



## 12: A DAY IN THE LIFE OF GLASS

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# DEVIL'S DETAIL

## THE LIFE OF GLASS

From glass skyscrapers to expansive windows that bring the world around us into view, glazing assemblies are part of everyday life. Earlier editions of the Devil's Details addressed the characteristics of fenestration systems, including thermal performance, U-Factor, solar heat gain coefficient, visible transmittance, and advances in glass performance. The series has covered how advancements in the framing of glazing assemblies have evolved to modern pressure-equalized rain screen systems that afford high thermal performance and resistance to air and water infiltration.

The most successful glazing systems are the result of a team effort, where the architect, engineer, contractor, and fabricator pool their knowledge and creativity to produce a functionally and aesthetically pleasing design.

## DESIGN ASSIST

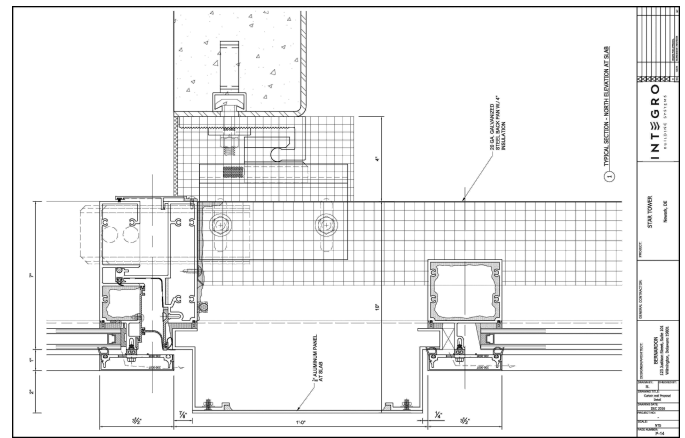
One example of collaboration between architect and glazing contractor comes through assistance before the completion of the design, using methods known as Integrated Project Delivery (IPD) or hybrid IPD. The project delivery method known as Design Assist allows an owner to award a construction contract prior to full execution of a design solution. Subcontractors are retained and engaged to assist the architectural team and construction manager with development of design and construction documentation.

Design Assist engages all teammates early to provide maximum value to an owner. Each teammate adds his or her expertise from the early stages, ensuring the project meets all functional, aesthetic, and performance goals while staying on budget, minimizing change orders, and proactively mitigating risk.

For those interested in learning more about Design Assist, Building Design + Construction Magazine offers [The Way to Really Fly](#),<sup>®</sup> an AIA-accredited continuing education program that offers 1 AIA/CES credit to participants who read the Design Assist overview and take a short exam.

*At right: architect's concept rendering of Star Tower in Newark, Del. (image courtesy of Bernardon used with permission of Delle Donne & Associates, owner)*





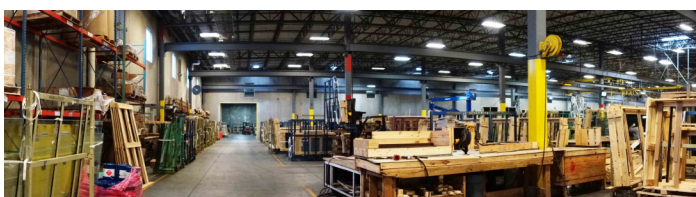
From left: R.A. Kennedy & Sons glazing system proposal for review and selection by the design team; shop drawings illustrate critical details

## GLAZING ASSISTANCE

Glazing contractors can offer significant value when engaged early through Design Assist or other forms of collaboration, providing expertise about different glazing systems pros, and cons. Once the architect has resolved the overall cladding concept for the structure, cladding system details can be developed further in shop drawings created by the general contractor and subcontractors. The glazing contractor often develops glazing assembly shop drawings through collaboration with material suppliers, and interpretation of the architectural drawings and specifications.

Typically, the shop drawings clearly depict the proposed glazing products and systems for review and approval by the design team. These documents convey technical information such as glass make-up, metal framing and finish types, and overall system performance criteria. There may be multiple iterations of the drawings as details are coordinated and refined to more accurately reflect the architect's design intent.

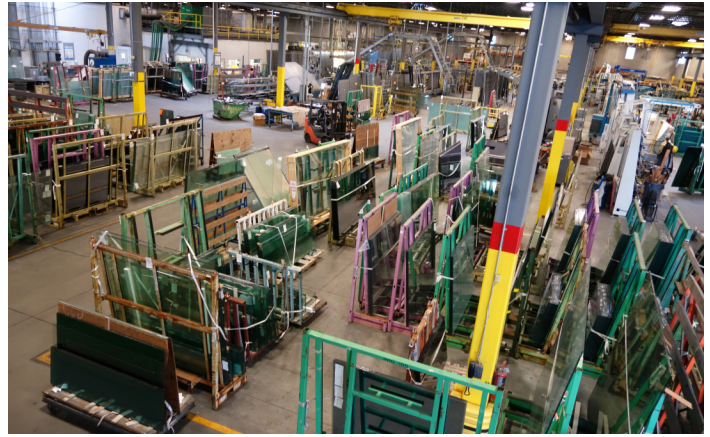
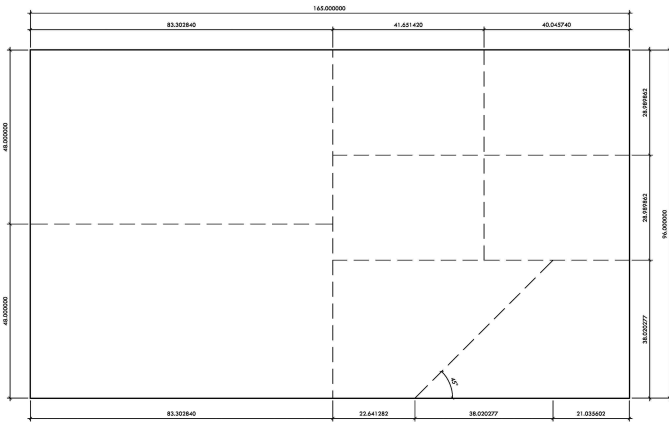
The drawings clearly indicate the framing members while also illustrating how the system will control air, water, and condensation. The drawings include how the system will be installed while meeting or exceeding the specified structural performance requirements and anticipated building movement. Explanations of how the proposed glazing system interfaces with other substrates – such as connections to the building structure and critical dimensions – are addressed during this process.



## SHOP DRAWING PROCESS

The shop drawing process may include a series of submissions that chronicles the development of glazing system details. The final set of shop drawings, approved by the architect, typically contains the following items:

- **Drawing List:** The cover sheet of the shop drawing set should contain installation instructions for the project, including instructions for the perimeter framing joint conditions that are not typical joinery conditions.
- **Glass Types:** The shop drawings should provide detailed information about the building code requirements for the project and the location of safety glazing and special glazing as well as their means of identification.
- **Perimeter Conditions:** Perimeter sealant joint sizes should be included with tolerances and minimum/maximum joint sizes required for building movement. These dimensions are critical to ensure proper fabrication and field installation. Embedment locations for anchorage points must be shown, as these are necessary for structural calculations. These should identify reaction loads imposed on the structure, including dead load and live load reactions. Often through this process, the location of the anchor points must be moved or adjusted for improved structural performance.
- **Building Floor Plan Views of the Assembly:** Drawings must include the locations of walls, beams, columns, and slabs, and their dimensions for all the tolerances required for installation, which are critical for coordination of adjacent construction.
- **Elevation Drawings:** Dimension limits for movements should be shown for all moving joints including provisions for expansion and contraction. Shop drawings should show in detail how the system will accommodate building deflections. Elevations and/or plans with respective wind loads must be



At left: Optimization detail: glass manufacturers cut glass sheets ranging in sizes from 96x165" to 120x192" to make individual IGUs, using specialized equipment to calculate the most efficient cutting criteria and maximize the yield of each sheet; right and below: J.E. Berkowitz fabrication facility

- calculated to ensure accurate glass strength requirements and identification of areas of the building requiring additional measures to meet the design loads. These areas must be defined during preparation of structural calculations.
- **Section Drawings:** Wall sections should be included depicting requirements for materials and systems such as insulation, fire containment insulation (fire safing), vapor retarders, and their respective dimensions. Proper documentation and coordination of these materials with the exterior façade materials is vital to ensure proper design and installation
- **Details:** Of critical importance is the path for water drainage from the glazing system to the exterior. Detailing must include the collection, control, containment, and discharge of incidental water infiltration from the glazing pocket, the perimeter surrounding conditions, or perimeter gaskets. Additionally, glazing system shop drawings should depict joinery details showing the extent of the continuous and intermediate framing members, and how the joints are sealed. Sealant continuity notches should also be included to prevent water infiltration by capillary action in any metal-to-metal joints, and internal seals should be detailed throughout the drawings.

## PREPARATION

Once the shop drawings are completed and approved by the architect, they become the basis for fabrication of the glazing components. The glazing contractor will coordinate the quantities of glass and metal extrusions and their details with suppliers or fabricators. A production schedule will be established and coordinated with the general contractor for installation preparation. Concurrently, the glass and metal extrusion suppliers will begin the production processes.

## FABRICATION

The glass company typically starts the fabrication of Insulated Glass Units (IGUs) by verifying quantities and sizes of the required glass types. Specific requirements such as glass type availability, and heat strengthening or heat soaking that may require additional fabrication time are identified and communicated to the glazing contractor. Once the order is established and authorized by the glazing contractor, fabrication begins. The glass fabricator generates a production sequence of specific fabrication activities that generate the correct glass product.

As construction progresses, the general contractor coordinates and schedules individual trades according to the sequence required to meet the construction schedule. Often during construction of the project, changes are made that may be the result of various circumstances, from field conditions to architect- or owner-requested changes. Changes that involve dimensional revision of the glazing assemblies are particularly challenging due to the complex process of fabrication.

When changes are made that affect either the glass or frame, the glazing contractor must act swiftly to coordinate these changes with his or her suppliers.



## MATRIX OF ISSUES

A complicated matrix of issues must be considered and resolved in order to develop a logical and realistic schedule for the proper sequencing of the glass system's manufacture, fabrication, and installation. The glass manufacturer's project manager begins the order process by checking the substrate material (glass) and sourcing the materials. This essentially means identifying which glass types are available from which manufacturers to meet the project specifications. It is critical that the manufacturer review and verify the project sequencing, which dictates in what order the product will be fabricated and packed for delivery.

Because the glass is manufactured and boxed in the order that is input into the production system, it is critical that the glass manufacturer verify the order sequence with the glazing contractor because this is the order that it will be delivered to the project. Consequently, one of the most important tasks for the general contractor and glazing contractor to establish is in what order the glazing system will be installed (e.g. floor by floor or vertically in drops, elevation by elevation).

It is also very important to understand how other construction activities will affect the glazing installation schedule, since glazing typically occurs later in a project.

## UNFORESEEN CONDITIONS

Despite all of the planning and scheduling, or placement of the glass and metal extrusion orders, sometimes, unforeseen conditions arise that impact the glazing contractor's construction schedule. Worse, some conditions require changes to the glazing system be made once fabrication has begun.

If glass components have gone into fabrication, changes are very difficult but not impossible. This is due to optimization and a number of other factors.

The glass manufacturer optimizes glass utilization during production by calculating what sizes and how many pieces of glass can be produced from full sheets of glass. To complicate this further, a production run of a certain type of glass may be comprised of multiple orders from different customers. For example, if orders are placed by a number of different glazing contractors for a certain blue colored glass meeting a certain specification, the glass manufacturer combines all the orders to optimize the amount of full-size glass sheets they need to fabricate those orders. The only way to change the production run involves deleting it before it goes into fabrication and re-entering the entire order with the revised information. If changes are required after fabrication has begun, unfortunately in most cases, this requires an additional production run.

## EARLY ACTION

The creation of a successful, aesthetically pleasing, high-performance building requires an interactive approach during the design process. The best results are the outcome of substantive involvement by all stakeholders. Everyone involved from the planning, design, construction, and operation of the facility should understand the issues and concerns and interact closely throughout the phases of the project.

As described, the complex nature of the systems that comprise the building's exterior requires consideration of a multitude of issues. Early attention should be given to the manufacture, fabrication, and installation of the glazing assemblies. The earlier in the process that the glazing contractor and glazing experts are brought to the table, the sooner their expertise can be utilized to successfully achieve project goals and add the most value to the project owner.

## About the Devil's Details

The AGI educational series illustrates and describes common glazing challenges as a means to communicate best practices for the design and construction industry, not as a sole source for design guidance. AGI recommends design professionals consult with an AGI contractor regarding specific project challenges. AGI contractor profiles may be accessed at [www.theagi.org](http://www.theagi.org). To share a devilish detail of your own, contact [info@theagi.org](mailto:info@theagi.org).