CLEAR PERFORMANCE SOLUTIONS

JW MARRIOTT, NASHVILLE

PHOTO BY CHAD BAUMER, COURTESY OF TECHNOFORM.

HIGH-PERFORMANCE SOLUTIONS: Nashville's new standout 33-story JW Marriott tower touts a curving façade that combines high-performance glass with thermally broken framing. It features YKK AP's YWW 50T Window Wall MegaTherm aluminum framing system with Technoform polyamide thermal barriers, and insulating glass from Viracon: VRE1-38 with 44 percent reflectance for the tower, and VE1-2M with 70 percent VLT and 11 percent reflectance for the podium.

THE PLAYERS: Architects, Smallwood, Reynolds, Stewart, Stewart & Associates (Smallwood) and Arquitectonica; general contractor, Skanska USA; glazing contractor, Custom Enclosure Solutions (CES); curtain wall supplier, YKK AP; thermal barrier supplier, Technoform; glass fabricator, Viracon.

THE ARCHITECT'S GUIDE TO GLASS AND GLAZING PERFORMANCE **BY KATY DEVLIN**

High-performance building is no longer optional. Building codes require it. Owners and occupants increasingly demand it. And our global sustainability depends on it, say industry sources. "Anyone who can see the data on climate can see that something has to change when it comes to carbon emissions. We need to do it quickly," says Josh Wignall, director of marketing, EFCO Corp.

The glass and glazing industry is ready to help architects bring their projects—new and old—to the next level of building performance. "[Our industry] has the technology. We just have to make sure we prioritize it," Wignall says.

To achieve high-performance targets, jurisdictions must adopt and enforce the newest, more stringent energy codes, project teams must work more collaboratively to design and construct buildings that meet performance goals, and team leaders and building owners must prioritize performance and be willing to invest in available solutions, sources say. "There are systems on the market that can meet the most stringent energy requirements. They are just not being used," adds Helen Sanders, strategic business development, Technoform.

The following pages present "Glass & Metals 501: The Architect's Guide to Glass and Glazing Performance." The guide takes a closer look at baseline energy code updates and provides information about glass and glazing products to meet new requirements. It presents key considerations for glass and glazing performance from industry experts, and examines the cost-benefit analysis of building for performance.

Glass & Metals 501 is part of Glass Magazine's six-part series "All About Glass and Metal: A Guide to Glazing for Architects and Specifiers." The complete series provides an in-depth look at specification and design for glass and glazing. It begins with "Glass and Metals: 101: An Introductory Guide to Glazing for Architects and Specifiers" and continues through "Glass & Metals 601: The Architect's Guide to Complex Façades." It covers topics ranging from specifications to interior glass, to protective glazing and more. To access the complete series, visit glass.org/store.

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PERFORMANCE & PAYBACK

If glass and glazing solutions are readily available, why aren't they being used to their fullest potential on every project? Glass and glazing industry experts point to a range of hurdles that stand in the way of performance, including cost, and outline the opportunities for payback in terms of people, energy costs and more.

AFFORDABILITY & EFFICIENCY

Cost often stands in the way of performance.
Perhaps the biggest roadblock to high-performance building design and construction is cost, say industry officials. "The biggest hurdle for our industry—for our nation as a whole—to driving performance to the next level is commitment," says EFCO's Wignall. "We must commit to achieving certain levels of thermal performance. We need to overcome the cost-benefit paradigm. We have the technology that can get us to net zero, but are people willing to pay?"

High-performance glass and glazing products are often taken out of projects due to higher upfront costs, sources say. "Specs often start off with high-performance systems. Design teams are interested in thermally broken systems, but because of cost they are value engineered out," says John Cox, project executive, Giroux Glass.

Reduce costs with more standard high-performance solutions.
Glass and glazing companies have developed a range of high-performance solutions that are achievable and affordable. "With a standard thermally broken window and curtain wall systems, you can achieve good edge-of-glass [performance] using standard low-E. You can do it. You just need to know what is available," says Technoform's Sanders.

To keep costs down, Viracon Technical Resources Manager Alissa Schmidt recommends that architects "stay within the realm of typical 1-inch insulating glass systems and stay within an average module size. Not varying systems, not going with unique shapes, can help with pricing," she says. For glass coatings, she recommends designers work with suppliers to find the most affordable low-emissivity glass for the project. "Tinted substrates are also an option. There is minimal cost to go with basic tint," she says.

Performance pays back.
High-performance façades can translate to lower heating, cooling and lighting costs, while offering improvements for occupants. This is true on new construction and, in particular, on retrofits. "It's not a huge investment to update the envelope. The paybacks can be major. You can improve occupancy comfort, save on your energy bill, reduce the loads on the air conditioning or heating. This can save a lot of money, and you'll see increases in lease rates and property values," Wignall says.

PERFORMANCE FOR PEOPLE

Glazed high-performance façades make for productive, healthy occupants.
Building occupants are healthier and perform better when they are granted access to views and are comfortable in terms of daylighting levels and temperature. Studies on occupant comfort show increased healing times for patients, improved test scores among students, and decreased absenteeism and increased productivity among office workers. "We can't underestimate the importance of daylighting and its ability to improve health and happiness within the workplace," Wignall says. "People can't sit in a brick box with no light."

Occupant costs dwarf operational costs.
Because people in healthier buildings miss fewer days of work, perform tasks more efficiently and stay in their jobs longer, owners and employers can see notable paybacks. Employers see productivity improvements and building owners can charge higher lease rates.

Too often, building managers and owners don't factor people into the building performance equation. However, it's the people who represent the costliest aspect of running a building, says Stephen Selkowitz, former senior advisor for building science, and former group leader of the Windows and Envelope Materials Group in the Building Technology and Urban Systems Division of Lawrence Berkeley Lab. He estimates that occupancy costs reach about 100 times the cost of energy.

People need daylight—just not too much.
Although building occupants need access to daylighting and views, too much daylight leads to glare and heat gain, which negates the potential occupant comfort benefits. "One of the biggest misconceptions I see is the automatic, if not subconscious, assumption that all-glass façades lead to better daylight and views," says Galen Burrell, director of lighting design at View Inc. "However, the reality is that there can be too much of a good thing, and so we should focus on optimizing daylight rather than maximizing it. Unchecked sunlight can create various comfort issues associated with excessive glare and heat. As a result, blinds get closed and generally remain closed, and the entire value proposition of daylight and views get lost."

GLASS & GLAZING PERFORMANCE

Misconceptions about glass and glazing performance, lack of high-quality modeling and a siloed approach to design and construction all impede performance goals. To meet and exceed expectations, industry experts recommend project teams clearly understand the various performance values of glass, consider the relationship between the glazing and the rest of the façade, ensure correct modeling from the start, and more.

EFFICIENT GLASS AND GLAZING

Performance values must include the glass and the framing.
The biggest misconception in glazing system performance is that it's all about the glass. Performance values for the glass must be considered in concert with values for the framing system to develop whole-system performance values. "To many, glass seems to be the most obvious factor in performance, but the opposite is true," says Anthony Intintoli, architectural sales representatives for YKK AP. "You have to find the right glazing system and framing system to achieve the desired high performance."

Look beyond center-of-glass U-factor.
Center-of-glass (COG) thermal performance values, U-factors, can't be used alone to determine the performance of a complete glazing system. "The COG U-factor makes up only part of a window's performance," says Technoform's Sanders. "It is necessary to look more broadly at the window system, including the edges: the frame and edge of glass. … You can have a great center of glass value, but if you don't match that with thermal performance in the framing, you're going to have performance issues, condensation issues."

Storefronts and curtain walls perform differently.
Framing systems are designed to meet different structural, water and air performance requirements depending on their application. These differences translate to varying high-performance methods and thermal performance targets. For example, curtain wall systems can be made wider, thus allowing for improved thermal elements such as multi-cavity insulating glass units, or larger and more complex thermal breaks. "With a storefront, you're typically not going to achieve the performance as you would with a curtain wall," says EFCO's Wignall. "You usually see pour and debridge thermal breaks in storefront; you will typically have fewer opportunities for glass in terms of thickness."

Performance and aesthetics can be at odds.
At times, performance and aesthetic goals are at odds on projects. In recent years, this has been the case with trends toward ultra-clear, less reflective glasses that can create challenges with solar heat gain and glare. "This is a big hurdle when it comes to glass performance," says Viracon's Schmidt. "It's important to work with glass suppliers to find a compromise. How much are you willing to sacrifice in terms of appearance to achieve performance goals? We can come up with solutions for a building that meets renderings but still performs."

BEYOND THE GLAZING

Connection points matter.
A project can feature the highest performing glazing system options, but if thermal performance doesn't carry over to the connection points, the façade won't meet its goals. "We see big issues around the interfaces," says Sanders. "This is where the thermal bridging happens."

To tackle the problem, Sanders recommends project teams model the interfaces. "The models have to be well detailed. They need to say who is responsible for doing what. And, we have to measure the performance—take infrared pictures of the buildings," she says.

Glass and glazing performance can't be siloed.
Next-level façade and building performance comes when glazing systems are integrated into the full building. "Every building, every façade is going to be different," says Tom Culp, code consultant for the National Glass Association and owner of Birch Point Consulting. "You have to look at everything together—the glazing with the shading. Are you going to incorporate sunshades? Automated blinds? Are you going to do things with a double wall? Are you going to tie in daylighting controls? We have to think more broadly, beyond just two panes of glass."

Automation and smart building management make a difference.
Occupants often stand in the way of performance goals. "On day one, building performance might be perfect. But that can change quickly if people in the building don't understand how it should be used—if they are not operating windows, shading, at the right times," says Selkowitz. Automated systems that control shading, lighting, HVAC and more ensure the building performs as it should. However, facility managers, as well as occupants, should be educated on why the automated systems are working as they are, Selkowitz says.

MODELING AND TESTING

Thermal modeling is complex work. Glazing system manufacturers can help.
When calculating system performance values, seek assistance of suppliers. "Many manufacturers offer advanced thermal analysis to help demonstrate the performance of framing systems," says YKK AP's Intintoli.

When completing performance calculations, it is essential to make calculations based on the specific products chosen for the system. Not all systems, despite the similarities, perform alike. "You need to be careful that you're doing good modeling, and that the actual modeling is featuring the products you're using," says Selkowitz.

Modeling software has its limits.
For most projects and glazing systems, computer modeling can provide a good general picture of glazing system performance. "If you're using off-the-shelf products—fixed external shading, or simple motorized shading—a good model run by a competent engineer should be able to do that. But, as you get into switchable glass, light shelves and other more complex systems, there is more risk involved," Selkowitz says.

Complex systems call for performance mockups and testing.
Performance modeling can only take a project team so far. For complex projects, Selkowitz recommends teams look to performance mockups that study energy and thermal performance, daylighting and occupant comfort. Doing so can identify potential problems before it's too late, he says.

ORANGE COUNTY GOVERNMENT CENTER, GOSHEN, NEW YORK

HIGH-PERFORMANCE SOLUTIONS: Built in 1967 and severely damaged by Hurricane Irene in 2011, the Orange County Government Center needed a complete revitalization. In a $74 million upgrade, the project team renovated two-thirds of the existing structure, vastly improving thermal performance of the envelope, while adding 80,000 square feet of new construction. EFCO curtain wall and storefront were selected for the renovated sections as well as the new addition. The project features EFCO Series 5600 curtain wall, 433 storefront and D502 Thermastile entrance doors.

THE PLAYERS: Architect, Clark Patterson Lee (CPL); general contractor, Holt Construction Corp.; glazing contractor, Forno Enterprises Inc.; glazing systems supplier, EFCO Corp.

CODES & STANDARDS

New updates to the energy codes continue to push for higher performing products. Increasingly, projects will need to feature glass and glazing with next-level performance attributes, such as improved framing, warm-edge spacers, argon gas fill and fourth surface low-emissivity coatings. The new code also includes stronger daylighting requirements, including demand for more controls and toplighting.

TRANSLATING CODE REQUIREMENTS TO GLAZING SYSTEM SOLUTIONS

Each new edition of the baseline energy codes brings increasingly stringent requirements for windows, particularly in terms of thermal performance. In the previous 15 years alone, ASHRAE 90.1 U-factors for windows reduced between 20 and 60 percent, depending on the climate zone.

The newest version of the baseline energy code, ASHRAE 90.1-2019, was approved in October 2019, and it continues its trend toward increased energy performance in glass and glazing systems. Among the updates include another 5 to 17 percent reduction in U-factor. In many cases, this creates roughly a "zone shift" between the 2016 and 2019 versions—what was required in Zone 7 will move to Zone 6, Zone 6 to Zone 5, etc. "This will give the industry more confidence about the practicality of the requirements. If you currently already have the product for one zone, it will not be a difficult push to provide that product in the next zone," says Tom Culp, code consultant for the National Glass Association and owner of Birch Point Consulting.

In general, the new code marks a push for improved framing, warm-edge spacers, argon gas fill and fourth surface low-emissivity coatings. The new code also includes stronger daylighting requirements, including demand for more controls and toplighting.

Looking ahead, Culp points to several code trends to watch: envelope backstops, thermal bridging requirements and verified performance.

Envelope backstops require a minimum level of envelope performance, no matter what else is done in the building. "The backstops would limit how much high-efficiency HVAC, lighting and hot water systems can be used as a trade-off against envelope components, including window area," says Culp. "These new backstops will not be in ASHRAE 90.1-2019 or 2021 IECC, but are being enacted in New York City, Massachusetts and Washington state."

Also on the horizon are thermal bridging requirements. Thermal bridging refers to the more thermally conductive—or thermally inefficient—sections or components of a system or wall. Identifying and addressing the thermal bridges on a system will improve whole-system performance. "In the New York City energy code, architects are going to have to make drawings that show all the thermal bridges with details that quantify transmission," says Dan Piselli, director of sustainability at FXCollaborative. "At first, there will be no requirement, just documentation. … In the next code cycle, they're going to have performance requirements."

Calls for verified performance will require project teams to prove their building lives up to energy and thermal performance targets after occupancy. A big driver of this is outcome-based codes. However, some developers and building owners are also adding contract clauses to withhold a portion of the payment until verified performance goals have been met. "We have started to see performance-based contracts. A team gets a base fee, and then gets more or less than that based on building performance," says LBL's Selkowitz.

HOW DO INDUSTRY COMPANIES HELP ARCHITECTS REACH PERFORMANCE TARGETS?

—YKK AP ARCHITECTURAL SALES REPRESENTATIVE ANTHONY INTINTOLI

First, we must make sure architects have identified the right glazing system for the application. For example, they should not be using a storefront system for a multi span opening. Second, we ask what level of performance is needed. If an architect is just looking to meet building codes, we can help them identify the right product that can meet that. If they are looking for higher performance, like passive house, which is becoming more popular, we will start building on the performance criteria (i.e. meeting a U-value of 0.17).

The balance that architects must strike is between application and performance. Our goal is to help them find the right glazing system to meet the performance.

HOW CAN ARCHITECTS MAXIMIZE CURTAIN WALL EFFICIENCIES AND PERFORMANCE IN THE NEW ERA OF ENERGY CODES?

—DAVID BANUELOS, MANAGER OF THE ARCHITECTURAL SERVICES DEPARTMENT AT C.R. LAURENCE.

Architects are feeling the pressure to design sustainable buildings because of ASHRAE 90.1-2019 standards and demanding local building codes like California Title 24. These energy conservation initiatives come as no surprise, seeing as buildings account for roughly 40 percent of energy usage in the United States.

Thermal performance is one of the most important considerations when working with curtain wall systems. Reducing cooling loads during the summer and heating loads during the winter is the priority. This is accomplished by mitigating heat transfer through the building envelope resulting in low U-factors.

Typical curtain walls incorporate 1-inch insulating glass and a thermal break point. In response to evolving energy codes, manufacturers are now offering 2-inch triple pane insulating glass, as well as systems with two to three thermal break points to further reduce U-factors. Triple pane insulating glass is very effective at mitigating heat transfer and is ideal for colder climates. Due to the added weight and cost, however, it's best suited for low-rise applications.

Manufacturers have found additional ways to improve thermal performance. The latest curtain wall systems incorporate a polyamide pressure plate, which is an upgrade to standard aluminum pressure plates. The polyamide plate acts as a low-conductivity thermal bridge that helps significantly reduce curtain wall U-factors.

Regarding insulating glass, customers have the option of filling it with gas to improve its thermal properties. Argon is the most common gas used in this type of application. Krypton gas is the next step up and works best where there is a thin gap between glass lites, which is the case with triple pane glazing. The most cutting-edge gas available today is xenon. It has the highest density of the insulating gasses and is very effective at reducing heat transfer. Xenon is recommended for buildings aiming to achieve LEED Platinum or Gold certification.

As previously mentioned, California Title 24 has set a new standard for energy codes, and jurisdictions across the United States are expected to follow suit. Manufacturers should verify that their curtain wall system is Title 24 compliant to ensure optimal thermal performance.

MEC HEADQUARTERS, EAST VANCOUVER, BRITISH COLUMBIA, CANADA

HIGH-PERFORMANCE SOLUTIONS: Essential to design goals for the MEC Headquarters in East Vancouver was to maximize the amount of incoming natural light to reduce energy consumption and environmental impact. CRL-U.S. Aluminum's Series HP3253 High Performance Triple Glaze Curtain Wall outfits a large portion of the building's façade. The system features dual thermal barrier technology, employing two fill and debridge pockets, and three thermal break points. This delivers potential U-factors of 0.32 to 0.17. Additional systems include CRL's Series 7200 Windows; Custom Fabricated Sunshade Systems that help minimize solar heat gain; and NFRC rated Series 750-T High Performance Thermal Doors.

THE PLAYERS: Architect, Proscenium Architecture + Interiors; general contractor, Ventana Construction Corporation; glazing contractor, Flynn Canada Ltd.; glazing system supplier, C.R. Laurence Co.

ZONE 8

Triple glazing

All of Alaska is in Zone 7, except for the following boroughs in Zone 8: Bethel, Dellingham, Fairbanks N. Star, Nome, North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, Yukon—Koyukuk

ZONE 6

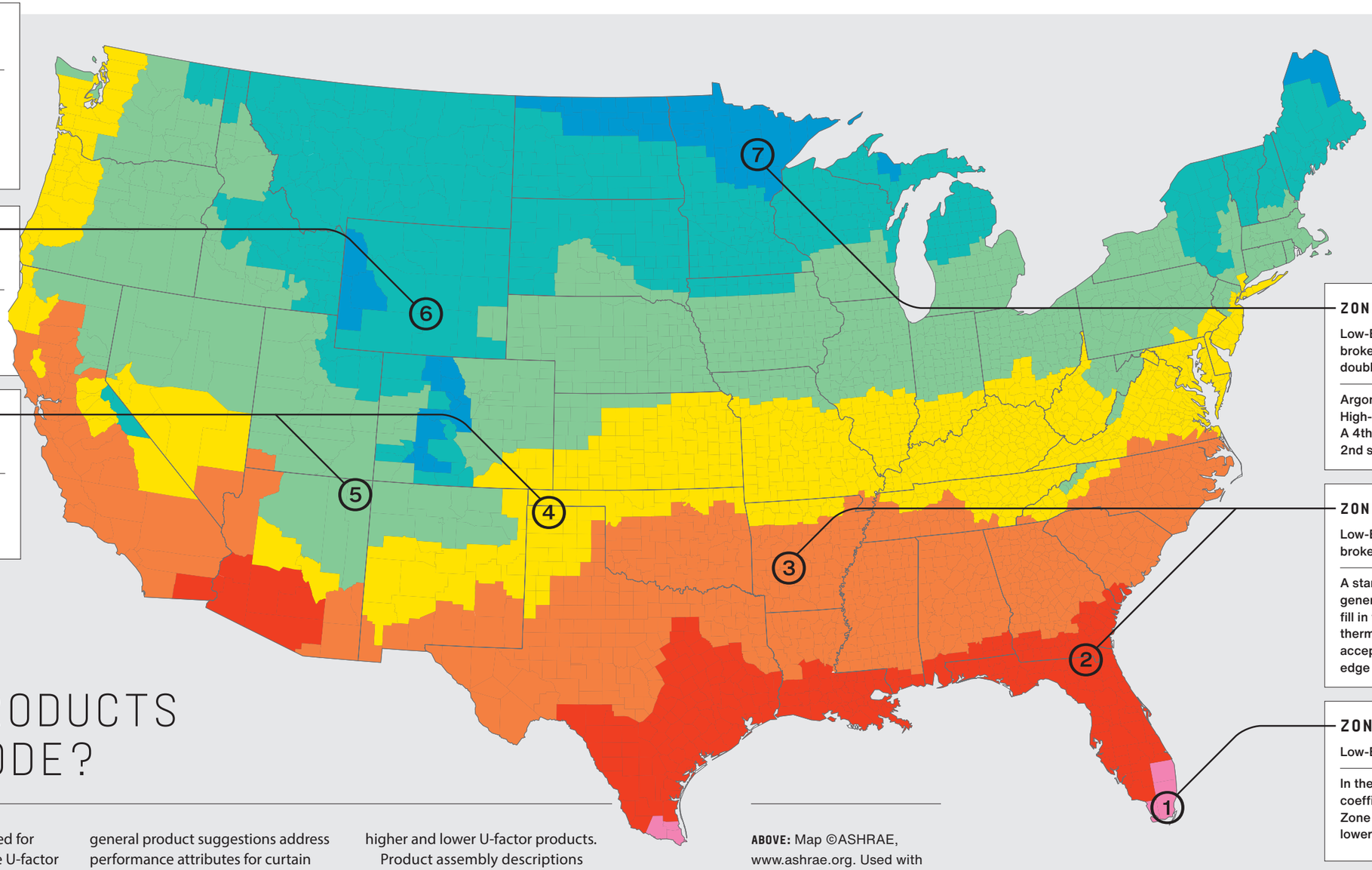
Low-E double glazing with thermally broken frame and three of the following:

Argon // Warm-edge spacer // High-performance thermal break // A 4th surface low-E (in addition to the 2nd surface low-E)

ZONES 4 5

Low-E double glazing with a thermally broken frame and two of the following:

Argon // Warm-edge spacer // High-performance thermal break // A 4th surface low-E (in addition to the 2nd surface low-E)



ZONE 7

Low-E double glazing with a thermally broken frame and all of the following, in double glazing, or move to triple glazing

Argon // Warm-edge spacer // High-performance thermal break // A 4th surface low-E (in addition to the 2nd surface low-E)

ZONES 2 3

Low-E double glazing and a thermally broken frame

A standard thermally broken frame will generally meet requirements with no gas fill in the IGU. Additionally, in Zone 2, a thermally improved frame would likely be acceptable with an argon-filled or warm-edge IGU.

ZONE 1

Low-E double glazing

In the latest update, solar heat gain coefficient requirements changed for Zone 1. Systems also will need to meet a lower SHGC of 0.23.

WHAT PRODUCTS MEET CODE?

What, roughly, will be required for glazing products to meet the U-factor requirements outlined in ASHRAE 90.1-2019?

Culp offers a general idea of the potential glazing solutions to meet U-factor requirements in descriptions above. Note, architects will also need solar control products to meet SHGC requirements. Additionally, the general product suggestions address performance attributes for curtain wall, window wall, and storefront, and, secondarily, sliding operable windows. Awning, vent and casement operable products will have more difficulty complying. In those cases, it will be necessary to add extra features, or use area-weighted averaging for the façade, which will balance out higher and lower U-factor products.

Product assembly descriptions are provided to offer a general idea of what high-performance systems might be required in the various zones. Actual U-factor and SHGC ratings will depend on the specific frame, spacer and low-E product choices. Do not rely on this for actual compliance.

ABOVE: Map ©ASHRAE, www.ashrae.org. Used with permission from 2016 ASHRAE Standard-90.1. Map has been recreated by Glass Magazine and does not include the Marine, Dry and Moist region divisions.

ONLINE: To access the complete six-part guide, “All About Glass and Metal: A Guide to Glazing for Architects and Specifiers,” visit glass.org/store.

UCLA’S MARION ANDERSON HALL, WESTWOOD, CALIFORNIA

HIGH-PERFORMANCE SOLUTIONS: The centerpiece of UCLA Anderson School of Management’s new Marion Anderson Hall is a glass-enclosed atrium flooded with natural daylighting. The atrium features $^{13}/_{16}$-inch high performance STC-rated laminated glass, which consists of ½-inch low-iron glass, a .030 PVB interlayer and a .030 acoustical PVB interlayer. The project also features a high-performance glazed exterior with Starphire insulating glass with Viracon VRE13-59 low-emissivity coating, and a thermal Arcadia T500 (OPG3000) curtain wall system. Photo by Brian Peregrina, Giroux Glass.

THE PLAYERS: Architect, Pei Cobb Freed & Partners; associate architect, Gensler; atrium glass fabricator, Glasswerks; exterior glass fabricator, Viracon; curtain wall supplier, Arcadia; glazing contractor, Giroux Glass.