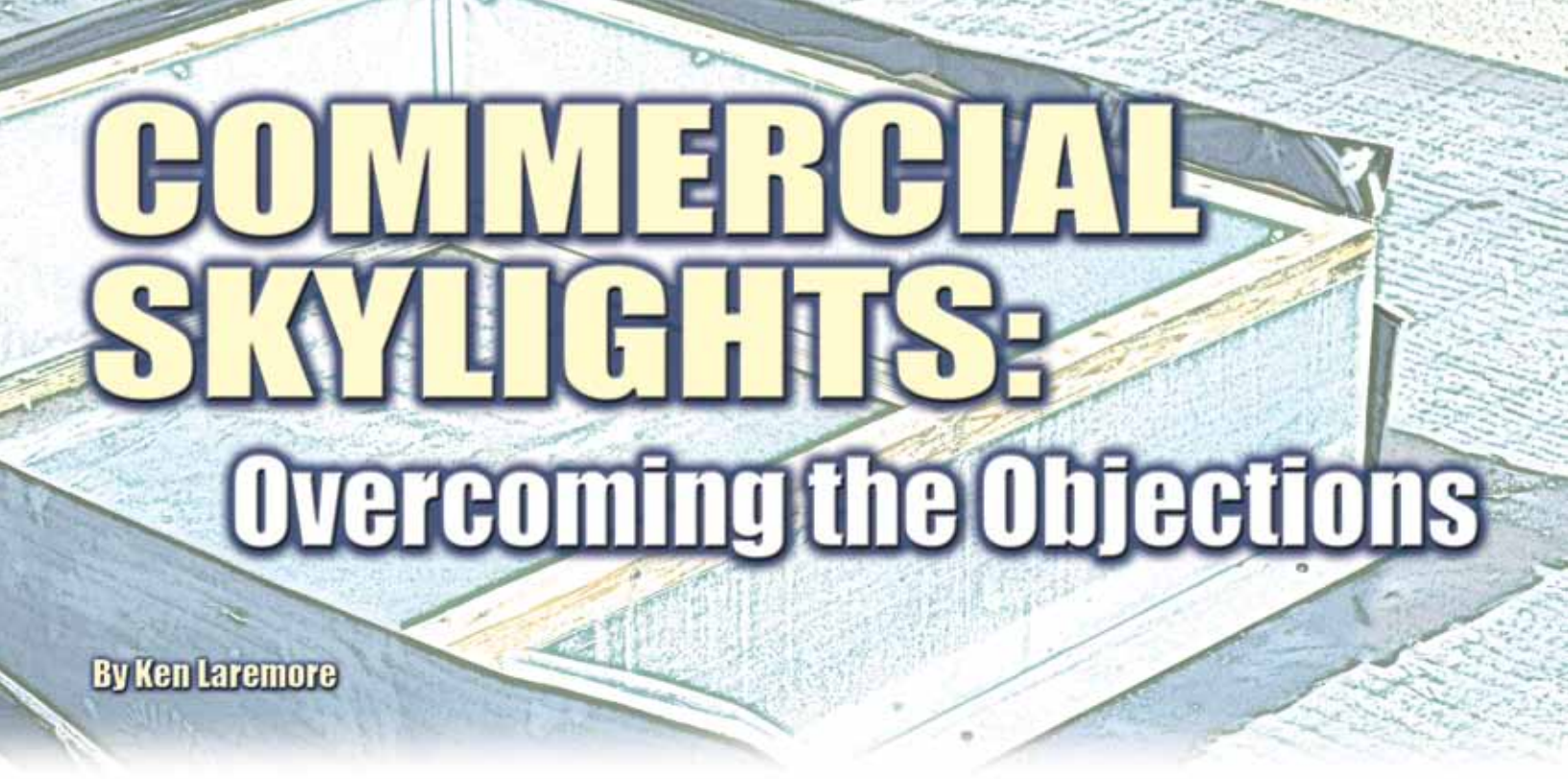

COMMERCIAL SKYLIGHTS: Overcoming the Objections

By Ken Laremore

Daylighting a commercial building with a well-designed skylight system is a very cost-effective way to save on energy expenses and reduce a building's carbon footprint. It is a strategy that supports the 2007 Economic Independence and Security Act (EISA) legislation, which mandates the transition to net-zero commercial buildings—both new construction and existing stock—in the years ahead. Even in a retrofit environment, skylights can be added to the roof assembly with very little disruption to the workplace below.

However, most building owners express an aversion to skylights for multiple reasons, many times associating them with troublesome leaks, even when the real culprit is dripping condensation. Unless skylight manufacturers can visibly demonstrate their products' leak-proof designs effectively, building owners will defer on the side of safety and omit skylights from the scope of renovation work, no matter the potential energy savings.

A recent advancement in the skylight manufacturing process could go a long way toward dispelling this common objection of building owners. The production process is called RIM, an acronym for reaction injection molding. RIM parts are created through a process that begins when two liquid reactants—an isocyanate component and a polyol resin mixture—are held in separate tanks at an elevated temperature with agitators. These liquids are fed through supply lines at high pressure to the mix head. When the injection begins, valves open in the mix head and the liquids enter a chamber at high pressures (usually between 1,500 and 3,000 psi) and high speeds. Here they are mixed by high-velocity impingement. From the mix chamber, the liquid flows into the mold at atmospheric pressure and undergoes an exothermic chemical reaction, forming a polymer in the mold. Reaction time is usually expressed in seconds. For extremely large parts, the reaction time can be extended to allow for proper filling of the mold.

When this process is used in conjunction with the manufacturing of skylights, the skylight glazing (glass or plastic) is placed into a mold and the RIM process creates the retainer frame around the glazing with a material called aliphatic polyurethane. Aliphatic polyurethane has been used in the automotive industry for over 25 years, encapsulating sunroofs, tailgates, slider windows, etc.—all assemblies that require waterproof performance or operation. As a result, the weatherability and performance of this material has been time-proven.

Aliphatic polyurethane is a nonconductive thermoplastic. It prevents cold temperatures from conducting through the skylight retainer frame from the outside, which, in the case of metal frames, often results in the lowering of the surface temperature of the plastic glazing while contributing to the formation of condensation on the interior lens. If this condensation accumulates at a steady rate, the volume of water collected will often overflow the gutter and fall into the space below, resulting in perceived leaks. Even skylight assemblies designed with weep holes (to drain the condensation to the outside) have proven problematic because the water in them often freezes during the cold weather months and prevents any escape of water.

The RIM integration of frame and glazing is seamless and does not require the use of any mechanical glazing methods to make the skylight assembly watertight. No gaskets or sealants are necessary because of the chemical bond that is established between the two thermoplastic materials as a result of the RIM process. Because this integration represents the bonding of two similar materials, the assembly will expand and contract at similar rates, unlike traditional skylights that utilize aluminum metal frames and plastic domes. In such assemblies, the frame and glazing "fight" each other during thermal cycling, often leading to failure.

Because of this improvement in glazing technology, some manufacturers are offering warranties on RIM-encapsulated skylights, with complete coverage against leaks, for up to 20 years. However, leaks can also result from poor installation techniques,

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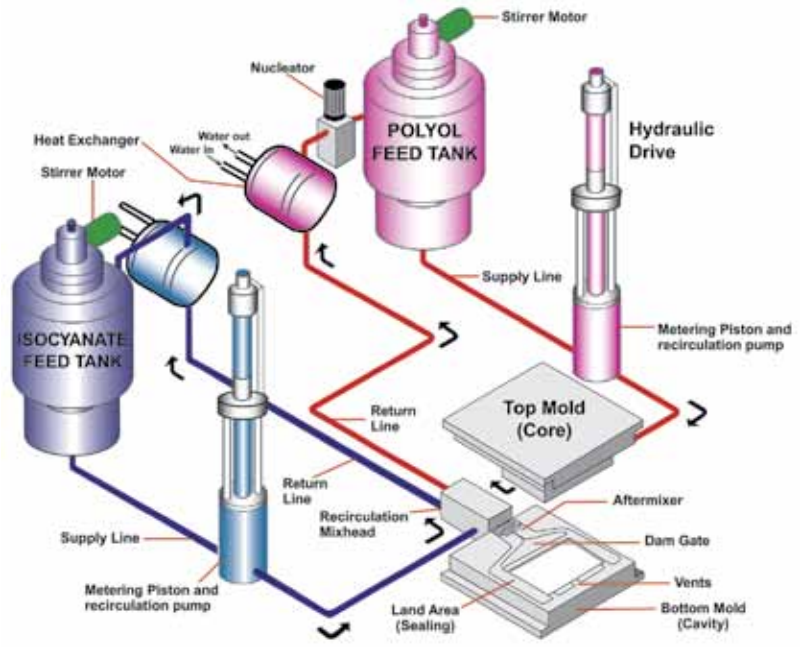

The RIM manufacturing process has been used successfully for decades in the auto industry and is now being used to create seamless skylights that eliminate the failure points that exist with traditionally built units.

a factor that has driven some manufacturers to design and market prefabricated accessory products that help improve integrity by reducing the likelihood of human error during installation. Most of these installation-friendly flashing accessories are designed for single-ply roof systems. Such accessories include new one-piece TPO and PVC flashing sleeves that slip over the curb and require simple heat welding to the deck membrane. For EPDM, pressure-sensitive flashing rolls (20 in. x 50 ft.) are available to wrap curbs and seal to the base membrane.

Building owners' objections to the potential of heat gain and heat loss through the building envelope by skylights must be addressed as well. Owners need to be reminded that their operation of electrical lights in a space actually contributes to more heat gain than the infrared light spectrum transmitted by skylights. In fact, the heat produced by 30 to 40 fluorescent

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Prefabricated and pressure-sensitive flashings for TPO, PVC, and EPDM single-ply roof systems make it easier for installers to flash in newly installed skylights while increasing overall roof system performance.

fixtures (100,000 lumens of light) would require 0.67 tons of additional HVAC equipment to be installed in order to mitigate the heat produced compared with 0.27 tons for the same amount of visible light transmitted by diffusing skylights. Metal halides and some high-intensity discharge (HID) lamps are even worse in regards to heat versus lumen production.

Heat loss can be managed by selecting better insulating glazings for skylights and better thermal break strategies. One other advantage of the aliphatic polyurethane skylight frame assembly described above is its ability to greatly deter temperature transference through its mass. In other words, it does not conduct heat or cold, which, in the case of aluminum-framed skylights contributes to lowering the inside surface temperature of the glazing. This occurrence increases the possibility of condensation forming on the inside surface of the skylight glazing. The nonconducting properties are well known, because most thermally broken aluminum extrusions use polyurethane material for their thermal break.

Skylight curbs deserve a good deal of consideration in the area of heat loss as well. Typical insulated metal skylight curbs offer R-values between 4 and 5, depending on their thickness, which varies from 1 to 1½ in. As a result, no matter how insulating the skylight glazing may be, heat loss through curbs can take place at a rapid rate. Field-fabricated curbs made from dimensional lumber provide an even worse heat-loss scenario. One new curb design now available involves the use of structural insulated panels or SIPs. These are high-performance building panels used in floors, walls, and roofs for residential and light commercial buildings. The panels are typically made by sandwiching a core of rigid foam plastic insulation between two structural skins. Depending on their thickness, higher R-values are possible, as evidenced by one manufacturer's offering of a 4-in.-thick SIP curb that is rated at R-15. These curbs are also available with white reflective interior skins to assist in light diffusion and negate the painting and maintenance aspects required of typical metal curbs.

SkyCalc: Skylight Design Assistant - Graphic Results

Company Name: _____

Project Description: _____

Dome Skylight Effective Aperture = 1.18%, Skylight to Floor Ratio (SFR) = 3.57%

Average daylight foot candles (fc)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0	0	0	0	0	0	0	0	3	9	18	24	27	27	23	15	8	2	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	1	5	15	24	32	35	35	31	24	15	5	1	0	0	0	0	0
Mar	0	0	0	0	0	0	0	3	11	22	31	40	43	41	37	31	22	10	2	0	0	0	0	0
Apr	0	0	0	0	0	0	2	10	22	34	43	47	48	47	46	40	28	16	5	1	0	0	0	0
May	0	0	0	0	0	1	5	15	28	41	51	55	59	59	55	45	35	21	9	2	0	0	0	0
Jun	0	0	0	0	0	1	7	17	32	45	54	62	64	62	57	48	37	25	13	4	0	0	0	0
Jul	0	0	0	0	0	1	6	17	30	43	54	59	63	63	59	49	41	25	12	4	0	0	0	0
Aug	0	0	0	0	0	0	3	11	24	38	47	54	54	59	56	47	36	22	8	2	0	0	0	0
Sep	0	0	0	0	0	0	1	7	19	30	42	47	50	49	44	34	23	11	3	0	0	0	0	0
Oct	0	0	0	0	0	0	0	3	13	24	34	39	41	39	33	22	13	4	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	1	5	13	20	25	27	26	22	14	6	1	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	3	9	16	22	23	21	18	11	5	1	0	0	0	0	0	0

Design Illuminance = 50 fc

< 1 fc; < 25 fc; < 50 fc; > 50 fc;

SkyCalc helps rooftop designers identify the average daylight foot-candles produced by a selected skylight layout over the course of a 24-hour day through all 12 months of the year.

One of the most important factors for building owners considering skylights is the expense, a major potential hurdle to overcome in today's economic climate. However, skylights actually pay for themselves over time, as long as some form of lighting control is utilized that will take advantage of the natural daylight being transmitted through the skylights in conjunction with turning off the electric lights. (Installing skylights without lighting control will actually

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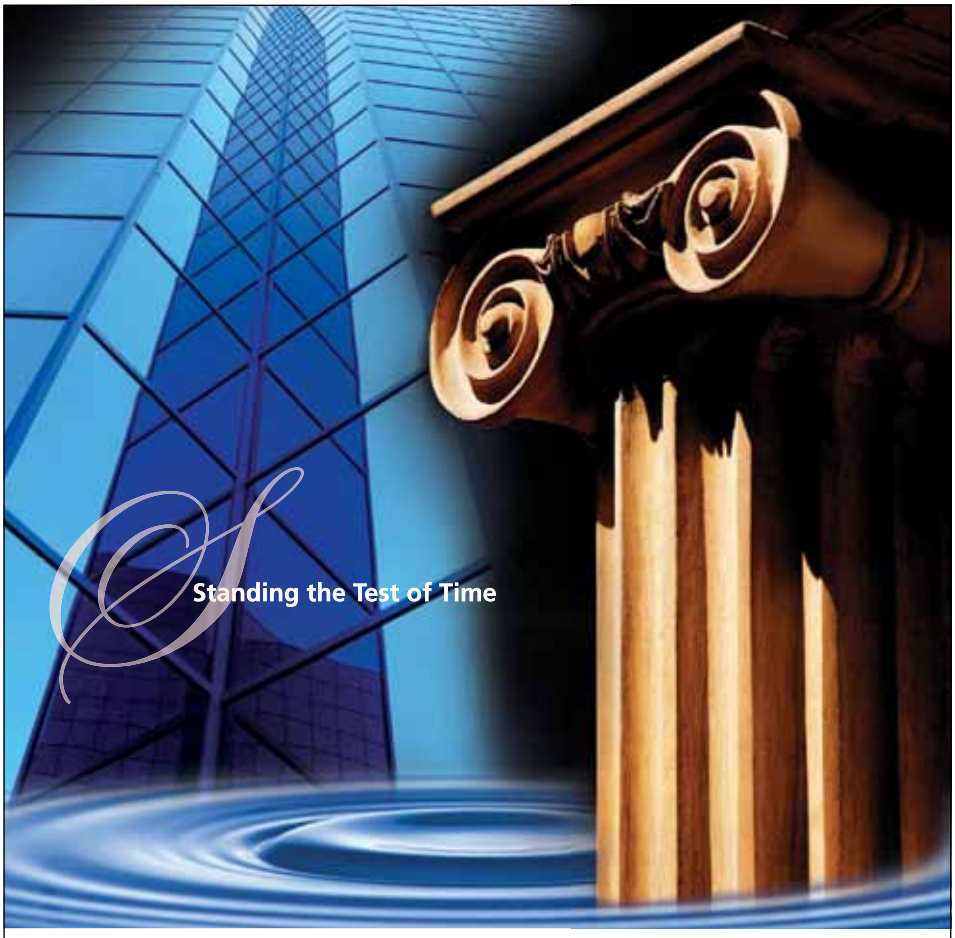
contribute to greater energy use because of heat gain and loss through the skylights in situations where the building being daylit is climatized.) The amount of energy that could potentially be saved by using skylights in commercial buildings can be quantified by utilizing a software program called SkyCalc®. This program was created by a California consulting group, Heschong Mahone, which also performed a follow-up study of SkyCalc's forecasted results and found an accuracy rate over 95%.

SkyCalc is a Microsoft® Excel-based program that also utilizes files provided by the U.S. Weather Service. When building owners provide basic information about the space to be daylit, including dimensions, hours of operation, and lighting type, SkyCalc will recommend the quantity of skylights that should be installed in the space. The program determines the optimal solution for even light distribution while maximizing the energy-saving benefits that can be achieved with some form of lighting control. SkyCalc does not overspecify skylight quantities, and the energy savings it generates are based upon the cost and type of energy used in a particular building. Typical return on investment time periods for skylight system installations usually range in the area of three to five years, depending upon the cost of energy in the region and installation labor rates charged by the contractor base.

SkyCalc will also generate a foot-candle illumination footprint of the space being daylit for a 12-month span and for each hour of the day (see table). This documentation provides further evidence to the building owner in support of the effectiveness of skylights in providing natural illumination to the prescribed space. Bear in mind that SkyCalc generates a net energy saving figure by accommodating within the software both the factors of heat gain and heat loss through the skylights. In other words, the energy-saving figures shown on the report are net numbers and do not require any adjustments for skylight performance. Skylights can also contribute to other factors that will help defray costs, depending upon the type of building being renovated.

It is well known and documented that skylights, in a retail environment, will result in higher sales per square foot. Studies have shown increases anywhere from 5% to over 20%. In manufacturing and office environments, productivity gains have averaged 15%. Within school environments, there

Skylight curbs made from structural insulated panels (SIPs) help increase the energy-efficient benefits of skylights by offering up to three times more R-value than a typical metal curb.



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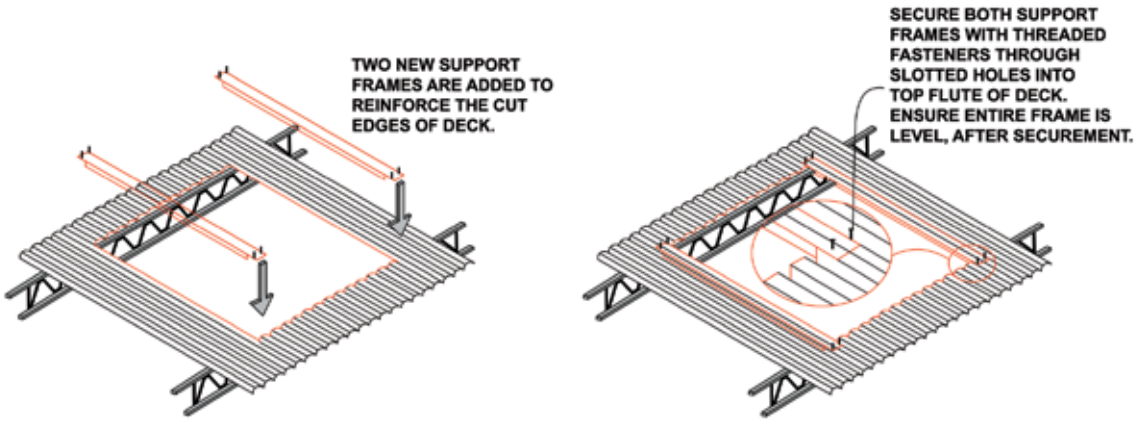

Heavy-gauge U-shaped lineals in metal deck support kits are mechanically fastened to metal roof decking in order to fully support proper sizing of skylights from bar joist to bar joist in lieu of welding steel angle irons in place.

have been positive results based on student performance as they relate to scoring on reading and math tests. Although building owners do not like to consider these factors when computing ROI, they represent significant contributions to the occupants of a facility.

One final consideration for building owners contemplating a skylight system installation is the area of roof support requirements. In situations involving typical metal decks, there are now some cost-effective solutions available that eliminate the high labor cost and fire danger of welding steel angle irons in place. Typical bar joist spacing in commercial buildings usually falls into a 5-ft. o.c. or 6-ft. o.c. spacing category. An ideal skylight size in this case is a 5- x 6-ft. unit because one of its dimensions will span the bar joists and be supported by them. To support the deck transition space from bar joist to bar joist, some manufacturers offer metal deck support kits, which consist of two U-shaped galvanized steel lineals (figure above). The lineals are notched at each end to allow a tongue to sit on top of the bar joist and are positioned so that the low point of the corrugated deck sits on the top service of the lineal. Once deck and lineals are screwed together, the opening is supported in both dimensions.

The skylight installation process must also address Occupational Safety and Health Administration (OSHA) requirements regarding workers' rooftop safety when holes are cut into the deck. OSHA offers specific guidelines regarding this issue and its mitigation, but a great deal of confusion surrounds the understanding of what specific measures fulfill their requirements. Even though many skylight manufacturers have drop-tested their domes based on their interpretation of the OSHA guideline, all plastic glazings will deteriorate molecularly under continuous UV exposure, and no one can guarantee how long a thermoplastic dome assembly will continue to be able to support mandated weight requirements. For permanent protection, fall protection screens are always recommended as a fail-safe solution.

Daylighting a commercial building is one of the most cost-effective strategies for building owners to save operating dollars, reduce their carbon footprint, and demonstrate their commitment to green/sustainability policies. For property management companies, it is a strategy to attract lessees, because it will lower their energy costs compared with conventionally lit spaces. Most, if not all, of typical building owner objections to skylights have been met and answered by many of the new techniques and innovations that have been developed over the past few years. It's time to "let the sun shine in!"

Kenneth Laremore

Kenneth Laremore is the skylight product manager for Carlisle SynTec Systems. He has been active in the building materials industry for over 40 years. Laremore's involvement in skylights began in 1993 with his employment at Thermo-Vu Sunlite Industries, Inc. He introduced a number of advanced product designs and features while at Thermo-Vu. Laremore joined Carlisle in 2007 to help introduce and launch a new innovative skylight utilizing proprietary RIM technology.

SKYLIGHT DEMAND GROWS

Residential skylight demand in the U.S. experienced a 2% increase from 2010 to 2011, bucking the overall demand for windows, which decreased during the same period. These facts were uncovered by the "2011/2012 Study of the U.S. Market for Windows, Doors and Skylights" by the Window and Door Manufacturers Association (WDMA) and the American Architectural Manufacturers Association (AAMA). The increase in skylight sales was driven by the continued strength of remodeling and replacement activity, now representing more than 80% of the residential skylight market. For 2012, the market is expected to grow 6% overall, with continued growth expected through 2015.

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