargent and Greenleaf

Assa Abloy has acquired Sargent and Greenleaf, a U.S. manufacturer of high-security mechanical and electronic locking solutions and safe hardware.

Sargent and Greenleaf was founded in 1857 and has some 100 employees. The main office and factory are located in Nicholasville, Kentucky.

Architectural Fabrication and Armetco Systems Announce Merger

Architectural Fabrication and Armetco Systems announced the merger of its operations. Under the combined structure, Jeff Cash and Jeff Kenny's leadership roles across the organization remain unchanged, with Cash continuing in his role as CEO and integrator, and Kenny continuing as owner and visionary across the organization.

The merger does not impact existing customer relationships, contracts, or project teams, say company officials. According to the company, customers can expect the same service, contacts, and commitment—now supported by a broader, more integrated organization.

Clearlight Glass & Mirror Acquires New Facility

Clearlight Glass & Mirror, a North Carolina-based custom glass fabricator, announced that it has acquired a fabrication facility in Stoneville, North Carolina, previously owned by Press Glass Inc. The Stoneville facility processes glass from 3/32-inch to 3/4-inch across a broad product mix, including clear, low-iron, low-emissivity coating and patterned substrates. With this acquisition, Clearlight will expand capacity for custom shower enclosures, residential

and commercial glazing, and specialty fabrication, while adding high-volume capabilities in insulating glass units, lamination, back-painted glass, digital ceramic printing and high-throughput tempering. Clearlight leaders note that the facility provides machine redundancy, including multiple tempering ovens, CNC and cutting assets and integrated logistics capacity.

LionGlass Windows in Development with Vitro

LionGlass, a sustainable glass invented at Penn State, will soon be developed for windows due to a new partnership with Vitro Architectural Glass. The company signed a multi-year research agreement to scale up the new glass technology for use in flat glass applications across architectural and automotive markets. The project, which runs through July 2028, will focus on adapting LionGlass for the float process.

As part of the agreement, Vitro will be sending one of its own employees, Daniel Kramer, back to Penn State to pursue a doctorate and work directly on the project. Kramer will lead the research alongside Nicholas Clark, assistant research professor at Penn State and co-inventor of LionGlass, whom Kramer trained in Mauro's lab as an undergrad. The team will evaluate LionGlass's compatibility with industrial float processes and optimize its composition for flat glass applications. The team will also test its compatibility with various down-

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NEWS TO KNOW

stream, value-added processes used in architectural and solar glass markets.

TSS Glass Machinery Partners with Koja USA

TSS Glass Machinery Sales Inc., which supplies a full range of spare parts, technical support and installation services to the glass industry, announced a partnership with Koja USA Inc. Koja USA provides advanced carbon fiber fan impeller solutions designed for cyclic operation, delivering energy and time savings.

FrontLine Bldg. Products Breaks Ground on Plant Expansion

FrontLine Bldg. Products Inc. broke ground on a 45,000-square-foot expansion at its facility in Medford, Wisconsin. Planned improvements include the installation of sprinkler systems throughout both the new and existing facility, a new three-phase 480 volt electrical service and an upgraded dust collection system. Construction is expected to be completed in summer 2026.

DFI and Nanoveu Announce Partnership

Diamon-Fusion International announced a long-term strategic licensing partnership with Nanoveu Ltd. The agreement grants Nanoveu exclusive rights to deploy DFI's Diamon-Fusion nanocoating technology in the concentrated solar power (CSP) energy sector, specifying a multi-year term and territory coverage for CSP projects worldwide.

Through this partnership, Nanoveu will introduce DFI's proprietary super-hydrophobic, impact-resistant coating systems to CSP operators worldwide. These technologies are engineered to extend solar panel lifespan and improve power output. They also reduce maintenance and water consumption.

PEOPLE

Merritt Gaunt has been named president and CEO of **Guardian Industries**. In this role, he will assume leadership



Gaunt

of Guardian Glass. This change follows the retirement of *Ron Vaupel*, president and CEO of Guardian Industries since 2014.

After joining Guardian in 2013 as managing director of corporate development, Gaunt held operations and other leadership roles. In his most recent role as executive vice president, Guardian Industries, Gaunt led the company's business development and supply chain strategies. Prior to Guardian, Gaunt gained ten years of experience in finance, marketing and business development leadership at other Koch companies.



Branch

The **American Institute of Architects** has named *Richard Branch* as its new chief economist.

In this role, Branch will analyze U.S. economic trends and construction markets, assessing their impact on architectural practice. He will also oversee the production of key indicators and reports to forecast construction activity and provide strategic guidance to AIA members. Most recently Branch served as chief economist for Dodge Construction Network.



Fronsoe

Vitro Architectural Glass announced the promotions of *Chris Fronsoe* to director of innovation, commercial segment, and *Trevor Hall* to west national architectural team manager.



Hall

In his new role, Fronsoe will lead the company's efforts to bring new glass product concepts from development to market. He will be responsible for defining the innovation vision for the architectural commercial market, leveraging his experience in both technical and market-facing roles.

Hall will assume Fronsoe's previous role as west national architectural team manager, leading the architectural team for projects west of the Mississippi. ■



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CAREY MOBIUS LEAVES A GLASS INDUSTRY LEGACY

Industry veteran is remembered as a friend and mentor to many **BY RACHEL VITELLO**

Longtime owner of Garibaldi Glass, National Glass Association volunteer and overall steward of the glass industry Carey Mobius passed away on Jan. 7, 2026, at the age of 61.

His legacy

Born into the glass industry, Mobius' life and career were inseparable from the business his family built. He began working alongside his father at a young age, traveling to the company's early Squamish, British Columbia, location and sleeping on the cutting table as a toddler. When his father passed away at just 42, Mobius faced responsibility at an early age. Through periods of financial hardship, including rebuilding the company from a staff of 40 that had declined down to four, he steadily

rebuilt the business brick by brick.

Over more than four decades in the industry, Mobius shaped not only glass, but people, partnerships and a culture grounded in the philosophy of "Never Ever Give Up." In recent years, Mobius focused on guiding the next generation of his family and leadership team, not simply teaching them how to run a business, but how to lead with integrity, curiosity and heart.

His loss has been felt by many in the industry who considered him not only a colleague, but also a friend and a mentor.

Industry reflections

"Carey was a leader, a mentor and a friend who profoundly influenced my career and my life," says Rich Porayko, storyteller for Construction Creative

Marketing + Communications. "He gave me my start in the glass industry when he hired me at Garibaldi Glass in 2003. He shared his knowledge generously and led by example. His passion, enthusiasm, and belief in people were constants in everything he did."

"I can tell you that he was a people-first type of person. If you came to town, he was taking you out to dinner," says Robert Carlson, head of engineering, Tristar Glass. "He wanted you to get better and grow. The last time I visited his plant he pulled a book about scaling up off the shelf and gave it to me to keep. He always treated me like he was rooting for my success and wanted to hear my ideas and opinions. He had a way of making you feel valued."

"Carey Mobius was such a unique personality, a force. He led gently, yet with intention and persistence," says Urmilla Sowell, NGA vice president of advocacy and technical services. "He found value in serving the broader industry, knowing his own business and people would equally benefit. That is shown through his formation of Glass Days, at which I had the privilege of attending and speaking. It is also reflected in Garibaldi Glass' 25-plus year membership in the legacy GANA and NGA, including volunteerism shown by his employees to elevate the industry's resources. His mind, his care, his humor will all be deeply missed."

"I was sad to hear of Carey Mobius' recent passing. His loss is felt deeply, both personally and collectively," says NGA Board Chair and President Tim Kelley, Tristar Glass. "Carey was a dedicated volunteer for the NGA and a passionate advocate for the glass industry at large. He approached his volunteerism as he approached his work; with care, patience and a genuine appreciation for the industry. His kindness, dedication and belief in our mission will continue to be reflected in the work we do and the community we nurture." ■



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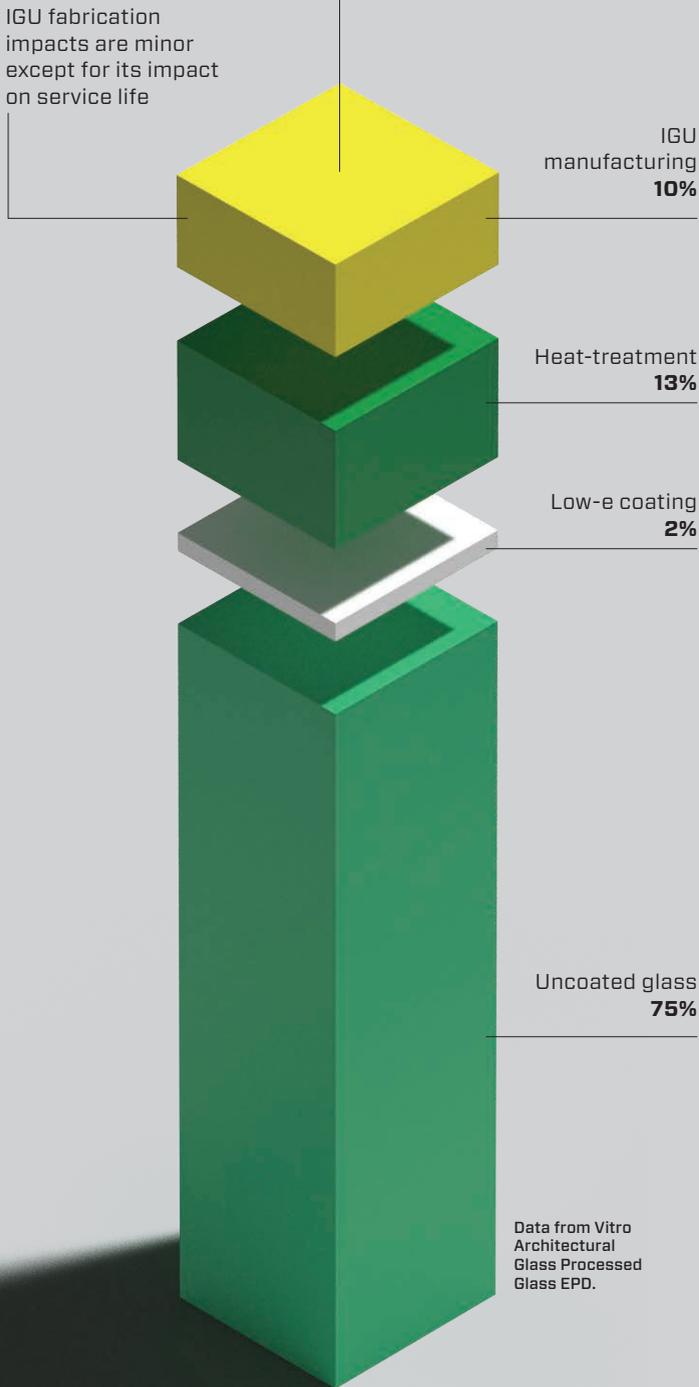
During Women's History Month, we celebrate the women of Glassfab whose knowledge, dedication, and leadership help move our company forward. Their contributions are felt across every department, supporting our teams, our partners, and our customers with consistency and care.

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We appreciate the impact they make each day and recognize the role they play in shaping our continued growth and success.



Fig. 1—Relative contributions to Global Warming Potential
Contributions to the embodied carbon of insulating glass



SUSTAINABILITY

THE IMPORTANCE OF SERVICE LIFE FOR IGUS

Why design-related decisions are crucial for reducing environmental impact **BY HELEN SANDERS**

Architectural and design firms, as well as some regulatory bodies, increasingly require environmental impact data for building systems. While designers are requesting carbon footprint metrics to quantify the embodied carbon of insulating glass units, the design community should also consider IGU service life—the estimated time an IGU can function before needing to be repaired or replaced. An understanding of service life, and how it relates to environmental impact, is crucial to capture the full carbon reduction potential of high performance IGUs.

Operational carbon and embodied carbon

Carbon emissions for glazing systems are often measured through two metrics: operational carbon and embodied carbon. Both metrics are important to understand with regard to reducing building emissions.

Operational carbon, or OC, is the carbon emissions caused by operating a building. For most buildings, the improved energy efficiency of building materials results in reduced OC. However, this is not always the case—for example, when a building’s power is sourced from clean energy, such as on-site renewables or a low-carbon

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electric grid, even an energy inefficient building could have low OC.

Embodied carbon, or EC, is the carbon emitted during a product’s raw material extraction and manufacturing. Approximately 75% of an IGU’s EC is from energy-intensive flat glass production (see Figure-1). Only 10% is due to the insulating glass process itself—approximately half from the electricity to run the IG line and half from the edge seal materials (spacer, sealants, desiccant).

Most factors that impact an IGU’s EC are those that glass fabricators cannot change. The project-specific IGU design itself determines the EC—the number and thickness of the lites, the heat treatment, as well as the edge seal materials specified. The fabricator’s location also impacts the product’s EC, depending on the electric grid’s carbon intensity. In addition, the dual seal polyisobutylene, or PIB, and silicone edge seal system is ubiquitous in commercial IGU applications. The quantities used are determined by durability needs and similar for all fabricators.

For IGUs, service life matters

IGUs have an important role to play in reducing both the OC and EC of a building. High-performance fenestration can play a significant role in reducing OC by reducing a building’s lifetime heating and cooling loads, assuming the fenestration’s efficiency performance does not degrade. These emissions reductions accrue through the building’s service life. Maximizing fenestration service life is therefore critical to maximizing accrued emissions reductions.

Extending the service life of an IGU assembly also plays a critical role in reducing a building’s EC. Securing a long service life for an assembly also preserves the large upfront EC investment in the flat glass used to make the IGU. For example, selecting an alternative product that halves the upfront EC, but also halves the service life, is not a better choice. Due to its shorter service life,

A decision-making framework for reducing embodied carbon. LCA = life cycle assessment.



the IGU will need to be replaced sooner, which then increases the overall EC for the building. EC per year of service life is an important (but not yet widely utilized) metric that should be used to support product selection.

Best practices for managing IGU service life

For these reasons, asking for the carbon footprint of IGUs from different fabricators to make supply chain decisions is not meaningful for project-level carbon reduction decision-making.

While the impact of IGU manufacturing on EC seems minor, the edge seal selection details and manufacturing quality have an oversized impact on service life, which is a driver of long-term embodied and operational carbon emissions.

- An IGU’s service life is maximized if:
- Its edge seal is carefully designed to manage the environmental conditions and climate loads;
 - Its edge seal uses high-quality spacer, desiccant and sealants in sufficient quantity, and if those materials are appropriate to the application and work effectively together as a system;
 - It is manufactured with consistent and effective quality control; and
 - It is carefully installed to effectively manage water, material compatibility and edge pressure, and provide sufficient edge support to manage shear and deflection.

Fabricator and installer certification programs—such as the IGCC/IGMA and IGMAC programs for IGU fabricators and the NACC and AGMT programs for installers—support quality fenestration designs, fabrication and installation. Choosing certified fabricators, IGU designs and installers can reduce service life risk, supporting improved performance and longevity. ■



Helen Sanders, Ph.D., serves Technoform Glass Insulation on its North American market team.

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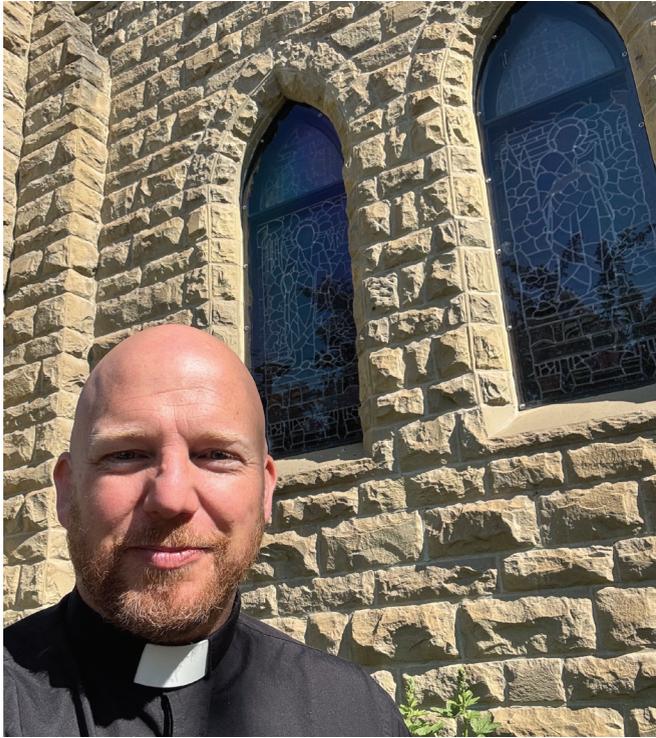
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Chris Dowdeswell, dean of the Cathedral Church of the Redeemer, worried for the safety of the building until protective products were installed over the church's stained glass windows.

PROTECTING THE PAST

Protective glazing products offer added security to retrofit projects **BY VINCE CROKER**

When crime and vandalism rates rose in downtown Calgary, Alberta, members of the Cathedral Church of the Redeemer worried for the safety of their building. After rocks were thrown at the historic structure's stained-glass windows, church volunteers reached out to ProGuard, one of ClearSecure's security panel dealers to find a solution that would protect the house of worship.

For years, the sandstone structure building had covered its fragile windows with fire protectant screens and older protective windows that affected the clarity of the biblical scenes presented. "It looked like an old, ramshackle type of security covering, and it wasn't putting our best foot forward, to put it lightly," said Chris Dowdeswell, dean of the Cathedral Church of the Redeemer.

The church's volunteers worked closely with ProGuard Construction in Edmonton, Alberta. Over a period of 6 months, ProGuard consulted with the church and heritage organizations to ensure that the installation of the panel over the church's stained glass would not take away from the integrity of the vintage glass's design and aesthetics.

"I don't know if we could have found a better solution to the problem," said Dowdeswell, after the installation. "I didn't expect to be able to see the underlying artwork so clearly."

The evolution of security glass

When I worked in the traditional glass sector, anytime someone wanted something that wouldn't break, we would traditionally grab a sheet of polycarbonate and make a replacement sealed unit. The trouble was, you couldn't

offer any warranty because it would typically fail, and yellow in the sun within a few years.

For a glass industry veteran like myself who has seen just about everything, customizing security panels to go over existing sealed units to prevent vandalism has become a very rejuvenating experience, especially seeing it all come together to protect heritage buildings and churches across North America. Now, in a single application, the security panel can be cut on a computer numerical control machine to match any size or shape that is required to protect existing glass.

Safety glazing typically includes laminated and tempered glass. Protective glazing options can vary depending on the client's needs—forced-entry protection or ballistic-rated, as examples. Advancement in security glass technology has allowed companies like ours to offer cost-effective options for mitigating vandalism.

More glass companies are realizing that products like security panels are a good thing because they can now offer another solution to their customers. And architects who are looking to specify a security glass product for their clients also benefit. They get glass that appears aesthetically pleasing, while remaining impact-resistant to disrupt the cycle of repairing or replacing broken glass.

And with the evolution of security glass, heritage buildings like the Cathedral Church of the Redeemer can benefit from proactive measures to help secure its facility as vandalism and crime rates increase. ■

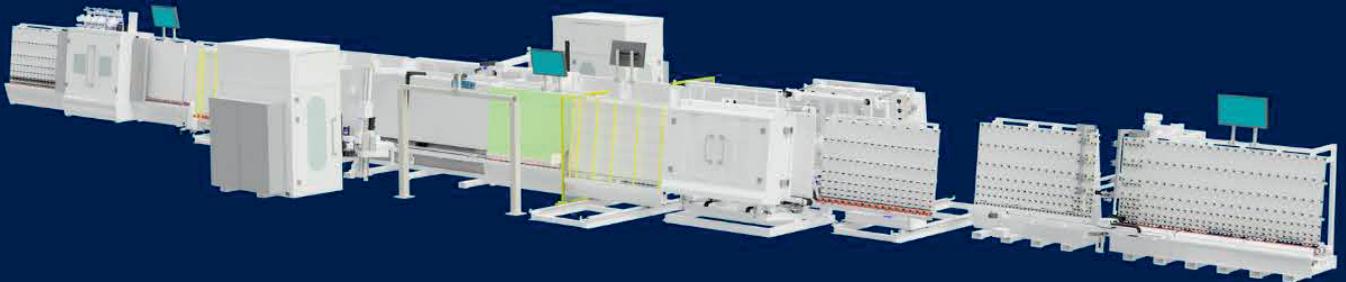


Vince Croker is vice president for ClearSecure Distribution and Manufacturing in Canada.

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Infinite Recycled Technologies recently collaborated on a study with NGA and AEC to look at the potential impact of end-of-life recycling. The company worked with building ownership at a project in Rochester, Minnesota, to remove and recycle glass and aluminum from a parking garage slated for demolition.

GlassBuild America, but in awareness and coordination.

Coordination amplifies circularity

Glass recycling is a cornerstone of circularity, offering significant environmental benefits. Glass is one of the few building materials that is infinitely recyclable without loss of quality. Architectural glass already plays a critical role in high-performance building envelopes during its use phase; with strategic collection and processing, it can continue to deliver value long after its initial application. Recycled glass applications can range from making new glass, fiberglass insulation, as well as a multitude of industrial applications. This approach extends the investment in the material, mitigates landfill impact and supports a version of sustainability that is both practical and scalable.

Using recycled cullet in glass production can also help mitigate carbon dioxide emissions. According to NSG Group “remelting of one [metric] tonne of cullet avoids approximately 400 to 600 kilograms of carbon dioxide emission.” Similar reductions are shared by Saint-Gobain Glass where they elaborate that for each ton of cullet used, their consumption of virgin raw material is decreased by 1.2 tonnes and lowers the energy needed for melting cullet by 30%, compared to melting primary raw materials. Using more recycled cullet in place of virgin materials in glass manu-

TURNING WASTE INTO OPPORTUNITY

How collaboration and circularity are transforming the building industry

BY STANLEY YEE

Recycling architectural glass is not only possible, but also practical, cost-effective and increasingly embraced across the industry. This year’s GlassBuild America in Orlando served as a powerful example of what can be achieved when stakeholders unite around a common goal.

The glass industry trade show provided an opportunity to showcase glass recycling in action. Infinite Recycled Technologies partnered with the GlassBuild organizing team, the National Glass Association; Freeman, the show’s operators; and the staff of the Orange County Convention Center, where the trade show was held, to implement a recycling program on the show floor. The IRT staff engaged exhibitors to collect what ultimately amounted to 14.3 tons of glass waste—most of which would otherwise have gone to landfill but was instead recycled at IRT’s South Florida location.

Every ton of post-industrial and post-consumer glass diverted from landfills represents a tangible step toward sustainability. The challenge lies not in feasibility, as shown by the success at



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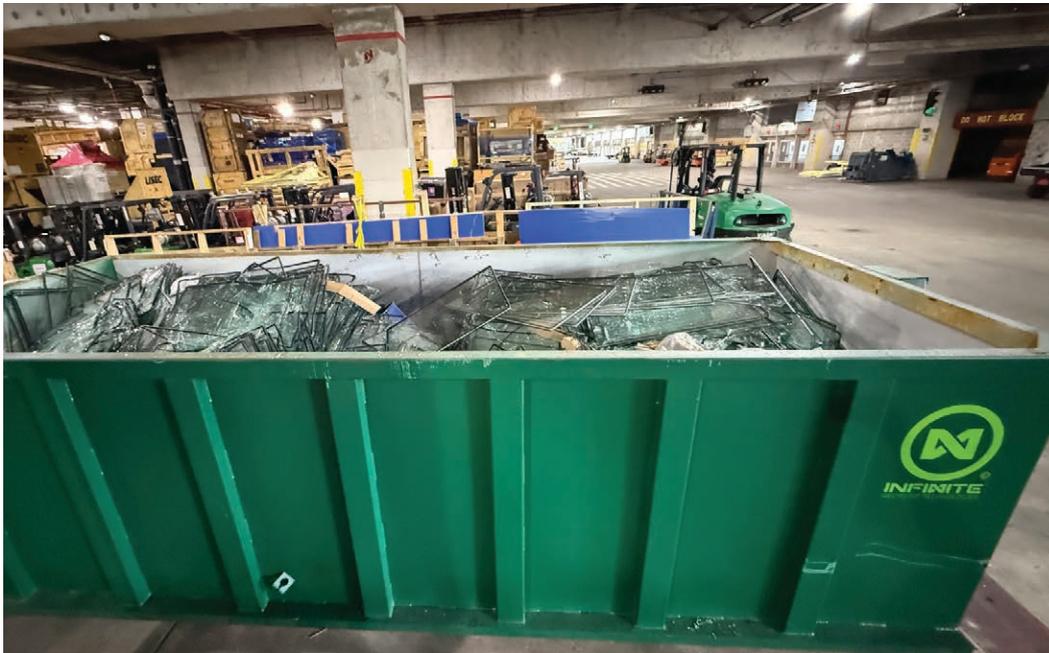
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Glass at the Infinite Recycled Technologies' facility.

facturing reduces energy requirements and, as a result, fuel consumption and emissions.

Services offered by IRT include hauling and recycling glass from fabrication processes—whether monolithic, reflective/low-emissivity/ceramic-frit-coated, mirror, insulated, laminated or a combination thereof—and working with project teams recovering glass from building renovations, demolitions and fit-outs. Historically, these materials were sent to landfills; today, they can be redirected into productive reuse.

For over two years, IRT has enhanced efforts across the architectural glass value chain to dispel misconceptions that recycling is difficult, costly or uninteresting. The reality is quite the opposite: fabricators, developers, architects, contractors and building operators have shown strong interest in sustainable alternatives.

In New York City, industry stakeholders from a cross-section of the industry have joined together to collectively share experiences and connections related to glass recycling. Engagement with this group has allowed compa-

nies to facilitate new pilot projects to recover glass from various retrofit or repositioning projects in and around the New York City area.

In 2025, this initiative resulted in glass being recycled from about 20 projects, diverting about 800 tons of architectural and flat glass from landfills. The positive results seen in New York in 2025 can be attributed to the positive and proactive engagement of this industry glass recycling group, which offers members group support, project opportunity sharing and specifications writing for those projects and stakeholders wishing to enhance project sustainability objectives through waste mitigation and diversion plans and process. These project specifications can be written utilizing IRT's guide specification or collaborating with architects/specifiers writing their own documents.

A recent project in Rochester, Minnesota, illustrates the potential impact of end-of-life recycling. As part of a study funded by NGA and the Aluminum Extruders Council, IRT collaborated with the building ownership and contractors to remove and recycle glass

and aluminum from a parking garage slated for demolition. This effort not only diverted demolition waste but also allowed the team to better document recycling outcomes. The study provided the project team with more information about recycling and waste management rates, while also offering ideas about how teams can identify opportunities to recycle better and more effectively moving forward.

The success at GlassBuild America and projects like those in Rochester demonstrate that architectural glass recycling is not an abstract ideal, but an actionable reality. Through collaboration, education and commitment, industry can transform glass from a disposable commodity into a perpetual resource. By embracing circularity, we reduce carbon emissions, conserve energy and create a replicable model for sustainable construction practices. ■



Stanley Yee is the vice president for sustainability and technical initiatives at Infinite Recycled Technologies.

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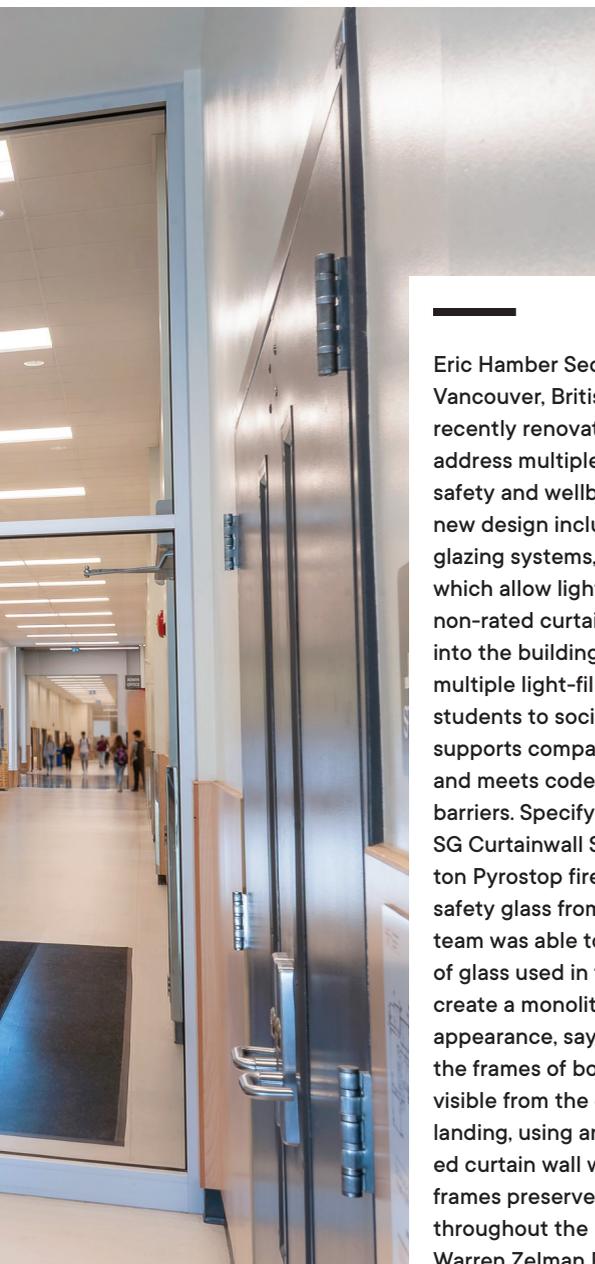
PROTECTIVE



GLASS

GLASS SYSTEMS CAN OFFER SECURITY AND LIFE-SAFETY WITHOUT COMPROMISING OCCUPANT COMFORT

BY NORAH DICK



Eric Hamber Secondary School in Vancouver, British Columbia, was recently renovated in order to address multiple goals for occupant safety and wellbeing. The school's new design includes fire-rated glazing systems, courtesy of TGP, which allow light from the exterior, non-rated curtain wall to filter deep into the building's interior, providing multiple light-filled common areas for students to socialize or study. It also supports compartmentation efforts and meets code requirements for fire barriers. Specifying the Fireframes SG Curtainwall Series with Pilkington Pyrostop fire- and impact-rated safety glass from TGP, the project team was able to maximize the spans of glass used in the assembly and create a monolithic structural glazed appearance, say officials. Because the frames of both systems are visible from the entry and third-floor landing, using an interior, fire-rated curtain wall with narrow-profile frames preserves a cohesive design throughout the building. Photo by Warren Zelman Photography.

→ In January 2025, the Palisades and Eaton fires burned through California with catastrophic results. In the end, 30 people were killed and 17,000 buildings burned. The fires caused \$30 billion in property damage and \$250 billion in economic loss.

The fires were just one event that made clear the need for building materials that protect structures and the people who live, work and learn inside them. Glazing systems can help protect buildings and people without compromising occupant comfort.

What is protective glazing?

Protective glazing has various definitions depending upon the context in which it is used. It can cover glazing designed to minimize injury and property damage from bullets, blast waves and/or physical attack. It can also indicate glazing designed to protect people and property from windborne debris associated with hurricanes.

Depending on the product make-up, protective glazing can also fulfill a range of other performance criteria, such as blocking the spread of smoke and flames, reducing unwanted noise, and insulating against heat gain and loss for improved building energy efficiency. Urmilla Sowell, vice president, advocacy and technical services at the National Glass Association, emphasizes that unlike traditional security measures, protective glazing options also help to maintain occupant comfort. "Traditional security measures can make places feel institutional, unwelcoming or even just remind us that there is a safety need to be met," she shared in the presentation "Protect with Glass: a Multi-Faceted Approach," offered at GlassBuild America 2026. "High walls, minimal windows and restricted sightlines are traditional approaches that we may have seen as safe, but they compromise the psychological benefits of daylight, views and connection."

Protective and security glazing is a powerful



design tool, she says, because these systems allow designers to maintain the transparency and openness that support well-being, while still providing the protection occupants need to feel—and be—safe.

1—SECURITY GLAZING

Security glazing is designed to remain intact after breakage. Security glazing systems can be used to protect against smash and grab crimes, firearms, blasts and more. It is important to understand how this type of protection differs from safety glazing:

- **Safety glazing** has passed ANSI Z97.1 testing to reduce cutting and piercing injuries when broken with accidental human impact.
- **Security glazing** tends to be defined as glass that resists intentional attack to provide safety and/or time for reaction.

One of the consistent characteristics between the two applications is the ability to keep glass shards small enough to reduce injury, or to keep it in-place and deter immediate penetration. That typically occurs by tempering the glass or using a material that is attached to the glass to enhance its performance. Tempered glass is known to break in small pieces, and when appropriately processed, is therefore deemed as a safety glazing. However, once broken, it does not provide penetration resistance, which comes from the use of surface-applied films, interlayer films or curing resins.

An overview of security glazing

Security and protective glazing systems and assemblies can offer protection against a multitude of threats, both internal and external to the space. Many window, door and curtain wall manufacturers have systems tested with security glazing. More information

The Wendell L. Cross Elementary School in Waterbury, Connecticut, was extensively renovated and expanded to become a facility designed to serve nearly 700 students from Pre-K through 8th grade. One of the upgrades is the addition of a ballistic-rated security vestibule and transaction window to enhance safety, provided by U.S. Bullet Proofing. Jim Wilson, project manager for project designer Friar Architecture notes that most newly constructed schools in Connecticut now incorporate security vestibules into their designs. “When the Sandy Hook tragedy happened in Newtown, it affected everything in the state immediately. It was a big driver and changed a lot of the code in the state and around the nation.” Photo by Lockheed Architectural Solutions.

is available from these manufacturers. Here is an overview of types of security glazing and how they function:

- **Burglary-resistant glazing** can be a deterrent to smash-and-grab crimes. Burglary-resistant laminated glass typically consists of two layers of annealed, heat-strengthened or tempered glass bonded together by a 0.060 inch or thicker interlayer. The glass can be installed into insulating glass units for improved thermal performance. Burglary-resistant glazing may also include self-adhesive polyethylene terephthalate films that are on the exposed, interior side of the glass.
- **Forced-entry-resistant glazing** can be used in detention facilities or other installations with a high risk of attack, and may also resist penetration from hand-held or hand-thrown objects such as hammers, crowbars, bats, knives, bricks and rocks.
- **Bullet-resistant glazing** is designed to resist penetration from a variety of firearm ammunitions. There are numerous types of bullet-resistant laminated glazing, including all-glass laminates, glass-clad polycarbonate laminates, glass laminates containing other rigid polymers, laminated polycarbonates, and glass/exposed plastic laminates (exposed polycarbonate or PET). Bullet-resistant glazing must be tested in accordance with standard procedures to demonstrate its ability to resist a specific ballistic threat level. Bullet-resistant glazing provides an improved safety barrier against bullets and related flying glass or plastic fragments, such as spall or splinters.
- **Multiple forced-entry assault (ballistics and forced entry)** products are designed to combine the resistance of ballistic classified laminates with additional resistance to forced entry. Testing for these glazing systems involves weakening the sample by ballis-

IN DEFENSE OF DAYLIGHTING

One of the major design benefits of protective glazing is that it also allows for daylighting, which is critical to ensuring psychological well-being for occupants.

Daylight has qualities that cannot be replicated by electrical or artificial light. The changing intensity, direction and color of natural light connects building occupants to the weather, season and time of day. Views through windows can stimulate the well-being and productivity of building occupants. With careful design and controls, daylighting can also substantially reduce energy use.

The potential for daylighting and views is largely a function of orientation, window placement and window area, as well as the

windows' visible transmittance. However, daylight admission must be balanced with glare control and thermal comfort.

Glazing can be separated into glazing for daylighting and glazing for views, while daylight is redirected by means of light shelves. Top lighting fenestration, such as roof monitors, can be another means of controlled daylight access. Advanced glazing for daylight control is available with electrochromic coatings or between-glass blinds. Finally, orienting glazing along an east-west axis typically reduces the potential for glare and allows for more balanced light conditions throughout the day.

tic assault, but not allowing the bullets to penetrate. The glazing is then tested to withstand physical impact and attack with various weapons. This glazing would carry a ballistic and forced-entry classification and would be used in very high-risk areas where intruders may be armed with guns.

- **Blast-resistant glazing** can substantially reduce injury from flying glass resulting from direct-blast shock waves, or overpressures. When properly designed, framed and anchored, blast-resistant glazing is capable of maintaining the integrity of the building envelope following an explosion and reducing interior damage. Low-level, blast-resistant, laminated glazing typically consists of two layers of glass bonded together by a 0.030 inch or thicker interlayer. For higher level blasts, thicker constructions may be needed. The glass can

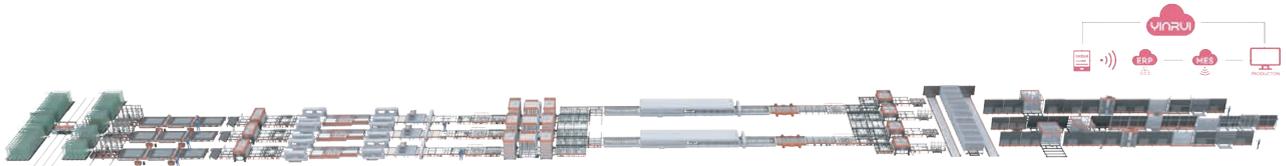
be annealed, heat strengthened or fully tempered. The glass can be installed into insulating glass units for improved thermal performance.

- **Hurricane-resistant laminated glazing** reduces the effects of windstorms on buildings by preserving the integrity of the building and preventing glass particle fallout. Hurricane-resistant laminated glazing may offer some level of burglary or forced-entry resistance but typically are not bullet-resistant without further specification of a ballistic threat level.

The U.S. General Services Administration developed a training program that addresses emergency egress through security glazing. Architects specifying systems and schools installing security windows need to be aware of the potential time needed to get through security glazing.



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Considerations for school security

According to Everytown for Gun Safety and the K-12 Shooting Database, since 2013 there have been at least 1,322 incidents of gunfire on school grounds, resulting in 436 deaths and 936 injuries nationally. The average length of active shooter events is 8 minutes; the shortest is 90 seconds.

Security glazing is designed to buy time for first responders. Active shooter events happen most frequently in retail/commerce spaces, open spaces and education facilities.

Schools and institutions have responded to active shooter events in many ways in recent years. Districts are spending millions of dollars to “harden” schools, or adding more security elements and equipment, and students are spending more class time on active shooter drills. The Department of Homeland Security released documents to guide schools and districts on these new measures, and new school security requirements are under consideration at the federal level and in many states.

While these interventions help make schools safer, there’s more that glass can do to make schools secure. Protective and security glass and glazing systems have a part to play in keeping students safe while also maintaining a pleasant learning environment.

There are many reasons to use security glazing to protect students from active shooters:

- Security glass installed in school entrances looks like a normal entrance and is perceived as a point of weakness, but can isolate those entering the building, slow an active shooter down and delay entry into the building as the first line of defense.
- Windows can allow for line of sight, both exterior to interior and within the building, alerting school personnel and first responders of impending danger. Security windows can create safer spaces within the building. Opaque glass can provide privacy and allow light flow while selec-

tively blocking the line of sight of attackers.

- Windows can be designed for forced-entry resistance, bullet-resistance or both.
- Retrofit options are readily available for existing windows.
- Windows can create a secure environment, without it feeling like a secure environment to teachers and students, by protecting while being unobtrusive.
- Security windows provide passive protection, continuing to function during power outages.
- Students in classrooms with windows providing natural daylight and a view to the outside score 7%-30% higher in math and reading and have lower absenteeism.

2—FIRE-RATED GLAZING

Protecting against fire, whether wildfires or accidental interior fires, is a major design consideration. According to the National Fire Protection Association, 470,000 structure fires occurred in the United States in 2023, which amounts to 1,300 fires every day. The total damage includes:

- 3,070 deaths;
- 11,790 injuries; and
- \$14.7 billion in property damage.

Fire safety requires a balance of two complementary approaches:

Active fire protection: This includes automatic suppression devices—sprinklers being the most common. Active systems detect and respond to fire. They’re incredibly important—sprinklers cut fire death rates by about 80% in buildings where they’re present.

Passive fire protection: This includes fire-rated glass, fire-resistant walls, fire doors and compartmentation. Passive systems don’t require activation—they’re always working.

Fire-rated: Fire-protective and fire-resistive glass

In commercial buildings, fire-rated

glass enables safe egress through proper compartmentation and protected egress paths. All fire-rated glazing is tested, listed and labeled under the follow-up services of nationally recognized testing laboratories. In order to have their products listed and labeled as fire-rated glass, manufacturers must submit their products to a certified laboratory to be:

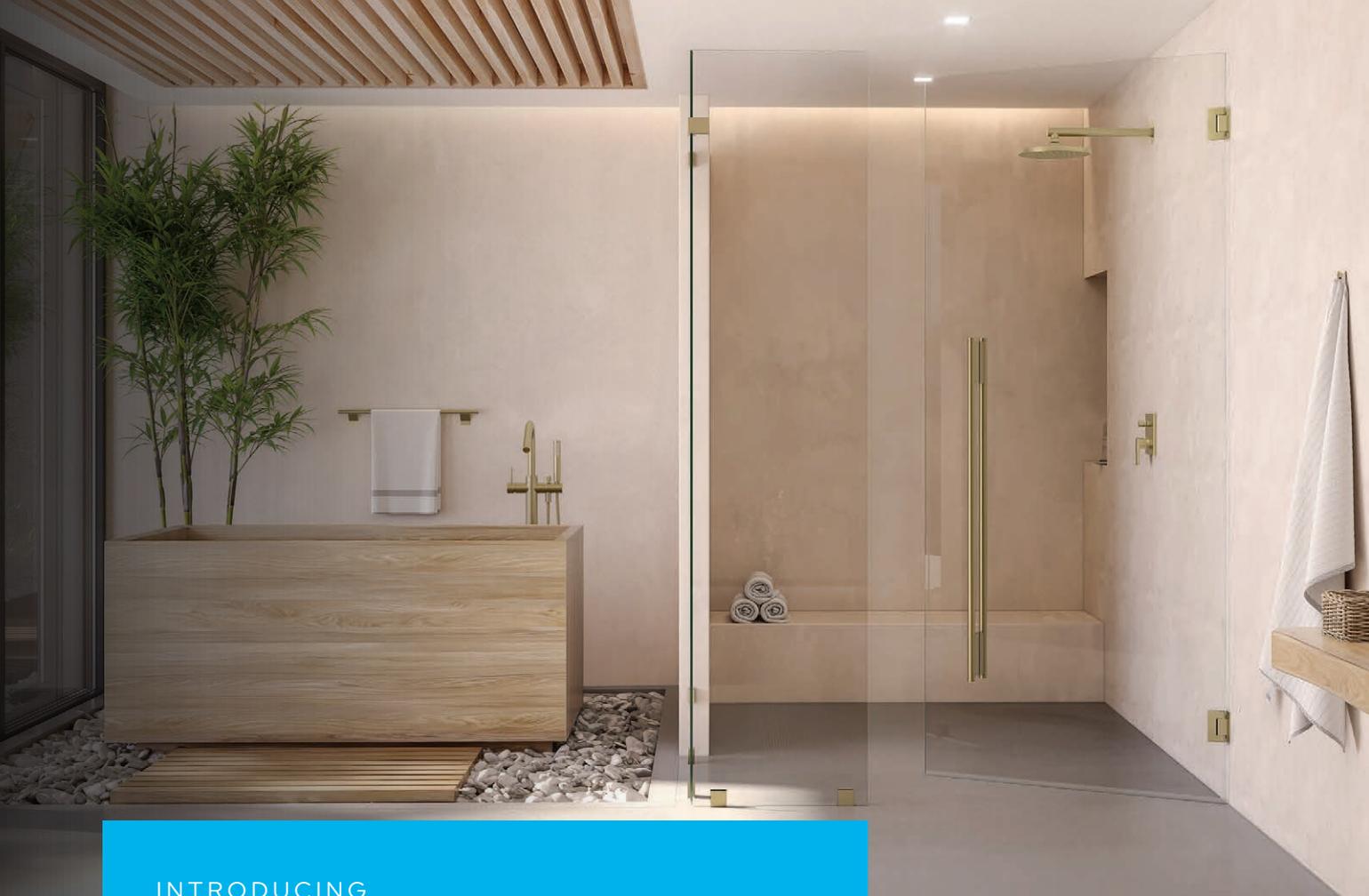
- fire tested for periods lasting from 20 minutes to 3 hours,
- thermal transfer tested, if necessary, and
- hose stream tested in most cases. If the product passes the required tests, the test lab awards it a listing and label either as fire-protection or a fire-resistance-rated glass.

Two different classifications exist for fire-rated glass.

Fire-protective glazing is tested to NFPA 257/UL 9 in fire window assemblies and NFPA 252/UL 10C and UL 10B in fire door assemblies. Fire window and fire door assemblies are referred to in the International Building Code as “opening protectives.” Fire windows and fire doors can be designed using fire-protection-rated glass to prevent the passage of smoke, flames and hot gases.

Fire-resistive glazing is tested as a “wall” assembly pursuant to ASTM E119/UL 263. Like opaque fire-rated construction materials, fire-resistance-rated glass is designed to prohibit the passage of smoke, flame, hot gases and the radiant heat from a fire.

All fire-rated glass is subjected to a fire endurance test. This determines the length of time—in minutes or hours—that the fire-rated assembly will withstand the fire of a test furnace, which can exceed 1,900 degrees Fahrenheit. The fire in a test furnace follows a fixed time and temperature curve designed to simulate an actual fire in which temperatures rise quickly, then gradually increase over time. To be listed and labeled, the glass and its entire assembly must remain intact for the



INTRODUCING

The NEW Trento Shower Door Hinge

The Trento Hinge is the latest advancement in shower hardware, designed to hold heavier doors, provide a luxurious look, and simplify installation with a one-size-fits-all gasket.

- One-size Non-Asbestos Fiber gasket for both 3/8" & 1/2" thick glass
- Clean, contemporary design with concealed screws
- Supports doors up to 140 lb and 40" wide
- Available in 5 popular finishes



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Figure 1: The Means of Egress



Exit access



Exit



Exit discharge

full duration of the test, which can last from 20 minutes to 3 hours, depending on the type of listing required.

Immediately following the fire endurance test, the glazing assembly is subjected to a hose stream test, where the water pressure is 30-45 pounds per square inch, depending on the fire rating. Water from a fire hose playpipe strikes the assembly in a prescribed pattern and duration, depending on the size, from 20 feet away. If the glass remains in place without exceeding the allowable limit of openings, it passes the test. Most, but not all, fire-rated glazing applications require the hose stream test. In the U.S., in 20-minute fire door assemblies installed in 1-hour fire partitions (e.g., corridor walls and smoke barriers) the protective glazing is exempt from the hose stream test. In Canada, all fire-rated glass must pass the hose stream test.

The ability to limit heat transfer is a critical distinction between fire-protective and fire-resistant. Fire-rated products are application-driven as much as they are code-driven. The duration rating should not be the sole feature determining code compliance. Fire-protective glazing is subject to various size and application limitations in the IBC because it does not prevent heat transfer. Where fire-protective glazing is limited or prohibited by code, fire-resistant

glazing can be considered when evaluated for the end-use condition.

Protecting the means of egress

The means of egress is the safe way to exit a burning building. This includes not just the exit, but the entire protected path from where occupants are to the outside. Commercial buildings must have fire-rated glass to protect individuals along the path of egress.

First, the exit access. This is the portion from any occupied part of the building to an exit. It starts where an occupant begins egress travel, includes all the rooms and spaces they pass through, and ends when they reach the exit. This might include corridors, aisles and doorways. Fire-rated glass in exit access corridors allows natural light and wayfinding while maintaining fire separation.

Exit. This is generally considered the point where the occupant has attained a certain level of safety, like an enclosed stairwell or exit passageway, that's separated from other building spaces. This is where fire-resistance becomes critical. The stairs occupants use to evacuate a high-rise are considered an exit, and must be protected with fire-rated construction, including any glazing.

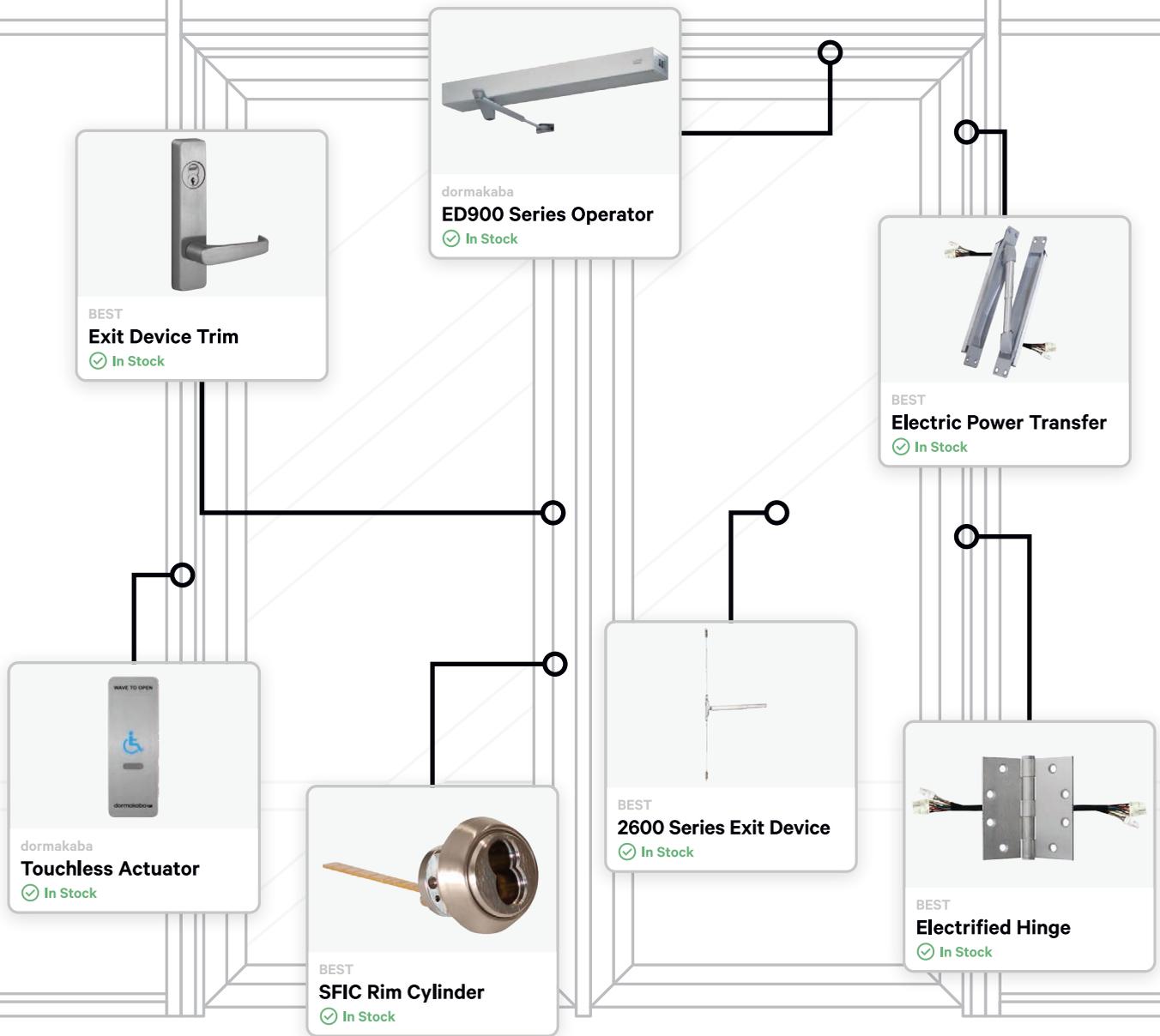
Exit discharge. This refers to the exterior area at grade where

RESOURCES FROM THE NATIONAL GLASS ASSOCIATION

This article was compiled using the following sources from the National Glass Association. All can be found at glass.org

- Security Glazing, FB43-14 (2020)
- School Security Glazing, FB71-24
- Bullet Resistant Glazing, FB16-07 (2022)
- Fire-rated Glazing 101, FB76-23
- Protective Glazing Manual, 2010 Edition
- School Security: Windows and Doors Respond First

an occupant leaves the building. Occupants are not truly safe until they've reached the public way. At every point along this path of egress, any glass present must be appropriately fire-rated, including windows looking into the exit stairs or doors with glass. ■



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STEEL

IN MODERN ARCHITECTURAL FENESTRATION



Sluishuis apartments in Amsterdam feature Jansen's VISS Fire roof glazing product.



FROM DURABILITY TO DESIGN
VERSATILITY: HOW STEEL
IS SHAPING THE FUTURE OF
FENESTRATION SYSTEMS

BY RACHEL VITELLO

IN modern architectural fenestration, steel can offer both structural integrity and design flexibility. It allows for slender framing profiles that maximize daylight and views without compromising durability.

Technical Glass Products is a supplier of fire-rated glass and framing systems and specialty architectural glazing products. Steel-based products that TGP supplies include its SteelBuilt window and door and curtain wall systems, Fireframes Designer Series doors and frames, TGProtect FR System, SmokeSafe Window & Door Systems, and more.

Jansen is a 100-year-old Swiss producer and distributor of architectural steel profile systems for doors, windows and facades. Jansen manufactures the steel profiles used in production of other products and sells to U.S. manufacturers who then make the finished unit.

BENEFITS OF USING STEEL

Robert Miller, CEO of Jansen, says that steel has two main value propositions: architectural creativity and environmental performance. Chuck Knickerbocker, curtain wall manager for Technical Glass Products, says that steel can also offer life-safety benefits.

“Steel is a very strong material, and as a strong material, you can really go with large dimensions and spans,” says Miller. “With that, larger spans of glass also become possible.” Miller adds that steel is naturally slow to expand and contract in response to heat and cold. Combined with a high-performance thermal break and high-quality glass, a high-performing, operable window or door is now possible, he says.

Steel allows for large, oversized and unique shapes, making it ideal for high-end residential, premium retail and premium restaurant spaces, says Miller. Steel also offers artistic craftsmanship that some other materials cannot offer due to its strength and versatility.

“At Technical Glass Products, we saw the benefits of these construction and manufacturing methods and prioritized the use of steel in our fenestration and curtain wall systems. Steel allows TGP to readily meet fire and life safety

standards,” says Knickerbocker, due to steel’s survivability. “With steel, the shape availability tends to be simpler, it can’t be formed into the shapes aluminum can, but steel improves operation efficiency and allows the use of smaller profiles. Within its inherent strengths, steel sets a baseline of design and performance excellence that is increasingly desirable in a wide range of the building industry.”

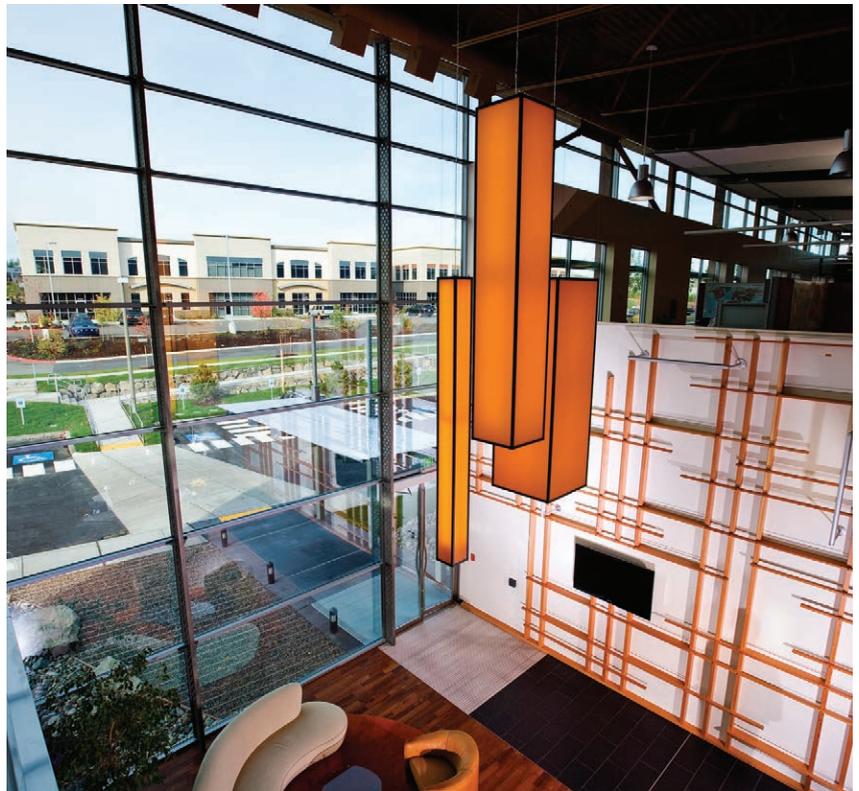
Steel’s material benefits offer value in exterior and interior non-rated and fire-rated curtain wall construction. It can also provide engineering value in door systems, like doors, sidelites, transoms and vision lites, and window assemblies by allowing larger spans without the need to plan supplemental support systems, according to Knickerbocker. This is especially true in fire-rated applications and other builds that require the use of heavier-than-average glazing units.

EVOLUTION OF STEEL IN ARCHITECTURE

Steel has been around as a structural framing material for more than a century. Steel windows and doors were first used in industrial and commercial buildings in the 19th century when steel construction methods were first developed.

An example of the evolution of the use of steel through the past century is the Battersea Power Plant in London, England. The former power station was constructed in the late 1920s and decommissioned in 1975. In 2022, the building reopened to the public containing residential space, bars, restaurants, office space, shops and entertainment spaces. Battersea also features steel windows with a thermal break, and windows that also match the historic period of the original structure. According to Miller, these steel windows demonstrate the benefits of steel.

“You’re able to get that original look and feel but with modern innovation and modern performance,” says Miller. Miller adds that steel architecture is more commonly being used in the renovation of historical buildings in order to preserve their original appearances.



Technical Glass Product’s Headquarters in Snoqualmie, Washington, featuring TGP’s SteelBuilt Curtainwall Infinity System and SteelBuilt Window & Door Systems.

Knickerbocker says that before the late 1800s, buildings tended to have massive masonry walls and had significantly fewer stories than modern buildings. It was the advent of steel in building construction, as well as the invention of the elevator, that allowed buildings to grow into taller buildings due to steel’s inherent strength.

But using steel framing in glazing systems is only a recent development, due to recent advances, says Knickerbocker. Cold roll-forming, a metal manufacturing process that shapes flat metal strips into uniform profiles, and laser welding techniques in steel manufacturing have allowed the creation of narrower profiles, he says, without compromising the material’s inherent performance capabilities.

In addition to allowing a wide range of cover cap materials, from aluminum to real wood veneers, steel-forming technologies also allow greater shape flexibility than what was previously possible for a more expansive aesthetic range, says Knickerbocker.

Likewise, the availability of anti-corrosion protection, like powder coating, continuous gasketing, among other technologies, has expanded where this material can be used throughout the built environment. Gaskets isolate the water and prevent it from coming into contact with the steel components. In systems like steel-framed curtain walls, a continuous gasket, typically made from extruded silicone, fills the gap between curtain wall components and keeps water off the tops of IGUs.

Knickerbocker says that steel’s strength and durability made it a popular choice as it allowed stronger and taller structures with less material expenditure. Today, steel is more commonly used for fenestration systems in Europe due to a combination of historical precedent, stricter energy efficiency standards, aesthetic preferences for slim profiles, which its strength allows, and different construction methods. ■

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NATIONAL GLASS ASSOCIATION with GANA



See the full NGA Annual Report

ANNUAL REPO

2025

We envision a future in which glass is the material of choice to enhance spaces where people live, play, learn, work and heal.

OUR GOALS

ADVOCATE

Be a strong advocate to defend and promote the glass industry

EDUCATE

Drive excellence, safety and results through education and training

WORKFORCE DEVELOPMENT

Advance the industry as a viable, thriving career path

PROMOTE

Elevate the image of glass as a safe, healthy, sustainable and inspiring building product

FROM THE CEO

I joined the NGA in July of 2025, and leading this association has been a joy. My career in construction-industry associations spans from the National Ready Mixed Concrete Association to the American Institute of Architects, and I've found incredible energy in the glass industry's passionate community.

My introductory period was like drinking from the fire hose—listening sessions with every board member, committee member, and staff; facility tours; and an invigorating GlassBuild America where I met the people who make this industry great.

2025 Standout Achievements

- Pushed through two critical ICC building codes promoting natural daylighting in schools and apartments
- Hosted the largest GlassBuild America ever: 9,600+ attendees, 598 exhibitors, 232,000+ sq ft
- Glass Magazine celebrated 75 years of industry leadership
- Made MyGlassClass.com free to members, increasing enrollments 1,000% from 2023 to 2025

This association belongs to you. I look forward to hearing from you about your work, your challenges, and how we can help move forward together.



LAKISHA A. WOODS, CAE, PRESIDENT AND CEO

RT

POWERING THE TALENT PIPELINE

“The glazier apprenticeship program has opened an avenue to attract the best and brightest. It has been a breath of fresh air after being in the industry for more than 30 years.”

—DAN MARTINEZ, ALLSTAR GLASS



Training

- Made MyGlassClass.com free to all NGA members in 2025
- Developed MyGlassFAB tempering furnace operator courses launching Q1 2026
- Translated resources into Spanish with free downloadable post-cards

Apprenticeship

- 100+ new apprentices joined programs in 2025
- 33 Registered Apprenticeship Programs in 27 states
- Added Director of Apprenticeship Amy Hadfield to expand support

Recruitment

- NGA partnered with Ajay Glass at ROC with Your Hands career event, providing 1,500 high school students hands-on experience with the glazing trade.



DEFENDING GLASS, ADVANCING THE INDUSTRY

School Security

NGA's School Security Task Group made this a top 2025 priority, clarifying industry standards around bullet-resistant glazing, ASTM F3561 testing, and engaging on Utah's H.B. 40 School Safety Amendments.

Daylighting Victory

The NGA Advocacy Team, partnering with AIA, UT Austin Professor Juan Miro, and the Aluminum Extruders Council, won approval for two ICC building code proposals promoting natural daylighting in schools, dormitories and apartments—addressing the troubling trend of windowless classrooms and dorms.

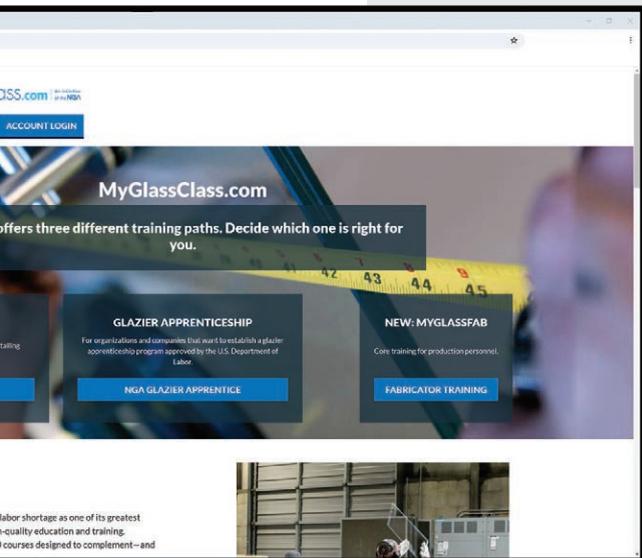
Bird-friendly Design

Updated bird-friendly glazing ordinance tracking for jurisdictions across North America and submitted proposals to ASHRAE 189.1, advocating for NGA's Design Guide DG01-21 as the industry standard.

Sustainability Leadership

- Provided detailed recommendations to Canada's 2030 National Model Codes on embodied carbon
- Enhanced World of Glass Map to include U.S. glass recycling facilities
- Developed 8 new technical resources through task groups

MyGlassClass.com was made free to all NGA members in 2025



672

VOLUNTEER HOURS ACROSS 4 COMMITTEES AND 27 TASK GROUPS ADVANCED INDUSTRY STANDARDS IN 2025

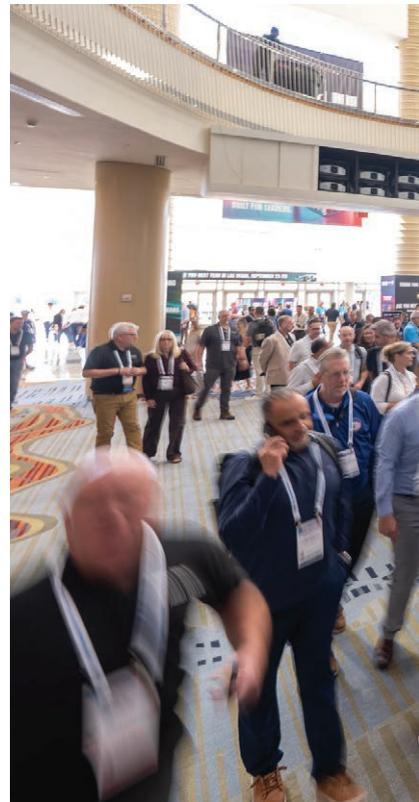
EDUCATING THE INDUSTRY

Glass Magazine Celebrates 75 Years

From a slim pamphlet in 1950 to 2024's record 180-page GlassBuild preview issue, Glass Magazine has evolved alongside the industry—providing expertise, trust, and insights for over seven decades.

Staying Connected

- **Thirsty Thursday webinars:** Monthly series on business, technical topics, training, and trends
- **Glass Cast & Window Cast podcasts:** Recorded live at GlassBuild for the second year
- **AIA-accredited courses** for architect education



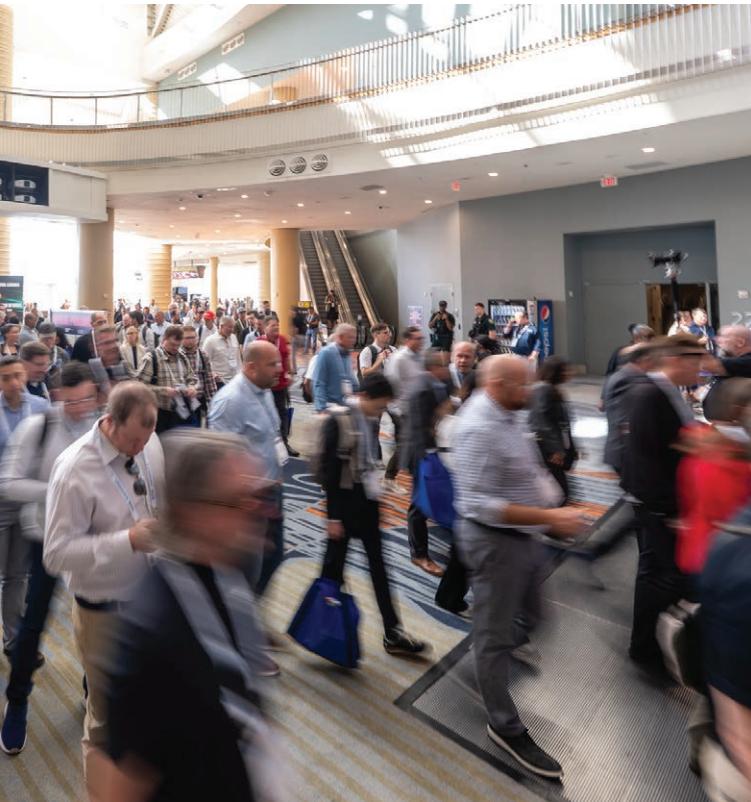
1.3 million

USERS ACROSS NGA WEBSITES: GLASS.ORG
 | GLASSBUILD.COM | GLASSMAGAZINE.COM |
 MYGLASSCLASS.COM | WINDOWANDDOOR.COM

RECORD-BREAKING EVENTS

9,600+

GLASSBUILD AMERICA PARTICIPANTS



GlassBuild 2025: The Biggest Yet

- 598 exhibiting companies
- 128 new exhibitors
- 232,000 net square feet
- Attendees from all 50 states + DC, Puerto Rico, Canada, Mexico, and 70 other countries

2025 Highlights

- GlassBuild Skills Challenge: Hands-on competitions including Shower Design Challenge and InstallationMasters Challenge
- Family Business Breakfast: Connecting family-run companies
- Blueprint for Collaboration: Fourth annual event for architects with Glass Magazine Awards ceremony

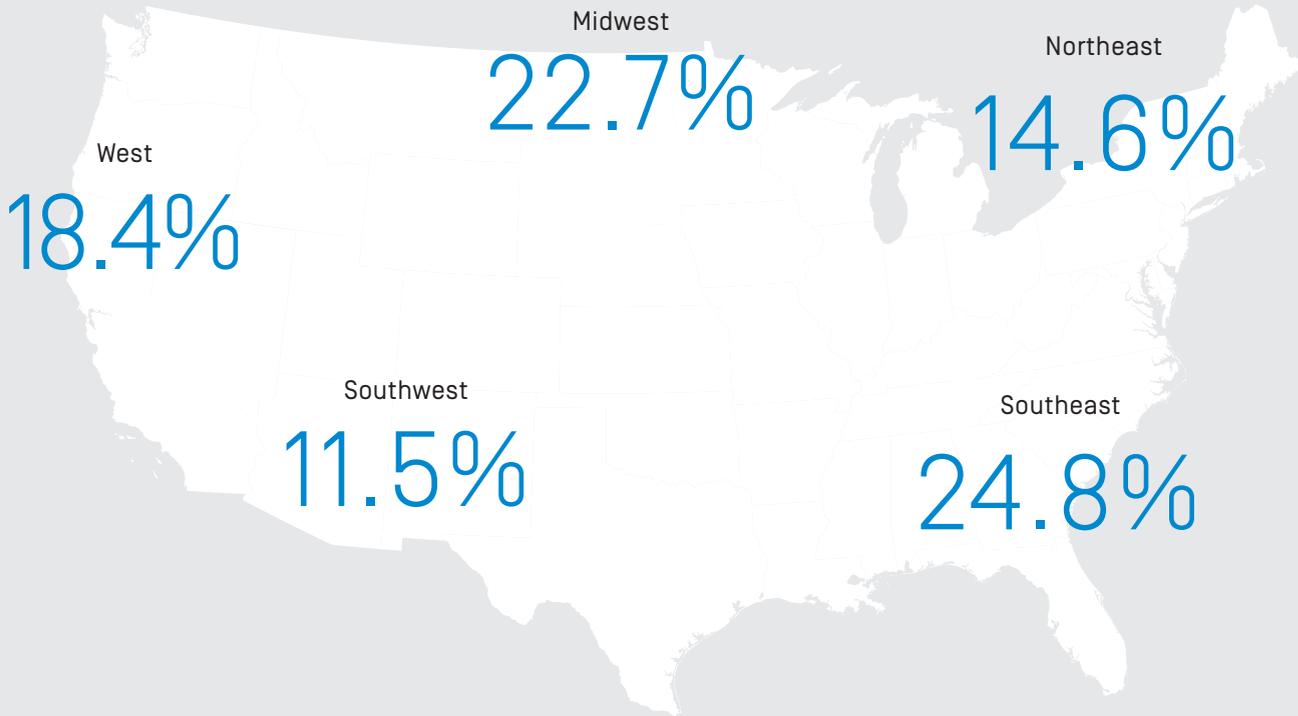
Other 2025 Events

- Glazing Executives Forum: 185+ attendees
- NGA Glass Conferences: Carlsbad & Ann Arbor (100+ participants each)
- BEC Conference: Nearly 800 glazing industry leaders
- Coming in 2026: New NGA Glass Fabricator Conference (GFAB) debuts June 14-17 in Chicago with three targeted tracks including quality control workshop at Skyline Design.

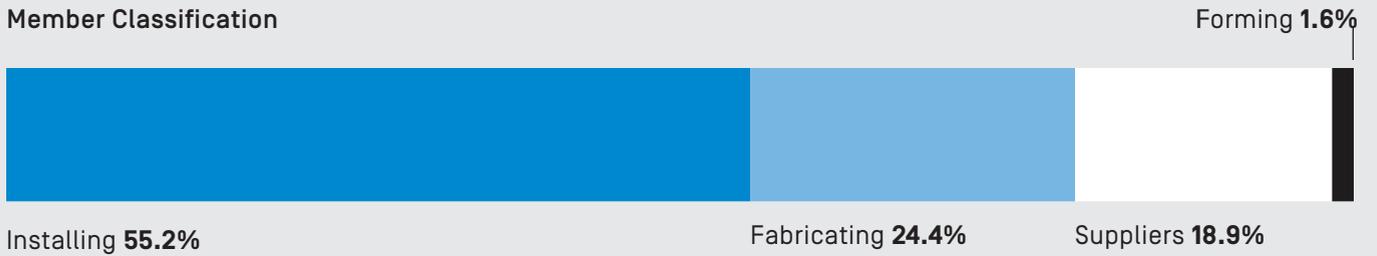


BY THE NUMBERS

Membership breakdown by region



Member Classification



1,900+

member companies

215

new members welcomed in 2025

WE ARE NGA

Meet the 2025-26 Board of Directors

Tim Kelley
Chair - TriStar Glass Inc.

Rick Locke
Immediate Past-Chair -
Montana Sash & Door

Jim Stathopoulos
Chair-elect - Ajay Glass
Co.

Courtney Little
Treasurer - Ace Glass

*Plus Joey Aragon, Jodi Martinez,
Syndi Sim, Tara Brummet, Taylor
Anderson, Vipul Bhagat, Mark
Seeton, Dan Reinhart, and Lakisha
A. Woods (ex officio)*

Awards & Recognition



2025 Volunteer of the Year: Robert Carlson
TRISTAR GLASS

“Being involved in these task groups is a wonderful opportunity to control your own destiny. You get to make a change for something that impacts your business and your industry.”



C.G. Carney Award: John Kent
ADMINISTRATIVE MANAGEMENT
SYSTEMS INC.

Recognized for 30+ years advancing industry standards through ANSI, ASTM, GANA, SIGMA, and IGMA— “one of the most dependable people in the glass and glazing industry.”

NGA Recognizes 11 Affiliated Chapters

- California Glass Association
- Colorado Glazing Contractors Association
- Connecticut Glass Dealers Association
- Houston Area Glass Association (a division of TGA)
- Massachusetts Glass Dealers Association
- Mid-Atlantic Glass Association
- Minnesota Glass Association
- Texas Glass Association
- TGA North Texas Division (a division of TGA)
- Utah Glass Association
- Washington Glass Association

NGA FOUNDATION

Mission

Train the industry and educate consumers about how glass and glazing contribute to a safe, healthy, sustainable, and inspiring built environment.

Focus Areas

1. Workforce Development & Training
2. Consumer Education & Awareness
3. Innovation & Sustainability Initiatives



Learn more and donate

CLOSING THOUGHTS

“We joined NGA to ensure that we have access to the latest industry news and updates, to network and share information, participate in technical committees and task groups, and to support my national industry association.”

—BRYAN KLINE, CEO, K LINE IMPACT WINDOWS AND DOORS



Not an NGA member yet? NGA can save you time, save you money and make your business better - learn more and join today!

PRODUCTS



01



02



03

01. Low-emissivity glass

Solarban Champagne by Vitro Architectural Glass is a warm-toned low-emissivity glass that reflects champagne tones. Solarban Champagne gets its color from the low-e coating, delivering a warm-neutral appearance and low reflectivity with the performance of Solarban glass. A complement for the soft, natural tones of contemporary architecture, Solarban Champagne low-e glass combines aesthetics with functionality. With solar control, it enhances energy efficiency and supports sustainable design goals.

412/820-8500 | VITROGLAZINGS.COM

02. Bird-friendly glass

Guardian Glass' Bird1st UV glass is engineered to support new building requirements while helping to preserve views and reduce the cost of installed IG units. This solution also offers the least visible-to-humans option within Guardian Glass' bird-friendly portfolio. In addition to being extremely difficult to see for humans, the new pattern is non-directional and available in split jumbo, jumbo and super jumbo sheet sizes. The product has been approved by the American Bird Conservancy.

866/482-7374 | GUARDIANGLASS.COM

03. Shower hinge

The Trento Hinge from CRL is a shower hinge for glass enclosures that has been modernized for today's demanding shower applications. The Trento hinge offers improved aesthetics by concealing the mounting screws, as well as increased weight-bearing capacity. Featuring a design with sharp edges, a narrow hinge gap and a rectangular center block, Trento can support glass doors up to 140-pounds and 40-inches wide.

800/421-6144 | CRLAURENCE.COM



04



06



05

04. Canopy system

Bendheim’s GripGlaze Canopy system offers a no-drill, compression-based mounting solution. The system’s innovation lies in its low-profile clip, a precisely engineered aluminum fitting that locks glass panels securely into place through compression. Each clip mounts directly to the steel structure, creating a continuous glass surface with no visible hardware interruptions. The design eliminates the need for notches, holes or specialized tools, reducing fabrication time and on-site labor.

800/221-7379 | BENDHEIM.COM

05. Sliding mall front door

Tubelite’s INT810 series sliding mall front doors deliver the accessibility of expansive entrances, the design versatility of storefront and the practical functionality of movable walls. This system is engineered specifically for commercial interior environments and is an ideal solution for shopping malls and retail centers, as well as other ground-level interior egress applications including restaurants, entertainment venues, health care facilities, schools and offices. It also comes in multiple sizes, configurations and colors.

800/866-2227 | TUBELITEINC.COM

06. Vacuum lifting tool

The Grabo Pro Brushless, a vacuum lifting tool, introduces a brushless motor and operates on Grabo’s 20V battery platform, delivering rapid suction of 30 liters per minute and achieving full vacuum in five seconds. The vacuum limit selector empowers users to safely handle fragile materials like glass, wood, metal, drywall, granite and more, by adjusting vacuum levels accordingly.

844/430-0510 | GRABO.COM

Suppliers Guide

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www.fhc-usa.com

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Fax: 201/553-1851
E-mail: sales@generalglass.com
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Fax: 209/229-1061
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www.GlassfabUSA.com



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PO Box 739
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Fax: 201/553-1851
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www.generalglass.com



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Fax: 856/579-3233
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www.mcgrory.com

BENT

Go to category BENT GLASS

BIRD-FRIENDLY

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US: 888/789-7810
Phone: 323/774-7373
E-mail: johnm@glasswerks.com
www.glasswerks.com



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Phone: 418/862-2274
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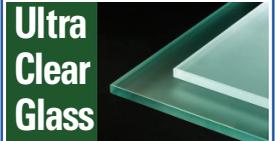
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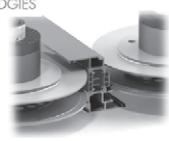
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Active shooter events
are becoming more
frequent.

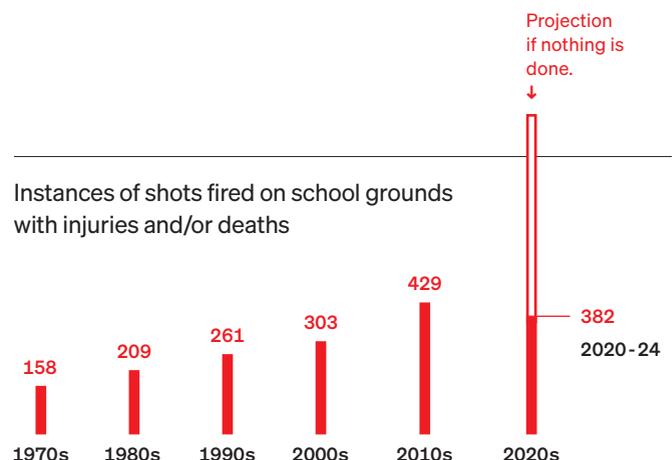
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Apprentices at the UGA appreciation barbecue.

RECOGNIZING THE NEXT GENERATION OF GLAZIERS

Why celebrating apprentices' achievements is an investment in your workforce **BY AMY HADFIELD**

I had the opportunity to attend the Utah Glass Association's Apprentice Appreciation BBQ with NGA Immediate Past Chair Rick Locke to celebrate UGA's graduating class of glazier apprentices. After joining NGA in 2025 as the director of apprenticeship, this was my first opportunity to meet with some of the glaziers and contractors that use NGA's Glazier Apprenticeship Curriculum as part of a Registered Apprenticeship Program.

It was great to share in this exciting time for the graduates. I was able to speak with several of UGA's current and past apprentices during my visit and found a common theme in their responses when I asked what the most rewarding part of being a glazier is—to quote one, it's "seeing cool stuff that I have built with my own hands."

Apprentices putting in the work

During my career, I've issued journeyworker certificates—the nationwide credential issued by the Department of Labor upon completing an apprenticeship program—to hundreds of apprentices. It's not often they receive the kind of recognition UGA provides for this accomplishment. But recognition is important.

Not only are apprentices working full-time, they're also learning on the job. Beyond the job site, they're spending a substantial amount of time—at least 432 hours—learning in a classroom (or classroom-like setting online). That's the equivalent of two college courses a year.

Apprentices aren't your most experienced employees, but they are putting in the work. As an employer, investing in their development and

"COMPLETING AN APPRENTICESHIP IS A BIG DEAL: MAKE PRESENTING APPRENTICES WITH THEIR JOURNEYWORKER CERTIFICATES A BIG DEAL."

celebrating their progress—especially completion of an apprenticeship—shows your team that you value growth, dedication and achievement.

Recognize the effort

Whether it's a barbecue, a pizza party, or formal banquet, have the celebration. Completing an apprenticeship is a big deal: Make presenting apprentices with their journeyworker certificates a big deal. Do it publicly and invite their families to share in the moment.

And now, with NGA's new digital Apprenticeship Badges, you can also recognize each milestone along the way. Apprentices will receive a custom digital badge upon completion of each year of the curriculum. Each badge will be delivered digitally and can be added to their email signature, LinkedIn profile, or professional portfolio. Encourage them to share it far and wide!

Recognition isn't just good for the morale of an individual, it's an investment in retention, your culture, and the future of your entire workforce. ■



Amy Hadfield is the director of apprenticeship for the National Glass Association. She has over 15 years of experience in state government, workforce development and registered apprenticeship.

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