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Introduction

The purpose of the GANA *Glazing Manual* is to educate architects, engineers, builders, fabricators, installers and the general public about the constantly increasing wonders of glass, the benefits to be derived from its use and to provide general guidelines for proper installation techniques.

The 1973 Arab oil embargo and recent dramatic fluctuations in oil costs forced national and local agencies to legislate new energy conservation standards. The glass industry responded to the challenge by developing an assortment of coated and spectrally selective glass products, which control, to a known degree, the passage of visible light, infra-red heat energy and ultra violet energy into all structures. Insulating glass units utilizing warm-edge spacer technology, insulating gas between the glazing lites and advanced low-emissivity (low-e) coatings have greatly improved the ability of glass to keep our buildings warmer in the winter and cooler in the summer.

Glass allows the architect and engineer to design structures to get the full benefits of daylighting while controlling heat transfer. The glass industry has become a major energy conservation industry.

Glass in windows, curtain walls and skylights produces important energy-saving benefits when properly designed and managed. The use of daylighting in commercial buildings reduces the demand for artificial lighting. Artificial lighting is the largest single user of energy in typical office buildings; daylighting is free. Energy costs to overcome heat gain and loss through glass are much less than for artificial lighting. Arbitrarily limiting glass area to a small percentage of exterior wall or roof area can produce higher operating costs than larger well-designed and well-managed glass areas.

Glass on sun-facing orientations of residences acts as passive solar collectors to offset a portion of winter heating costs. When double or triple glazing is used, especially in conjunction with a low-e coating, the net effect is energy conservation comparable to that of many opaque walls. When used with awnings, overhangs or indoor shading devices to reject summer sun, windows can be even more energy efficient and cost-effective.

Introduction to GANA

Founded in 1994, the Glass Association of North America (GANA) originated as an amalgamation of the Flat Glass Marketing Association (FGMA – founded in 1949), Glass Tempering Association (GTA - founded in 1958) and the Laminators Safety Glass Association (LSGA – founded in 1977). The three associations had a history of cooperation, having first worked together in 1976 to form Association Services Corporation, a multiple association management company, as a means of providing more efficient and less costly administrative services to their respective associations and other interested associations. Later, they aggressively pursued the formation of the Glazing Industry Code Committee as a means of dealing more effectively with the model building codes. More recently, member concern regarding the number of industry meetings each year and the quality of the programs led to their bringing together the primary glass and metal companies to initiate Glass Week™, the annual glass industry convention. The amalgamation was the logical next step in their organizational evolution.

The original structure of GANA consisted of three Divisions – Distribution/Installation, Laminating and Tempering with each Division having equal representation on the association’s Board of Directors.

In 1997 the Distribution/Installation Division split into two Divisions: Distribution and Building Envelope Contractors (BEC). The BEC Division diversified to focus on the specific needs of the building envelope suppliers and erectors. In 2000, the North American Association of Mirror Manufacturers (NAAMM) joined GANA and formed the Mirror Division. Following that merger, the Primary Glass Manufacturers Council (PGMC) followed suit and in 2002, became the Flat Glass Manufacturing Division. Also in 2002, in response to request from member companies, the GANA Board of Directors voted to transform the Distribution Division into the Insulating Division to serve the manufacturers and suppliers of the insulating glass industry. Currently, the Association strives to serve the needs of the glass and glazing industry with seven Divisions: Building Envelope Contractors, Decorative, Flat Glass Manufacturing, Insulating, Laminating, Mirror and Tempering.

Meetings are an important resource for GANA members. They provide regular opportunities for members to share information, ideas and experiences with peers, customers and suppliers. GANA conducts numerous industry meetings and educational seminars each year. Industry executive management and technical leaders gather in the first quarter of the year for the annual Glass Week™ meeting. Glass Week™ features committee meetings, industry topic forums as well as networking and social opportunities. The BEC Division hosts the annual Building Envelope Contractors Conference™, the industry’s leading opportunity for suppliers and window and curtain wall erectors to gather and address industry issues in February of each year. Spring brings the annual Glass Fabrication & Glazing Educational Conference™ with in depth training on glass insulating, laminating and tempering fabrication procedures as well
as technical presentations and forum discussions for glazing contractors. The annual GANA Fall Conference provides a second gathering for committee meetings, industry presentations and networking.

While each Division has a number of committees that address subjects of specific concern to its members, their Technical Committees are responsible for the Association’s major publications. GANA publishes a number of technical manuals and informational bulletins, but the *Glazing Manual, Sealant Manual, Engineering Standards Manual* and the *Laminated Glazing Reference Manual* are the most referenced and extensively used by industry, government, architects and specification writers. The Technical Committees make a concerted effort to see that Association technical manuals and information reflect the current state of the industry.

GANA staff actively represents the industry in the development of industry codes and standards, and serves as a liaison to other fenestration related organizations such as the American Architectural Manufacturers Association (AAMA), Glazing Industry Code Committee (GICC), Insulating Glass Manufacturers Alliance (IGMA), National Glass Association (NGA), and Protective Glazing Council (PGC) International.

GANA’s General Counsel monitors the activities of Congress and those federal regulatory agencies that impact the Association’s members or the industry. In addition to advising the officers, directors and staff, the Counsel regularly attends Association meetings and monitors its activities and publications to ensure strict compliance with current laws and regulations, particularly anti-trust.

Timely communication is essential in today’s business environment. The association’s website, www.glasswebsite.com, *Glass Reflections*, GANA’s electronic newsletter, Special Bulletins (issued on an as needed basis), monthly Safety Bulletins, *USGlass* Magazine (official monthly magazine publication of GANA) and Human Resource Reports as needed all serve to keep members informed regarding those technical, employee, energy and environmental issues that are a part of the day-to-day operation of a glass business.

GANA is committed to continuing its efforts to help members develop the management skills needed to remain competitive in a continually changing business environment, while maintaining the flexibility to respond promptly to matters of importance to members and the industry.
Disclaimer

The Glass Association of North America (GANA) has produced this Glazing Manual solely to provide general descriptions and information concerning the basics of glass. It is the responsibility of the user of this Manual to ensure that glass is selected and installed by competent professionals in compliance with all relevant laws, rules, regulations, standards and other requirements.

GANA disclaims any liability for any loss or damage of any kind arising out of the use of this Manual and all those using it agree, as a condition of its use, to release GANA, its members, officers, directors, employees and agents from any and all liability, loss or damage of any kind or nature arising out of or related in any way to its use. Users of this Manual understand that GANA is not responsible for any errors or omissions of any kind contained in this Manual and that GANA does not design, develop, manufacture, or guarantee any glass or glazing materials or any other products described in this Manual and does not make any express or implied representations or warranties as to fitness, merchantability, patent infringements or any other matter respecting any products, processes or equipment referred to in this Manual. GANA does not guarantee any results of any kind relating to the use of this Manual. GANA expressly reserves the right, in its sole discretion, to revise, amend, or otherwise modify the Manual from time to time as it sees fit and to do so without notice to prior recipients of the Manual.

The standards referenced in the GANA Glazing Manual 50th Anniversary Edition are under the jurisdiction of a number of organizations and agencies and are continuously being revised. The documents referenced in this Manual were those in effect as of December 31, 2008. The most recent standards should be referenced. Full names of reference standards and publishing entities are listed in Appendices 1, 2, 3 and 4.

Drawings contained herein are not to scale.
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50th Anniversary Edition
History of Flat Glass Production
In order to better understand the glass and glazing industry, a brief history of glass may be helpful.

Glass was discovered over 4000 years ago. It was considered precious and used by royalty and for religious purposes. During the Roman Empire, glass making reached a high degree of quality and use, but declined significantly during the Middle Ages when the main achievement was “stained glass.” In the 7th century, Syrians developed the “crown” method for forming flat glass, whereby the molten glass was taken in lump form and spun on a cylindrical disc to flatten the glass. Interestingly, this represented the most common method to produce flat glass for the next 1000 years.

In the early part of the 20th century, inexpensive sheet glass was formed by drawing the glass ribbon vertically out of the molten glass pool. Unfortunately, sheet glass still suffered from distortion because of the differences in viscosity of the molten glass. In order to obtain relatively distortion-free glass for use in coach windows or mirrors, the plate glass process was developed. Plate glass was made by pouring molten glass onto a table and rolling it until flattened, then grinding and polishing it into a plate. This process eventually advanced by feeding the molten glass though continuous rollers, grinders and polishers. Sheet glass is no longer commercially produced in the United States.

Float Glass
In 1959, the float glass process was introduced. This unique glass making process revolutionized the flat glass industry. In the float process, molten glass from the furnace flows by gravity and displacement onto a bath of molten tin where a continuous ribbon is formed. This glass ribbon is pulled or drawn through the tin bath and upon exiting is guided on rollers through an annealing lehr where it is cooled, under controlled conditions, until it emerges at essentially room temperature. The product is now flat, fire-finished, has virtually parallel surfaces and is annealed glass in terms of strength. Automatic cutters generally are used to trim the edges and cut across the width of the moving ribbon. This creates sizes, which can be shipped or handled for further processing. The float glass process accounts for almost all of the flat glass presently produced in the United States.

Commercial float glass is nearly colorless with a visible light transmittance ranging from 75 percent to 92 percent depending on thickness. With the