rethinking the barrier
CLADDING AND EXTERIOR INSULATION

COURTESY NICHIHA

The Austin Parks and Recreation Department and GSC Architects chose fiber cement panels for the rainscreen exterior of the Waller Creek Boathouse, home of the nonprofit Austin Rowing Club. The structure was built to withstand weather and wear-and-tear, and is a focal point in a heavily used recreation area.

BY C.C. SULLIVAN, CONTRIBUTING EDITOR

One old wives' tale holds that building enclosures can somehow be overly insulated or too "tight." They need to "breathe," goes the thinking, in order to dry out the cladding and structure with the natural ventilation that makes buildings more healthy. The alternative—those highly insulated, tight enclosures built after the 1970s oil embargo, for example, that led to interior condensation, mold, and sick building syndrome—can be avoided in this way.

That's only partly true. Enclosures need to have some ventilation and be allowed to dry out. But entire buildings?

"As far as insulation goes, there may be a theoretical point of 'too much,' but in most cases buildings have too little," reported Green Building Advisor (http://www.greenbuildingadvisor.com/content/can-houses-be-too-insulated-or-too-tight). Most buildings do not meet even the minimum R-values recommended by the U.S. Department of Energy or the prescriptive requirements of ASHRAE's Standard 90.1 and the International Energy Conservation Code (IECC), which will be updated in October in many jurisdictions to the 2012 edition. "Adding more is always a good thing," the report added.

In 2011, DOE mandated that all states adopt the 2010 version of ASHRAE 90.1 (or the 2012 International Energy Conservation Code, which is written to match 90.1) as "their minimum energy code." DOE determined that buildings meeting ASHRAE Standard 90.1-2010 would use an estimated 18.5% less energy than structures using the previous 2007 edition, says Paul Karrer, an energy-efficiency advocate with the Alliance to Save Energy, Washington, D.C. With this "final determination" of federal laws dating back to the 1992 Energy Policy Act, Karrer says, the states "are required to file certification statements to DOE that they have reviewed the provisions of their commercial building code regarding energy efficiency and made a determination as to whether to update their code to meet or exceed the Standard 90.1-2010."

The October 2013 deadline means that across the land, Building Teams will have a much stronger case to make their structures perform better. Highlights of the prescriptive language in the codes include mandates for:

• Continuous insulation, or CI, for steel-framed enclosures in climate zones 3-8.

• Maximum fenestration area of 40% of vertical enclosure area.

• Air barriers and detailing of exterior wall joints and penetrations to be "wrapped, sealed, caulked, gasketed, or taped."

To summarize, the mandate for Building Teams in Q4/2013 and

LEARNING OBJECTIVES

After reading this article, you should be able to:

+ DESCRIBE the new requirements for enclosure features such as continuous insulation (CI) and air barriers in the 2010 and 2012 codes and their impact on environmental performance.
+ LIST the benefits and drawbacks of commonly used cladding systems, especially with regard to indoor air quality and mold.
+ DESCRIBE performance issues of cladding and exerior insulation systems.
+ EXPLAIN several key areas of detailing and specification for successful wall performance as related to sustainable design and construction.

beyond is to boost insulation, control air leaks, reduce solar heat gain, and keep moisture out. That will means more attention to the specifications for exterior insulation for both new construction and reconstruction projects.

According to Green Building Advisor, adding a layer of rigid insulation exterior to the building's structural framing can help prevent thermal bridging, another cause of energy loss and condensation. Continuous insulation has been prescribed in the 2009 editions of the International Building Code (IBC) and the IECC, requiring a CI layer matching the R-values given in the 2007 edition of ASHRAE 90.1, typically a minimum of R-7.5 across the entire enclosure for most climate zones. For Building Teams that choose to meet the new International Green Construction Code (IgCC) or ASHRAE Standard 189.1 for high-performance green buildings, a higher minimum performance, R-10, is required for the CI assemblies.

In some cases, continuously applied exterior insulation can also serve as an air barrier, depending on how the joints are sealed and the insulation layers are terminated for board stock, for example, or how a spray-applied foam insulation is detailed in the assembly. The dual-use application is opportune, as air barriers are increasingly required by code in many jurisdictions. The ASHRAE 189.1 standard was the first (starting in 2009) to require air barriers that specifically met a battery of ASTM tests to prove their air permeance rate and effectiveness. The test standards include ASTM E 2178 (for air-barrier materials) and ASTM E 2357 or E 1677 (for air-barrier assemblies).

In October, jurisdictions adopting the 2012 IECC will require air barriers similar to those called out in ASHRAE 189.1. Any projects that are built to the 2012 IgCC voluntary standard will have the same requirements. Codes referring to IECC (or IgCC) will require air barriers passing the ASTM tests, which limit air leakage through the barrier materials to less than 0.4 cubic feet per minute per square foot.

Last, new building designs will better prevent the entry of bulk moisture and the condensation of water vapor within enclosures and plenums, which can cause mold, compromise wall durability, and reduce the R-value of some kinds of insulation. In fact, building design experts see moisture problems looming large in coming years. The new codes do not prescribe solutions, so success will rely on effective coordination between design and construction professionals.

Moisture problems can arise even when the cladding is perfectly weathertight. Internal elements such as heat generation, airflow, and exhaust should be factored into the design, and the insulation must be properly layered with building mass and air and vapor barriers. For example, wall insulation must be located exterior of nonpermeable air/vapor barriers in cold climates to avoid entrapment of internal condensation, and the nonpermeable air barriers should tie into window frames inboard of the thermal barrier. Vapor-permeable air barriers, on the other hand, can be placed in practically any location within the wall cavity. The vapor-permeable type provides requisite airtightness while helping to avoid moisture entrapment during various climatic or seasonal conditions.

CLADDING FOR 2013 AND BEYOND

With insulation and air infiltration taking on increased prominence, what kinds of claddings will offer adequate solutions for today's new buildings and retrofit projects? Maybe the same old claddings we have always used, say the experts, but now with attention to the backup system, and added materials and components for improved performance. According to David Altenhofen, AIA, a building enclosure consultant and Manager, The Facade Group East (www.facadegroup.com), who chairs the National Building Enclosure Council, there are two basic types of cladding systems to consider: barrier walls and drainage walls. Those break down into four categories:

Mass walls. These barriers walls include traditional masonry walls and single-wythe construction, such as with concrete masonry unit (CMU), as well as precast concrete barrier walls.

Face-sealed systems. Also barrier walls, these systems include metal panels with sealed joints as well as exterior insulation and finish system (EIFS) assemblies.

Internal drainage plane. Contrasting with the face-sealed barrier type, these walls position the barrier just behind the exposed surface to control moisture movement. These

COURTESY STO CORP.

Overcladding existing masonry walls with rainscreens or barrier wall systems (as shown in this before-and-after sequence) is an effective way to provide improved thermal performance and resistance to air and moisture infiltration.

wall types include traditional clapboard and vinyl siding as well as stucco and drained EIFS assemblies.

Drained cavity. Drained cavity assemblies include an air space within the wall where moisture can evaporate and water can drain out. These walls include brick veneer, siding over furring, and a number of metal panel systems.

Rainscreens have a drained cavity, and there is growing interest in the use of these "double wall," rear-ventilated cladding systems, such as cladding over existing walls. The outer layer, which may be made of metal panels, ceramic tile, wood, laminate, cement board, or other resilient materials, blocks the sun and helps keep out most of the bulk water, such as rain. The inner layer typically contains the structural wall members and primary barrier to heat and cold, air leakage, and, in many cases, moisture. Evaporation and drainage in the cavity removes water that penetrates through the rainscreen's panel joints, an effect that is designed into the enclosure system.

With rainscreens, wind pressures on the exterior panel surfaces are equalized within the cavity between the two walls. This is known as the *rainscreen principle,* and it helps prevent movement of bulk water through joints connecting the outer panels. In practice, however, the open-joint rainscreens are engineered to allow some moisture through the exterior cladding; that moisture must be allowed to drain out or evaporate within the cavity.

Rainscreens work well for overcladding buildings with poorly performing enclosures, says Mark Sealy, AIA, LEED AP, Design Principal at EYP/BJAC (www.bjac.com) "Existing buildings with moisture infiltration concerns may benefit by sealing the existing exterior and adding a rainscreen, as opposed to potential costly exterior wall deconstruction, repair, or replacement," he says.

On the plus side, overcladding is a cost-effective alternative to the complete demolition and rebuilding of most building façades. This is true of many cladding types, including masonry mass walls and face-sealed glazed curtain walls. For the curtain wall, a retrofit façade system may make use of existing mullions and require only minor structural reinforcement of floor slabs or decks. However, the engineering must be highly accurate to ensure that variable loading, moisture fluctuations, and thermal movement do not cause unplanned expansion of joints or other negative effects, says Mike Koppenhafer, President, Fisher|Koppenhafer Architecture|Interior Design (http://www.fisherkoppenhafer.com).

In all cases, rainscreens should be designed so that the air space is compartmentalized at the top and sides, says Altenhofen, with flashing angled down and outward at the cladding's base to allow for drainage of any water that enters the air gap due to capillarity or gravity. Intersections of the rainscreen and openings such as windows and doorways must be detailed carefully as well: Weather-barrier membranes and flashing must be extended into the glazing pocket, with a seal and insulation added to close off any cavities.

WHEN AN AIR BARRIER is not an air barrier

Detailed properly, these materials can serve as components of air barriers for an energy-efficient building enclosure:

- Concrete
- Gypsum drywall
- Plywood
- Siliconized gypsum sheathing
- Closed-cell rigid insulations
- Fully adhered roofing membranes
- Aluminum and steel
- Sheet metal flashing
- Glass
- Certain building wraps

These materials may not serve as air barriers:

- CMUs (concrete masonry units)
- Brick
- Open-cell rigid insulation
- Batt and blanket insulation
- Building felts
- Certain building wraps
- Plastic sheets
- Wood fiberboard sheathing

SOURCE: THE FAÇADE GROUP

COURTESY GEORGIA-PACIFIC GYPSUM

By using a water-resistant sheathing, the façade design for this car dealership in Garland, Texas, has a structural, durable surface for application of a drainage plane or air barrier, or both.

ADDING EXTERIOR INSULATION

Improving thermal performance is another reason to explore a rainscreen retrofit or renovation. "Renovation of an existing rainscreen system may also allow additional thermal insulation to be provided for the building envelope," says EYP/BJAC's Sealy.

Replacing or adding insulation to older buildings requires careful engineering, analysis, and modeling, however. "Changes to the flow of air, heat, moisture vapor, or liquid moisture through a wall can upset the balance between thermal performance, dew point location, and moisture performance," says building scientist Lee Durston, a Director of design firm BCRA (bcra.com). When insulation is applied to an existing wall system, it immediately moves the dew point location within the enclosure assembly, so that condensation caused by temperature and moisture swings may occur at a different place in the wall. This can create a new moisture problem where it never existed, he adds.

Still, the opportunity to improve R-value and add continuous insulation exterior of the structural steel is a powerful option. Model energy codes describe CI as “insulation that runs continuously over structural members and is free of significant thermal bridging.” For that reason, cladding designs must also consider how to avoid thermal bridging, which enclosure experts say can rob insulation of more than half its nominal R-value.

In fact, Building Teams often design framed walls and specify thermal control based on the insulation materials’ rated R-value, which does not take into account thermal bridging effects. This is a clear concern for cavity insulation installed between steel columns, purlins, or light-gauge steel studs: The thermal bridging over the steel cuts the effective R-value by up to 24% for wood-framed walls and by as much as 50% for typical commercial steel-framed façades. One seminal study by DOE’s Oak Ridge National Laboratory compared brick, stucco, EIFS, and wood siding over metal studs with cavity insulation designed to R-11. ORNL took care to include wall accessory penetrations, transition details, and other common discontinuities between the cladding and framing.

Cladding with continuous, two-inch-thick board insulation was shown to be much more efficient than brick veneer systems, for example. While the brick veneer’s cavity insulation was specified at R-11, the effective performance of the veneer assembly was only about R-7, showing how discontinuities and thermal bridging can dramatically affect building performance. ASHRAE 90.1 has included the Table A9.2B in the standard, which vividly compares rated material R-values against their effective R-values in the field. For example, in 16-inch OC steel wall framing, cavity insulation rated at R-25—with unusually deep, eight-inch framing members—provides an effective rating of the thermal barrier across the opaque façade of only R-7.8. So it loses two-thirds of its punch.

For better performance, continuous insulation is clearly beneficial for steel-framed walls, but it is also a good strategy for panelized metal construction, unit masonry exteriors, structural insulated panels (SIPs), and a multitude of barrier walls. Instead of designing with prescriptive R-values as a guide, Building Teams can use the IECC’s Table C402.2, which presents minimum CI values alongside total wall assembly U-factors, which describe the rate of heat transfer into or out of the building. In this way, the building design can meet the requirements of the IECC and ASHRAE 90.1 by using a total wall design measure—U-factor—rather than the single prescriptive measure of the R-value of the exterior insulation layer.

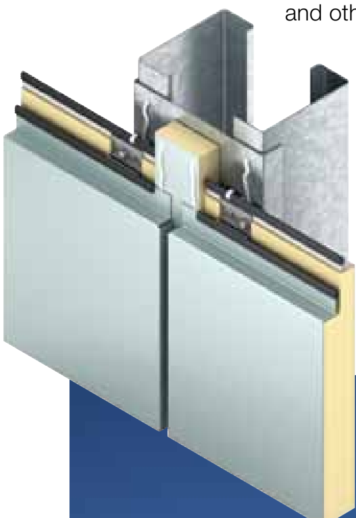
REAPING THE BENEFITS OF BECX

According to Evan Mills, PhD, a researcher at Lawrence Berkeley National Laboratory, building enclosure commissioning, or BECx, should be viewed as “the single-most cost-effective strategy for reducing energy, costs, and greenhouse gas emissions in buildings today.”

Mills studied the benefits of BECx, noting that commissioning only costs about $1.16/sf for new construction and $0.30/sf for existing buildings on average, with a payback period of as little as 14 months. Savings associated with using BECx from both maintenance and energy savings average about 16% for existing buildings and 13% for new construction. The main benefit is that whole-building energy savings are guaranteed, thanks to the pivotal role of the enclosure in determining efficiency performance.

“Further enhancing the value of commissioning, its non-energy benefits surpass those of most other energy-management practices,” including major first-cost savings through right-sizing of HVAC equipment, Mills has testified. “When accounting for these benefits, the net median commissioning project cost was reduced by 49% on average, while in many cases they exceeded the direct value of the energy savings.”

The National Institute of Building Sciences published its NIBS Guideline 3-2012 on enclosure commissioning last year. The U.S. Green Building Council has allowed the application of BECx to earn an innovation credit in the LEED rating system, and BECx was even considered as a prerequisite, but that proposal lost momentum, says Rob Kistler, AIA, NCARB, Committee Chair for NIBS Guideline 3 and Principal, The Facade Group.



COURTESY KINGSPAN

For this airplane hangar in Canada, an insulated metal panel cladding was used to provide continuous insulation, air barrier, and moisture control, all in a single panelized system. The metal panels were used as backup for some wall areas. Detailing of block spine façade joints (inset) is critical to ensure the integrity of the continuous insulation and moisture control.

For this school in New York's East Harlem neighborhood, a colorful rainscreen system was used to provide a barrier against the elements as well as a cavity for drainage space and drying of the enclosure.

It appears that LEED v4 will not explicitly encourage the detail review, onsite testing, and observation that some enclosure experts say is what makes BECx effective, notes Tristan Roberts, with BuildingGreen's LEEDUser service. Instead, the new LEED draft language directly quotes NIBS Guideline 3, which describes the following techniques as part of proper BECx for enhanced building commissioning:

- ***Devise a plan*** early in the project cycle that describes testing requirements, acceptance criteria, and documentation.
- ***Review details*** in the construction documentation to check for overall performance, continuity of weather barriers and insulation, and constructability.
- ***Conduct observations*** on the job site as required for critical milestones in enclosure installation, from field mockups to trades startup to field testing.
- ***Use mockups*** to benchmark workmanship requirements and ensure compliance with specifications and manufacturer's installation requirements.

The NIBS committee for BECx, which Altenhofen serves on, recommends including a consulting enclosure expert for the building project, especially in the construction administration phase. The expert will help ensure proposed cladding materials and systems are integrated properly into the design process, followed by visual observations of a statistical sampling of installation of work. Toward the end of the CA phase and before acceptance, a blower-door test will check whether the air infiltration levels are equal to or better than standard.

As noted in the summary of NIBS Guideline 3, BECx helps reduce the chances that inadequate cladding work will be discovered during the punch list phase: "The performance of the enclosure cannot be verified until the entire building is completely enclosed. At this time it is not possible to tune or dial in the performance. To access a nonperforming subsystem or assembly might be very expensive."

ADDRESSING MATERIAL COMPATIBILITY

One of the benefits of working with a commissioning consultant is the opportunity to review design phase details where material compatibility and systems integration may be causes for concern. Even manufacturer warrantees may be affected (or voided, in some cases) if the transition to adjacent materials or assemblies does not match the maker's requirements.

The continuity between various systems and materials is largely determined by the design detailing and proper construction work by the various trades. Yet compatibility is often related to chemical interactions at wall, roofing, and transition membranes, so the products must be either proven to work together or deliberately held apart or separated using inert materials, says Koppenhafer. "Each manufacturer will only warrant their proprietary system and not a connection to another, and that is where failures occur more than anywhere else," he says. "It's all about the connection of the different vertical and horizontal systems."

BCRA's Durston points out that some cladding systems require use of a second manufacturer's materials for a specific interface detail, such as wall-to-foundation and roof-wall connections. "In addition to calling out these details and producing a coordinated package of design and specification documents, Building Teams must perform on-site construction quality control and in some cases BECx to verify the performance of each system as constructed," he advises.

Simple material incompatibility issues should be listed by the suppliers or by subcontractors with experience in the product range. For example, uncoated aluminum cladding panels shouldn't touch fasteners or metal surfaces made with most other bare metals—zinc, copper, steel, stainless steel, or lead flashing—and where a panel might come into contact, it must be treated with barriers such as paints or bimetallic separation tapes or pads.

With air barriers, some of the coatings and membranes may prevent sealant adhesion or interfere with coatings and tapes. In such situations, designs should either ensure a compatible product mix or detail without such products as sealants, and instead use continuous trim clips, reglets, clamping strips, or similar joinery.

Window and door openings, where multiple materials and hardware interconnect, can be difficult areas to detail for an effective and continuous air barrier. In many cases, a flexible, nonpermeable membrane should surround the perimeter of the opening, completely sealing the opening before the IGU or window is inserted. Compression-sealed trim or sealant joints around the entire perimeter provide the requisite barrier.

TROUBLESHOOTING MOISTURE PROBLEMS

While air barriers and thermal barriers are found to be highly effective if they are continuous and structurally supported throughout the enclosure, commercial properties can be susceptible to moisture intrusion problems, notes Moisture Warranty Corp. (www.moisturewarranty.com). These often present themselves as material degradation issues, wetting of finish materials, and indoor air quality degradation related to mold.

"The commercial building market has operated with a responsibility void for problems related to exterior moisture," says Chris Burton, MWC's President. "When a problem is discovered, the parties involved often start pointing fingers at each other." A better path is to have a team approach to taking responsibility for the performance of the exterior cladding, to engineer a warranted solution.

To begin dealing with environmental loads that are moisture sources – including rain, temperature, humidity and the interior climate—Building Teams must consider three basic moisture control strategies, says Joseph Lstiburek, PhD, PEng, Principal, Building Science Corp. (www.buildingscienceconsulting.com):

1. Control of moisture entry
2. Control of moisture accumulation
3. Removal of moisture

Lstiburek points out that liquid flow due mainly to rain and capillary suction—primarily acting on groundwater—is the primary way buildings get wet. To a lesser degree, vapor diffusion and air transport also move moisture into the building enclosure.

In all project locations, the design should use techniques to protect building enclosure assemblies from getting wet due to air transport and vapor diffusion. That means using vapor barriers, air barriers, and air pressure control, as well as ventilation and dehumidification within the building, to control interior moisture levels, Lstiburek says. The climate dictates where those barriers are placed within the enclosure. In cold climates, the air/vapor barriers should occur closer to the interior surfaces in order to prevent moisture accumulation from the interior. In hot, humid climates, building assemblies are dried toward the interior, and wetting occurs from the outside, so air/vapor barriers should be installed to the exterior.

Proper placement in mixed climates is more complex, according to the Louisiana State University Agricultural Center. Wetting occurs from both the inside and the outside, and the wall assembly must be allowed to dry both indoors and out. That's because moisture flow changes direction from the heating season (inside to outside) to the cooling season (outside to inside). A classic solution is to locate an air barrier toward the interior side, with a permeable interior finish and a water vapor retarder—not a water barrier—that adapts to the seasons. This "seasonally adaptable vapor retarder assembly," says the LSU guide, can be achieved using:

- Insulating foam sheathing on the exterior side (minimum R-5), which serves as an exterior vapor retarder during the cooling season. Its inside surface acts as a warm-side vapor retarder during the winter, too, never getting so cold that it would lead to condensation.
- Insulation faced with kraft paper can be located toward the interior, which in the winter acts as a vapor retarder. Yet the material is permeable enough to deal with heavier concentrations of water vapor during the summer months.
- Novel membranes known as "smart" vapor retarders that change properties with ambient conditions are also available. The hygroscopic materials have vapor permeance characteristics that vary based on humidity level. They absorb water from humid air, and the water molecules allow water vapor to move through the membrane.

Regardless of the climate, Lstiburek and other enclosure specialists recommend a number of good practices for moisture control, such as sloping soil surfaces away from the enclosure both at grade and below grade. The surfaces underground should have a dampproofing layer or coating that serves as a capillary break, to prevent uptake of moisture. Lstiburek also recommends including a drainage plane or drainage layer for surfaces that are likely to experience wind-driven rain or snow. All assemblies, he adds, should have at least one air barrier and one vapor retarder or vapor barrier surface.

THE CASE FOR TWO LINES OF DEFENSE

The point is that moisture will occur, and even where properly applied air barriers, vapor retarders, and water-resistant barriers are included, there must be provisions for dealing with water, vapor, and condensation. "That means taking an approach that provides two lines of defense, using exterior cladding as a primary weather barrier and separated by a vented air space from the drainage plane on the backup wall," says James Oglesby, AIA, with design firm Shepley Bulfinch (www.shepleybulfinch.com). "This addresses water management by applying pressure-equalized rainscreen design principles."

The drainage plane is a flat, continuous plane that can serve as a drainage surface, an impermeable vapor barrier layer, and a continuous air barrier. This kind of a robust and durable control layer, which prevents the movement of air, water, and vapor, can then be covered with continuous insulation to provide requisite thermal control and make the building energy efficient. Continuous through-wall flashing of sheet metal or another robust material should be included at regular intervals, sloped toward the outside to direct water out of the cavity through weep holes. If the

TABLE C402.3 BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
Vertical fenestration								
***U*-factor**								
Fixed fenestration	0.50	0.50	0.46	0.38	0.38	0.36	0.29	0.29
Operable fenestration	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
Entrance doors	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77
SHGC								
SHGC	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
Skylights								
***U*-factor**	0.75	0.65	0.55	0.50	0.50	0.50	0.50	0.50
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

IECC 2012, TABLE C402.3 BUILDING ENVELOPE REQUIREMENTS: FENESTRATION
HTTP://PUBLICECODES.CYBERREGS.COM/ICOD/IECC/2012/ICOD_IECC_2012_CE4_SEC002.HTM

dealing with WINDOWS AND GLAZING

What about where continuous insulation ends, and windows or insulated glazing units begin?

These window-wall interface areas are among the key places where fenestrated cladding performance becomes most essential. For example, air infiltration must be kept to a minimum level. An incorrectly designed or shoddily installed window-wall interface or curtain wall will exhibit uncontrolled loss of conditioned air and create interior hot spots and cold spots. This is in addition to the effects of direct sunlight on fenestration, which adds heat to the building interior through solar radiation. The solar heat-gain coefficient of the glass, or SHGC, describes its propensity to allow heating through the glass panels.

Prescriptive U-factors and SHGCs are written into the IECC, so the code's growing adoption after October 2013 should lead to improvements in fenestration designs such as insulated glass units. New window-to-wall ratios (WWRs) will help restrain glazed area to some degree, ensuring that overall U-factors are tamed across new enclosure installations.

According to the University of Minnesota's Center for Sustainable Building Research, the maximum SHGC can be increased "if any permanently attached shading device has a projection factor (PF) greater than 2.0, where the width of the shading device is more than one-fifth of the height from the sill to the underside of the shading device." How much can the SHGC be increased? That depends on orientation, says the group, with north-facing glazing allowed less than windows oriented in other directions.

Buildings designed for daylighting may exceed the prescriptive 30% limits on fenestration area for vertical walls, earning an additional 10% of the total area in climate zones 1-6. In this case, at least half the conditioned floor area must be within a daylight zone and the visible light transmittance (VLT) for the fenestration glazing must be at least 1.1 times the SHGC value. Similarly, skylights are limited to 3% of the gross roof area, but that can be increased to 5% if there are automatic daylighting controls.

Last, the prescriptive limits for air leakage given in IECC 2012 vary depending on the kind of fenestration in question. One of the key limits is 0.2 cfm per square foot (or 0.3 cfm per square foot if tested at 6.24 psf) of air leakage for most kinds of windows, sliding doors, and skylights.

Make sure that the details between opaque areas and fenestration are properly executed, using subcontractor training and full-scale mockups to ensure good craftsmanship. If the team fails, will anyone notice? The person who pays the utility bills may not think that unseen gaps in the cladding are causing the uptick. But if the team requires blower door tests or commissioning procedures, in many cases, yes, installation issues will be noticed.

COURTESY GUARDIAN AND PYTHAGORAS SOLAR

This BIPV—for "building-integrated photovoltaic"—glass is an optically enhanced solar window to boost energy efficiency, PV power generation, and transparency in a standard window assembly.

structural framing and connections are detailed with minimal thermal breaks through the insulation, the enclosure will win the battle against heat, air, and moisture.

It's important to realize that moisture and air infiltration in modern cladding are often one and the same, because air transports moisture and water vapor. The main culprit is often air movement, which tends to cause condensation, says Wagdy Anis, FAIA, LEED AP, Principal of the enclosure consulting firm Wiss, Janney, Elstner Associates (www.wje.com). This can occur due to a thermal effect such as convection looping into building assemblies, which entrains water vapor to a surface that is colder than the dew point within the assembly. Another effect is infiltration or exfiltration due to air pressure differentials; these may be related to wind, HVAC system pressures, or the stack effect of heat rising through building cavities.

Since air likes to move, Building Teams should provide multiple layers of defense against its effects. Enclosure experts at the Judd Allen Group (www.juddallen.com) recommend sealing and flashing vulnerable joints twice. In this way, the exterior seal will absorb weather effects, wetting, and ultraviolet degradation, while the interior seal will remain protected and intact to keep moisture and air at bay if the outer seal is ever compromised.

Buildings move, too, which means you must also consider redundant enclosure detailing to protect the integrity of air and moisture barriers. At joints, for example, the water-resistive barrier layer may change from one material to another, such as from a membrane to a sealant. These different materials must be adequately joined together, such as by using an additional product that will address compatibility problems and accommodate movement at the joint, says the Façade Group's Altenhofen.

GETTING THE ENCLOSURE RIGHT

The efforts to improve modern enclosure systems with redundant seals, cavities, drainage means, and smart membranes ensure that the results will be complex. Yet studies of the increased focus on correctly specifying and installing air and moisture controls barriers suggest a good return on investment. A recent study by the National Institute of Standards and Technology concluded that air leakage was cut by more than 80% when proper air barrier systems were used, and reduction in leakage cut energy use in the subject buildings by more than 40% for natural gas and by at least a quarter for electricity.

> EDITOR'S NOTE

This completes the reading for this course.
*To earn **1.0 AIA/CES HSW learning units**, study the complete article carefully and take the exam posted at*
www.BDCnetwork.com/Cladding/Insulation

cladding + exterior insulation AIA/CES MODULE

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1. In October 2013, the International Energy Conservation Code (IECC) will be updated in many jurisdictions to the latest versions of the IECC, which is the …
   A. 2012 edition
   B. 2010 edition
   C. 2007 edition
   D. None of the above
2. Which of the following is NOT prescribed in the 2012 codes for building enclosures?
   A. Maximum fenestration area of 40% of vertical enclosure area
   B. Air barriers and sealing and caulking of wall penetrations
   C. Thermal insulation of R-18.4 or greater
   D. Continuous insulation, or C.I., for steel-framed enclosures in climate zones 3-8
3. ASTM tests are used to demonstrate the air permeance rate and effectiveness of air barrier materials, assemblies, and systems. The test standards include ASTM E 2178, which is for:
   A. Sealant materials only
   B. Air-barrier materials
   C. Air-barrier systems
   D. Window-wall penetrations only
4. To avoid entrapment of internal condensation inside façade enclosures in cold climates, wall insulation should generally be:
   A. used without an air/vapor barrier
   B. located either interior or exterior of the air/vapor barrier
   C. located only interior of the air/vapor barrier
   D. located only exterior of the air/vapor barrier
5. True or False: The IECC (International Energy Conservation Code) does not provide prescriptive U-factors or solar heat-gain coefficients (SHGCs) for building enclosures or glazing.
   A. True
   B. False
6. Which of the following is a barrier wall?
   A. Drained cavity or drainage plane
   B. Rainscreen
   C. Face-sealed system
   D. None of the above
7. The National Institute of Building Sciences (NIBS) published its NIBS Guideline 3-2012 to address what key construction topic?
   A. Building enclosure commissioning, or BECx
   B. Predicting air infiltration rates, given in cfm per square foot
   C. Skylight limitations for roof area, given as a percentage
   D. None of the above
8. One way to test full building air infiltration levels against projects requirements or prevailing codes/standards at the end of construction is by using:
   A. façade assembly mockups
   B. blower-door testing
   C. energy modeling software
   D. None of the above
9. True or False: Manufacturer warrantees may be affected or even voided, in some cases, if the transition to adjacent materials or assemblies does not match the maker's requirements.
   A. True
   B. False
10. The drainage plane is a flat, continuous plane behind the building cladding exterior that can serve which of the following functions?
    A. Drainage surface
    B. Impermeable vapor-barrier layer
    C. Continuous air barrier
    D. All of the above