Optimizing Performance in Commercial Fenestration

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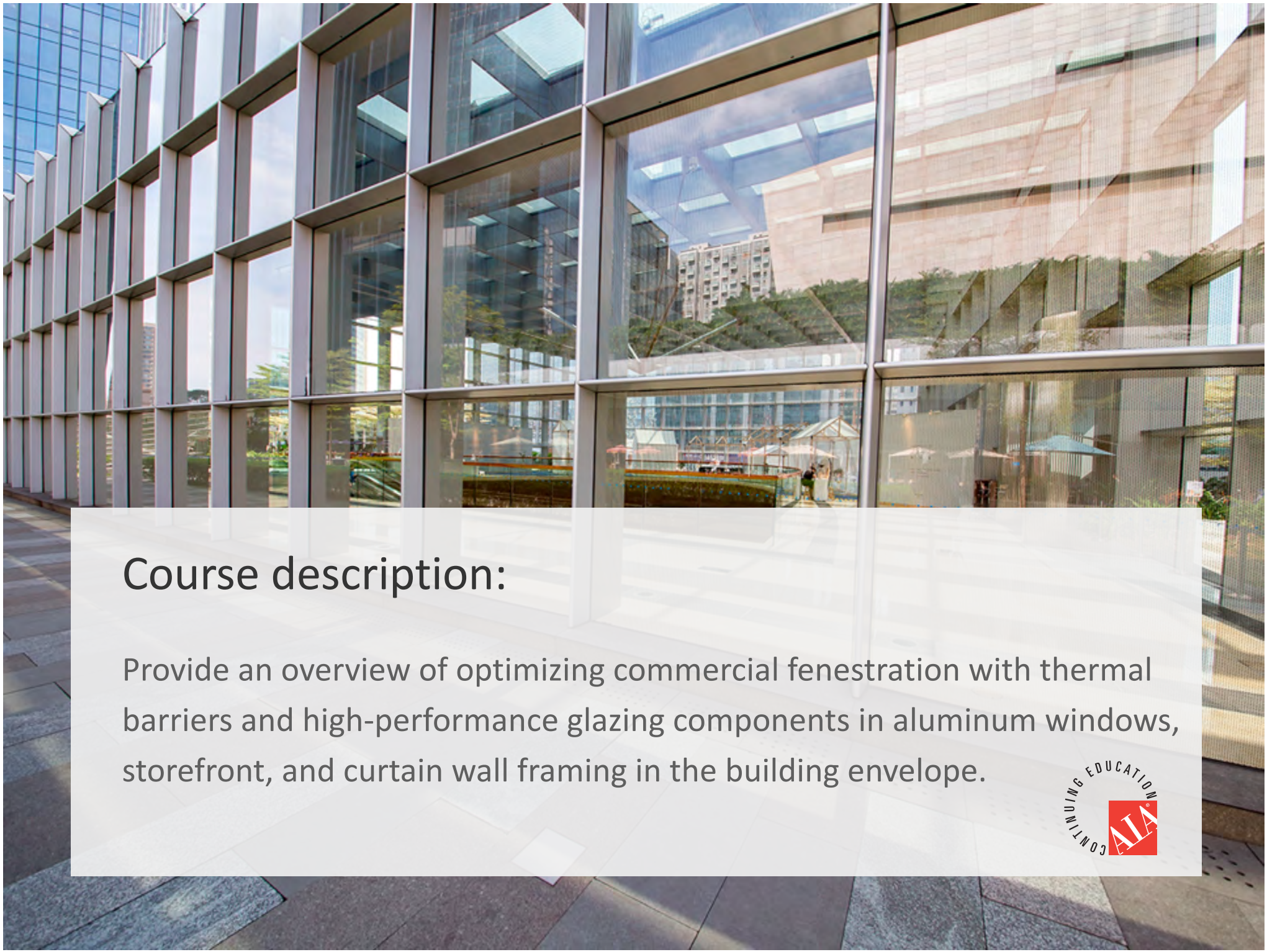


Course description:

Provide an overview of optimizing commercial fenestration with thermal barriers and high-performance glazing components in aluminum windows, storefront, and curtain wall framing in the building envelope.

Learning objectives:

1. Discuss the importance of optimizing energy efficiency in commercial buildings and initiatives to reduce energy consumption.
2. Evaluate the performance of aluminum window, storefront, and curtain wall fenestration systems in the building envelope through the application of structural thermal barriers and high-performance glazing.
3. Investigate performance and comfort-related topics in aluminum fenestration systems including material sustainability, thermal and structural performance, noise abatement and condensation resistance.
4. Observe a range of fenestration product types, measured performance outcomes, energy-savings, LEED, PassiveHouse and Cradle to Cradle℠ contribution through the use of multiple case studies.

Performance in fenestration systems

Government, NGOs*, policy makers:

Mega-trends: green awareness, sustainability, carbon footprints, net-zero energy, Title 24 – CA.gov

EPA, DOE, USGBC, ASHRAE, NFRC, IECC, LCA

*Non-Governmental Organizations

Performance in fenestration systems

Fenestration(**architecture**)

Refers to the design, construction, or presence of openings in a building.

Fenestration includes windows, doors, louvres, vents, wall panels, skylights, storefronts, curtain walls, and slope glazed systems.

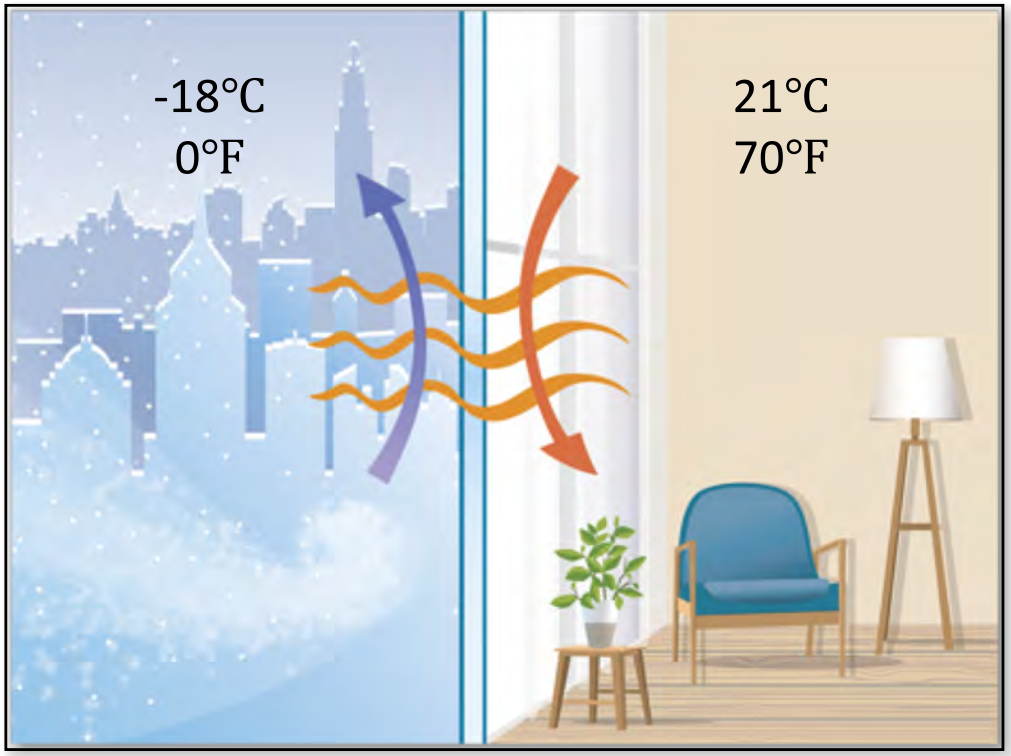
Performance in fenestration systems

U-Factor:

The rate of heat loss is indicated in terms of the *U-factor* (*U-value*) of a window assembly. The lower the *U-factor*, the greater a window's resistance to heat flow and the better its insulating properties.

Condensation Resistance Factor (CRF)

CRF numbers for windows range from 30 to 80; the higher the number, the better the window is at resisting condensation.



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Performance in fenestration systems

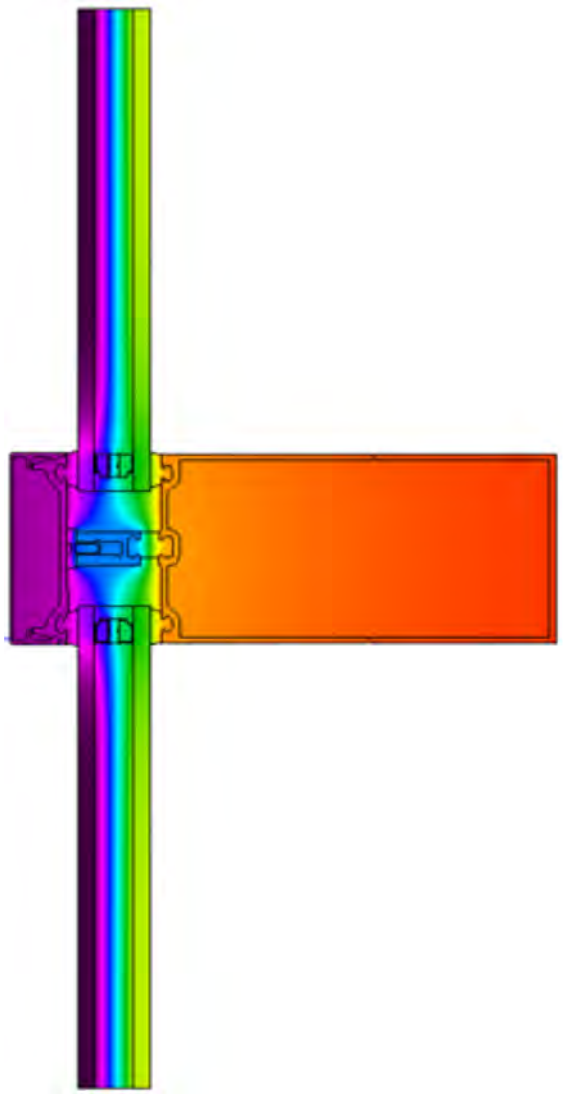
Tools for analyzing performance

WINDOW:

Berkeley Lab WINDOW is a publicly available computer program for calculating total window thermal performance indices (i.e. U-values, solar heat gain coefficients, shading coefficients, and visible transmittances).

THERM (LBNL):

Using THERM, you can model two-dimensional heat-transfer effects in building components such as windows, walls, foundations, roofs, and doors and other products where thermal bridges are of concern.

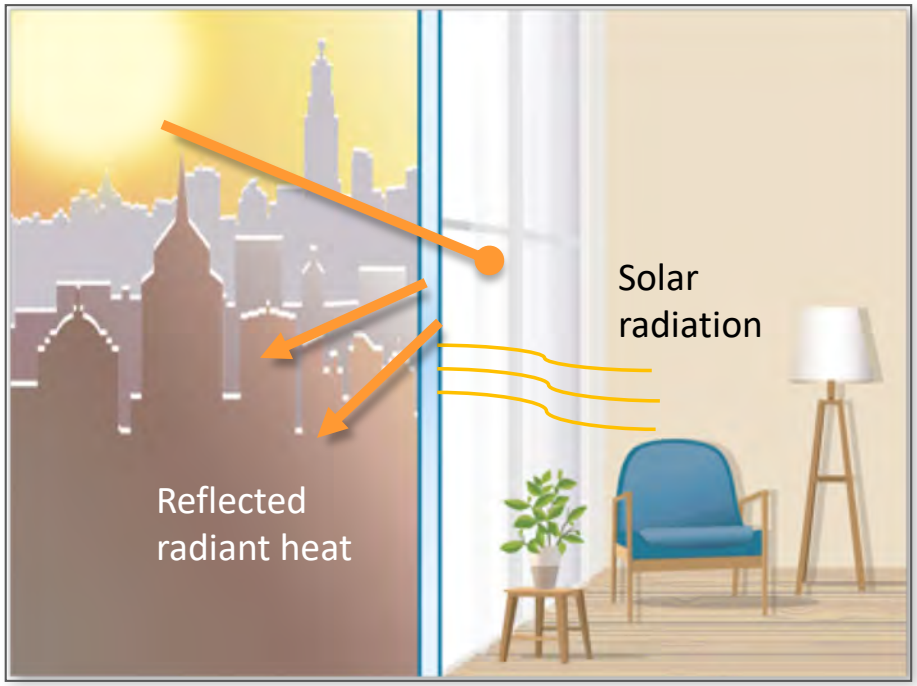


The U.S. Department of Energy (DOE)
Lawrence Berkeley National Laboratory (LBNL)

Performance in fenestration systems

Solar Heat Gain Coefficient (SHGC)

The **SHGC** is the fraction of incident **solar** radiation admitted through a window, both directly transmitted and absorbed and subsequently released inward. **SHGC** is expressed as a number between 0 and 1. The lower a window's **solar heat gain coefficient**, the less **solar heat** it transmits.



Solar heat gain can provide (free) heat in the winter but can also lead to overheating in the summer

Sound control for entire fenestration system, rather than for the individual acoustical fenestration components.

***Outdoor–indoor transmission class* (*OITC*)** is a standard used for indicating the rate of transmission of sound between outdoor and indoor spaces in a structure.

Commercial fenestration: an integration of aluminum and glazing

Aluminum for buildings is sustainable

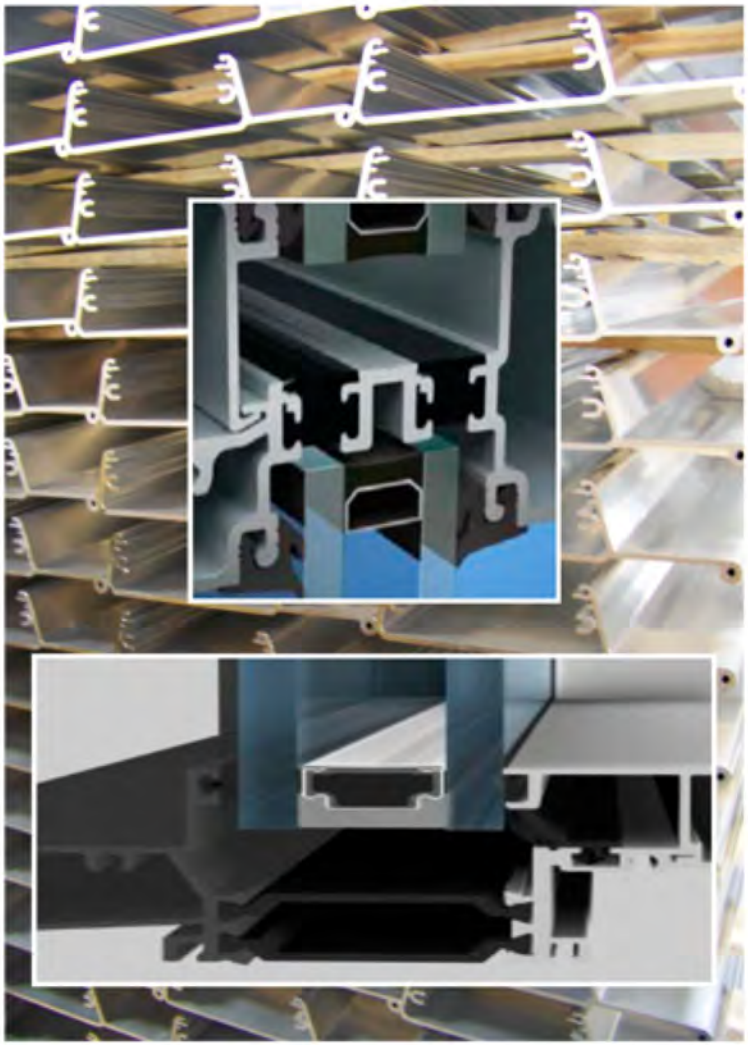
- Aluminum is 100% recyclable and it can be repeatedly recycled, retaining the same material physical properties
- Aluminum is the third most abundant element in the earth's crust next to oxygen and silicon, and the most abundant metal in nature
- A natural, durable material ideally suited for fenestration products designed to include a thermal barrier to facilitate energy savings

Aluminum Life Cycle: the never-ending story

- Aluminum frames are corrosion resistant when anodized and painted ensuring the sustainability of windows used in most environments
- Of all materials used for the fabrication of modern windows, aluminum is superior to vinyl, wood and fiberglass in absolute terms of the life cycle story
- Aluminum extrusion Environmental Product Declarations (EPDs) and Lifecycle Assessment (LCA) quantify the sustainability.

ENVIRONMENTAL PRODUCT DECLARATION **(EPDs)**

THERMALLY IMPROVED ALUMINUM EXTRUSIONS



Extrusions of aluminum with a thermal barrier, either mill finished, painted, or anodized, that are primarily used in the building and construction industry.

ALUMINUM EXTRUDERS COUNCIL

Aluminum extrusions offer engineers, architects and product designers a unique combination of attributes that can lead to outstanding product solutions. Strong, light weight, corrosion resistant, capable of complex shapes with tight tolerances and engineered performance … and infinitely recyclable, extrusions are ideally suited to today's world.

As the trade association for the North American aluminum extrusion industry, the Aluminum Extruders Council is committed to advancing extrusion technology, promoting the effective use of extrusions, and ensuring fair trade.

In producing this first AEC industry EPD, the Council and its members demonstrate their commitment to sustainability and transparency.

Visit www.aec.org for more information

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

Aluminum Extruders Council |www.aec.org

Learning objectives:

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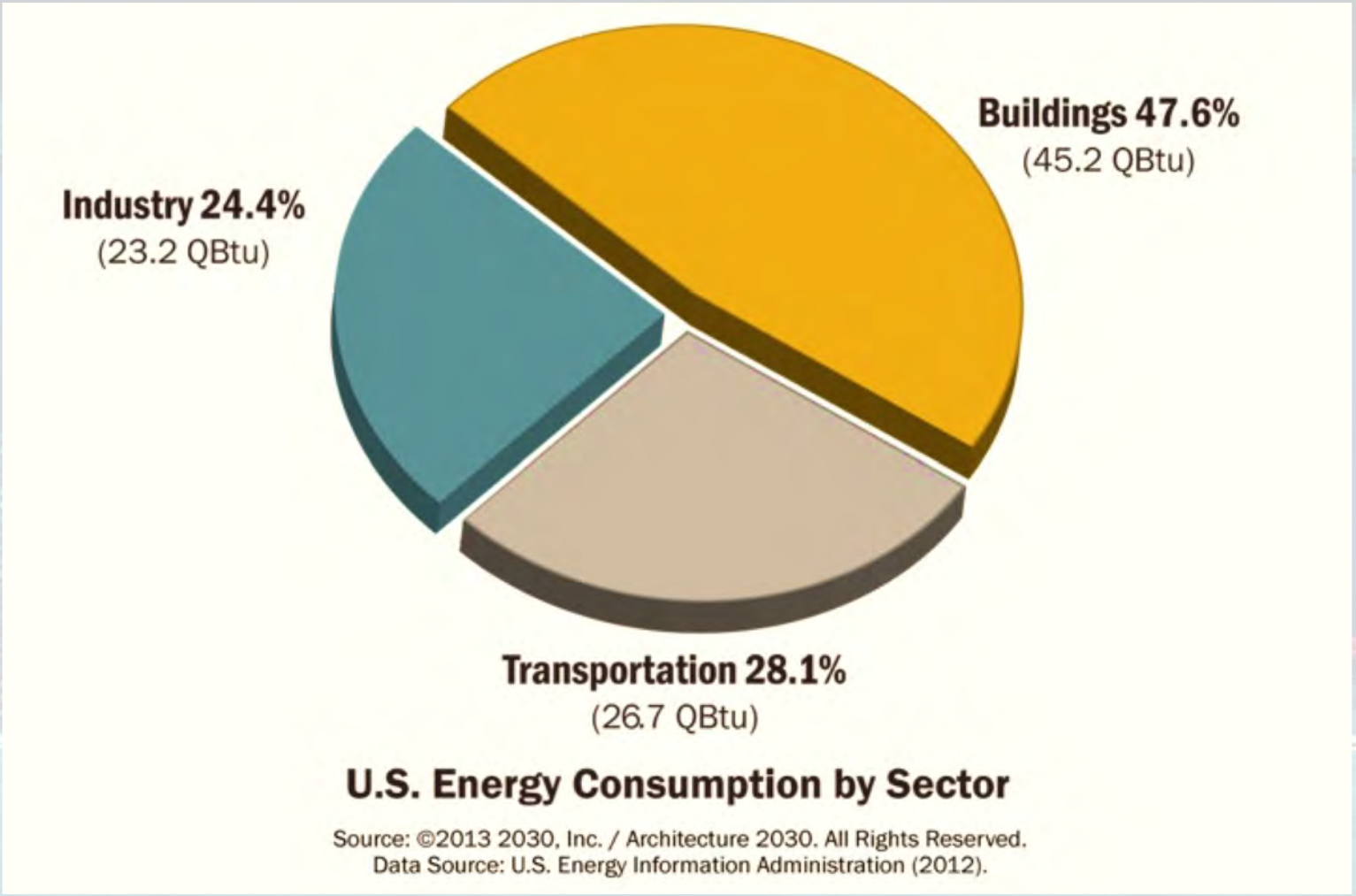
Commercial building energy consumption

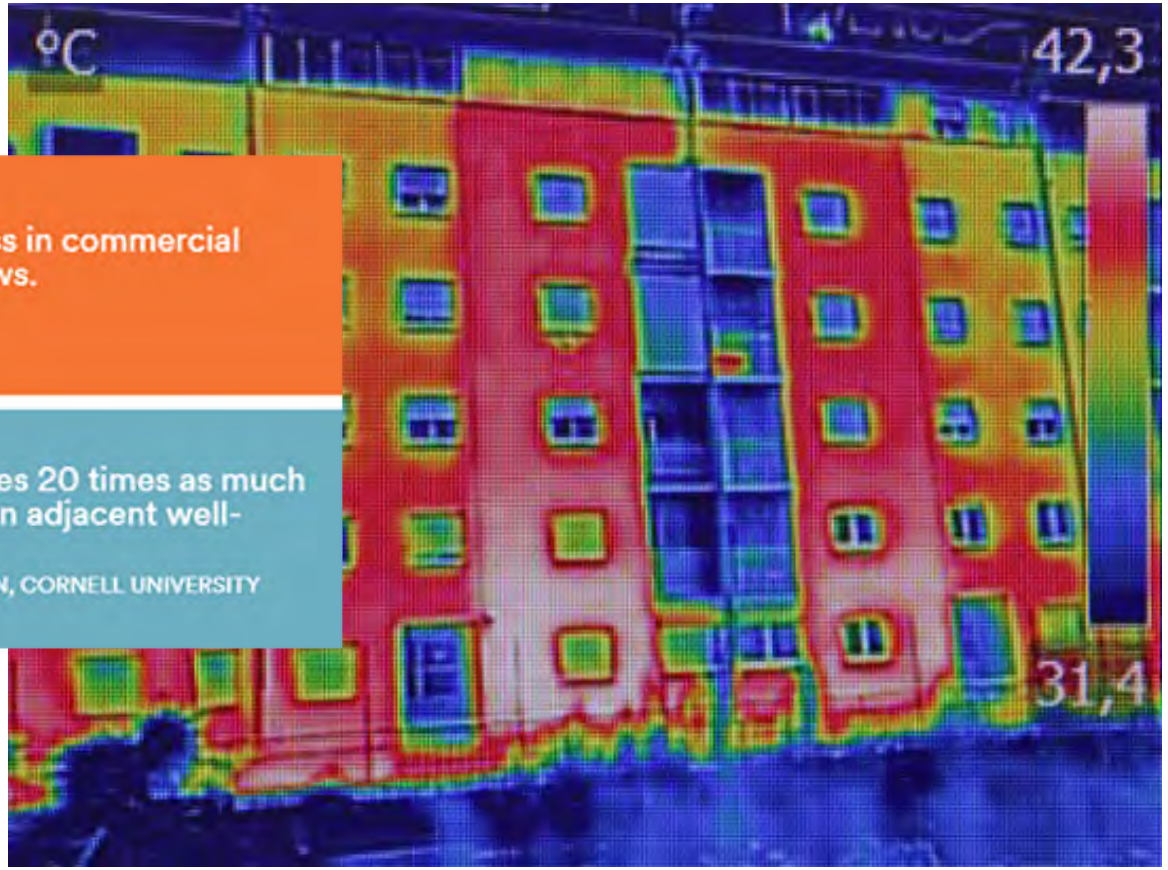
Commercial building energy consumption



Energy loss in commercial buildings

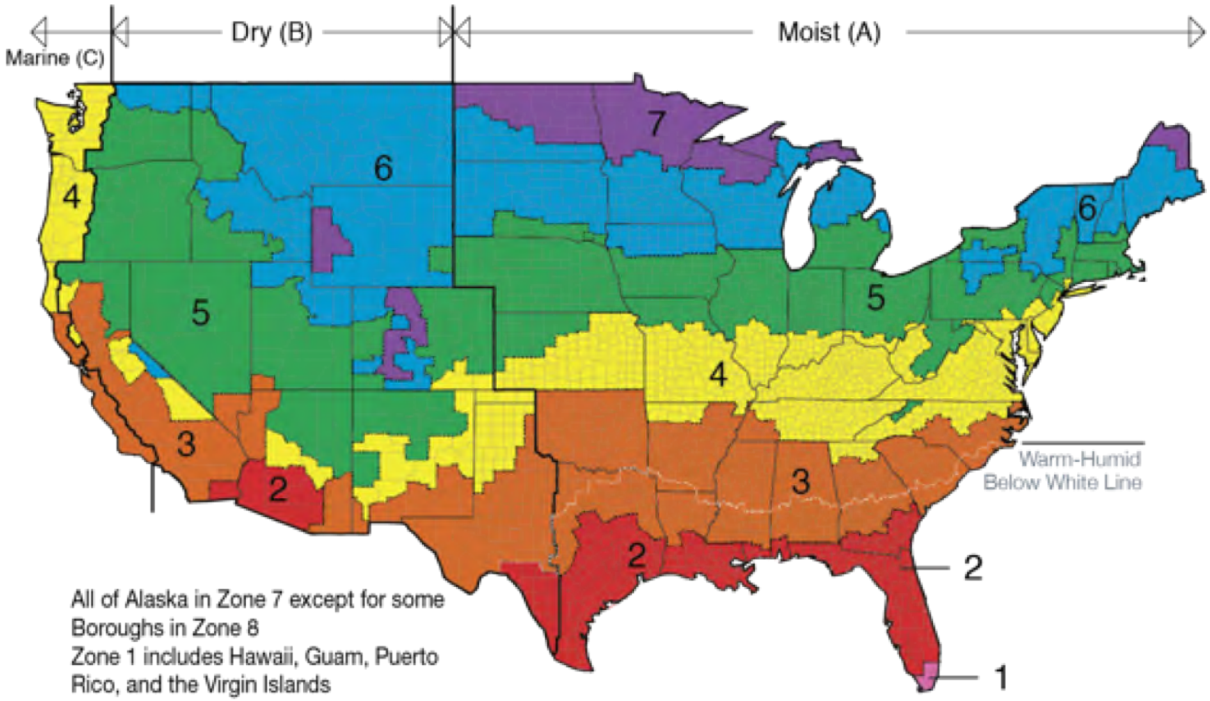
40% Nearly 40% of heating loss in commercial buildings is due to windows.
U.S. DEPARTMENT OF ENERGY

20x A single pane window loses 20 times as much heat as the same area in an adjacent well-insulated wall.
CORNELL COOPERATIVE EXTENSION, CORNELL UNIVERSITY



Infrared thermal image showing poor thermal insulation on multi-story building

2018 IECC Commercial Climate Zones



Max. U-Factor & SHGC Requirements

TABLE C402.4
BUILDING ENVELOPE FENESTRATION MAXIMUM *U*-FACTOR AND SHGC REQUIREMENTS

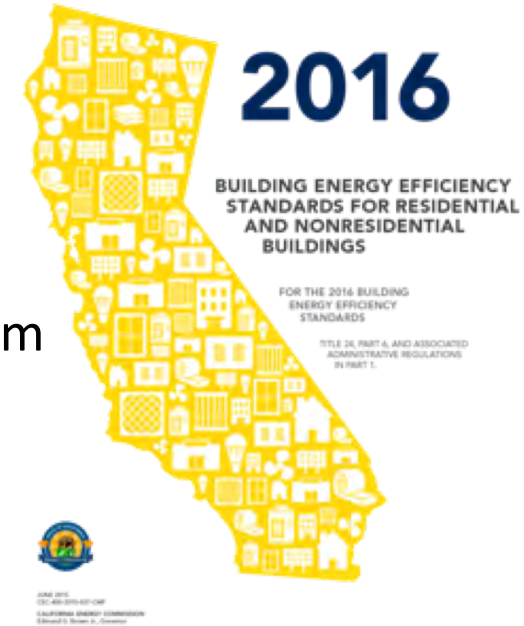
CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
Vertical fenestration																
U-factor																
Fixed fenestration	0.50		0.50		0.46		0.36		0.36		0.36		0.29		0.29	
Operable fenestration	0.65		0.65		0.60		0.45		0.45		0.43		0.37		0.37	
Entrance doors	1.10		0.83		0.77		0.77		0.77		0.77		0.77		0.77	
SHGC																
Orientation[a]	SEW	N	SEW	N	SEW	N	SEW	N	SEW	N	SEW	N	SEW	N	SEW	N
PF < 0.2	0.25	0.33	0.25	0.33	0.25	0.33	0.36	0.48	0.38	0.51	0.40	0.53	0.45	NR	0.45	N
0.2 ≤ PF < 0.5	0.30	0.37	0.30	0.37	0.30	0.37	0.43	0.53	0.46	0.56	0.48	0.58	NR	NR	NR	NR
PF ≥ 0.5	0.40	0.40	0.40	0.40	0.40	0.40	0.58	0.58	0.61	0.61	0.64	0.64	NR	NR	NR	NR
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	

CONTINUED: TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				All Climate Zones			
				Fixed Window	Operable Window	Curtainwall or Storefront	Glazed Doors[2]
Envelope	Fenestration	Vertical	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
				Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%		40%			
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	
				Max SHGC	0.25	0.25	NR	
			Area-Weighted Performance Rating	Min VT	0.49	0.49	0.64	
			Maximum SRR%		5%			

CALIFORNIA ENERGY COMMISSION

Title 24:
Building Energy Efficiency Program



Advantages of aluminum fenestration

Aluminum windows are able to provide all these benefits:

- High strength to weight ratio
- Excellent structural performance
- Narrow sightlines
- Environmentally friendly
- Unlimited color finish options
- LEED certification* *(Leadership in Energy and Environmental Design)*
- Catastrophic events: hurricane, blast, tornado, intrusion

Imagine: no insulating barrier against energy loss

Non-insulating
single glass

Non-thermal
aluminum frame

Thermal conductivity:

The ability of a material to transmit heat.

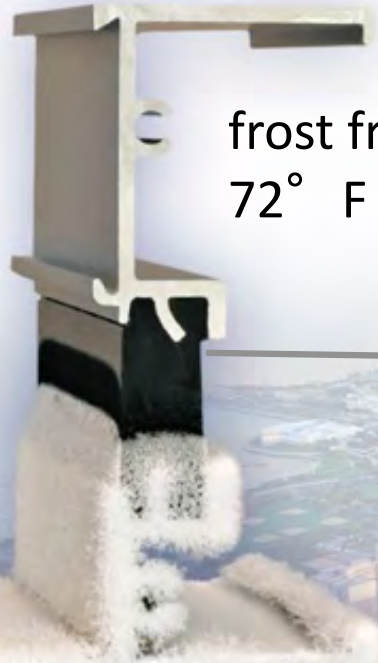
The higher the number, the easier it is for heat to transmit.

Conductivity: great for beverages

The thermal conductivity of aluminum is **1,109**

. . . poor for buildings

Role of thermal barriers



frost free at
72° F (22° C)

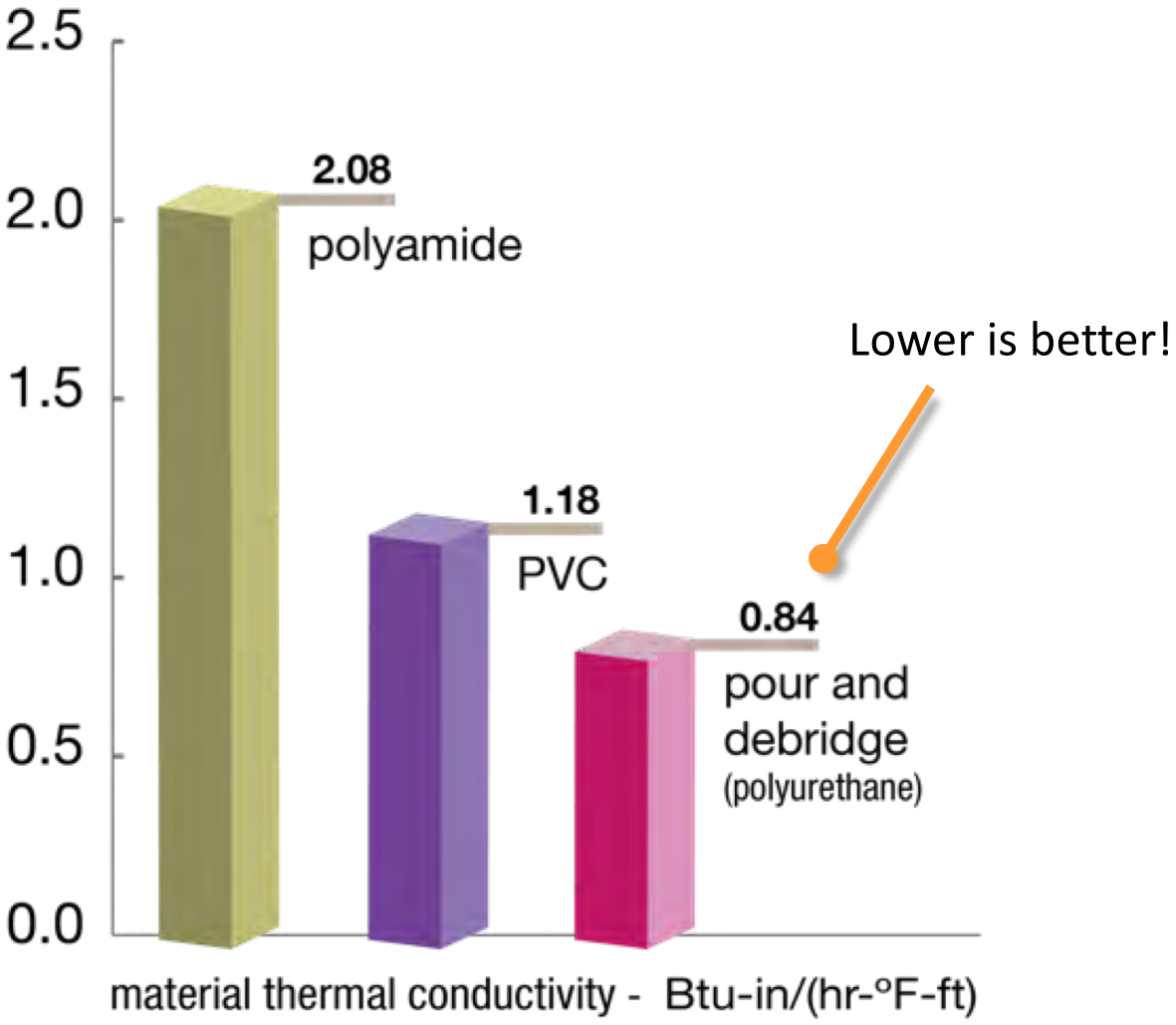
thermal
barrier

frost forms
easily on the
aluminum frame

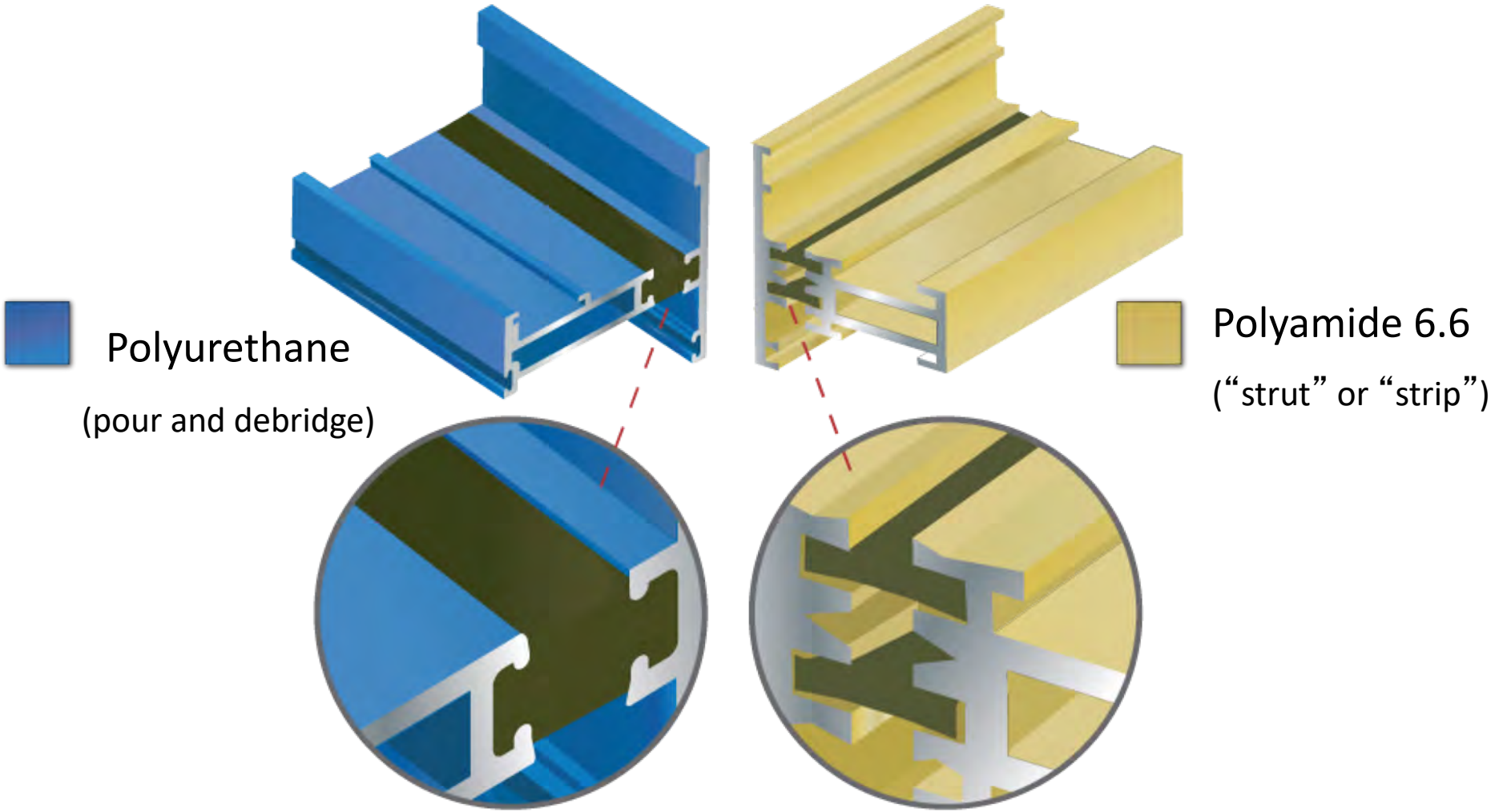
dry ice at -148° F (-100° C)

Thermal conductivity

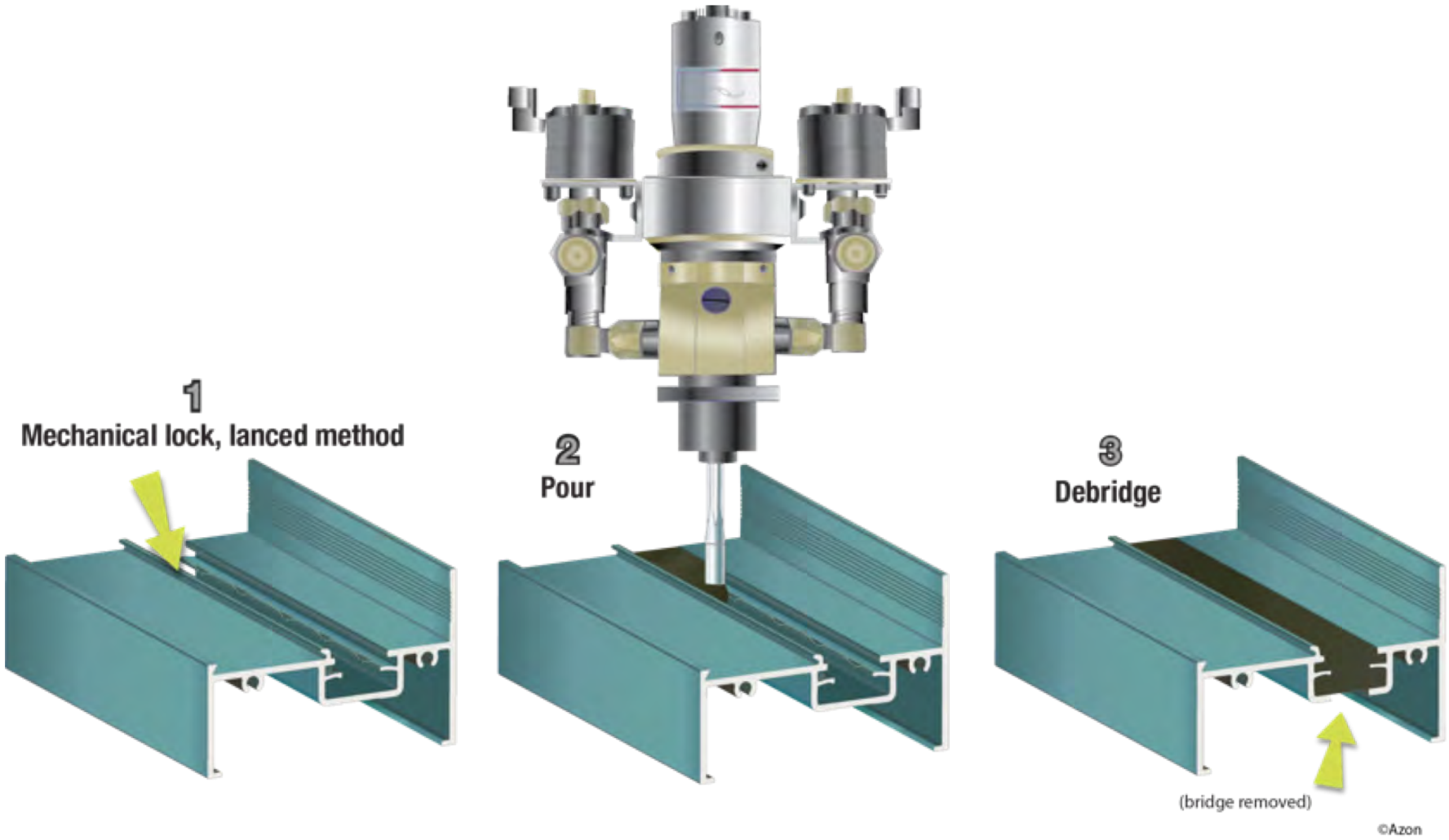
(The rate of transfer of *heat* through a given material)



Thermal barrier types and comparisons



Thermal barrier fabrication: pour and debridge



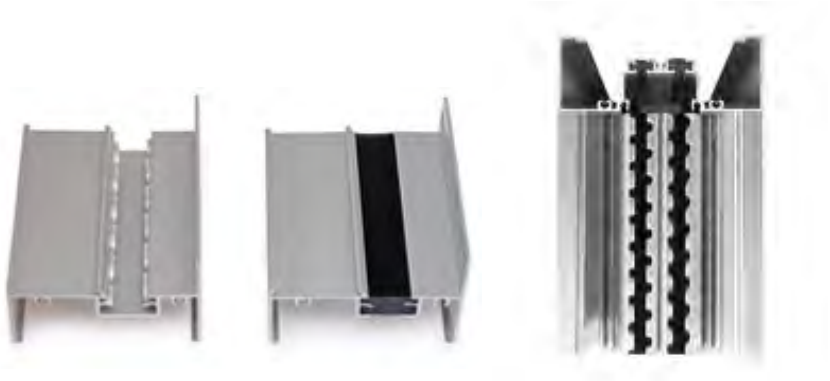
Mechanical locks improve structural strength

Method #1

Abrasion hooks improve the adhesion between the polyurethane polymer and the surface of the thermal barrier pocket in the aluminum window extrusion.

abraded method

Method #2

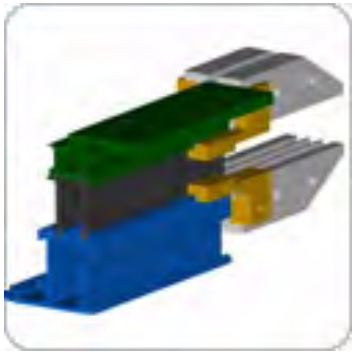


lanced method

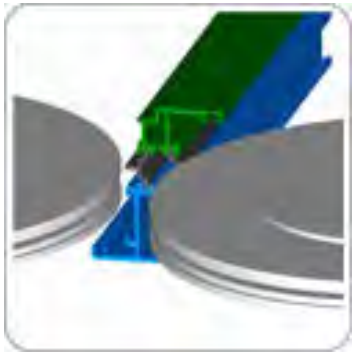
Lanced indentations mechanically lock the thermal barrier polymer in place to ensure maximum adhesion of the thermal barrier to durable architectural finishes.

Thermal barrier fabrication: strut (or strip system)

Knurling. Knurling is the first step in the production process.
It is performed to produce teeth in the aluminum pocket that will “bite” into the Strut during the crimping process. Proper knurling is required to insure adequate shear strength of the composite profile.



Insertion. Prior to struts being inserted they are properly selected and verified against the production paperwork.



Crimping. The crimping process uses three sets of wheels which rotate the aluminum on to the strut to crimp it into place, forming the bond between the two extrusions and the strut.

Thermal barrier types

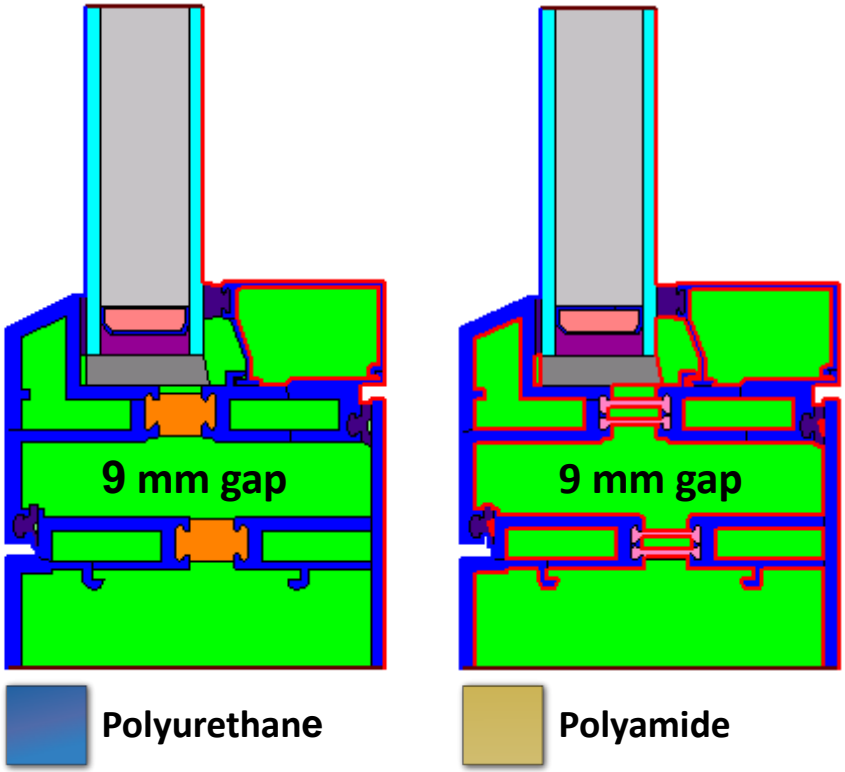
Polyamide
Strips (2)

Polyurethane

Keys to thermal efficiency:

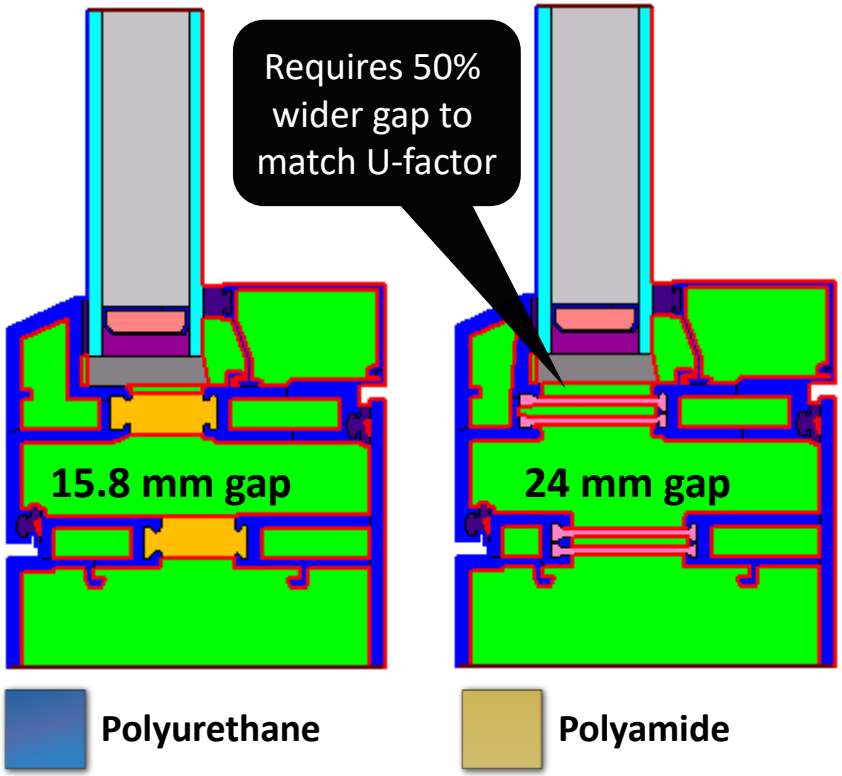
Thermal conductivity and separation of the aluminum

Similar thermal gap:



U-factor=0.43 U-factor=0.44

Same U-factor, dissimilar gap:



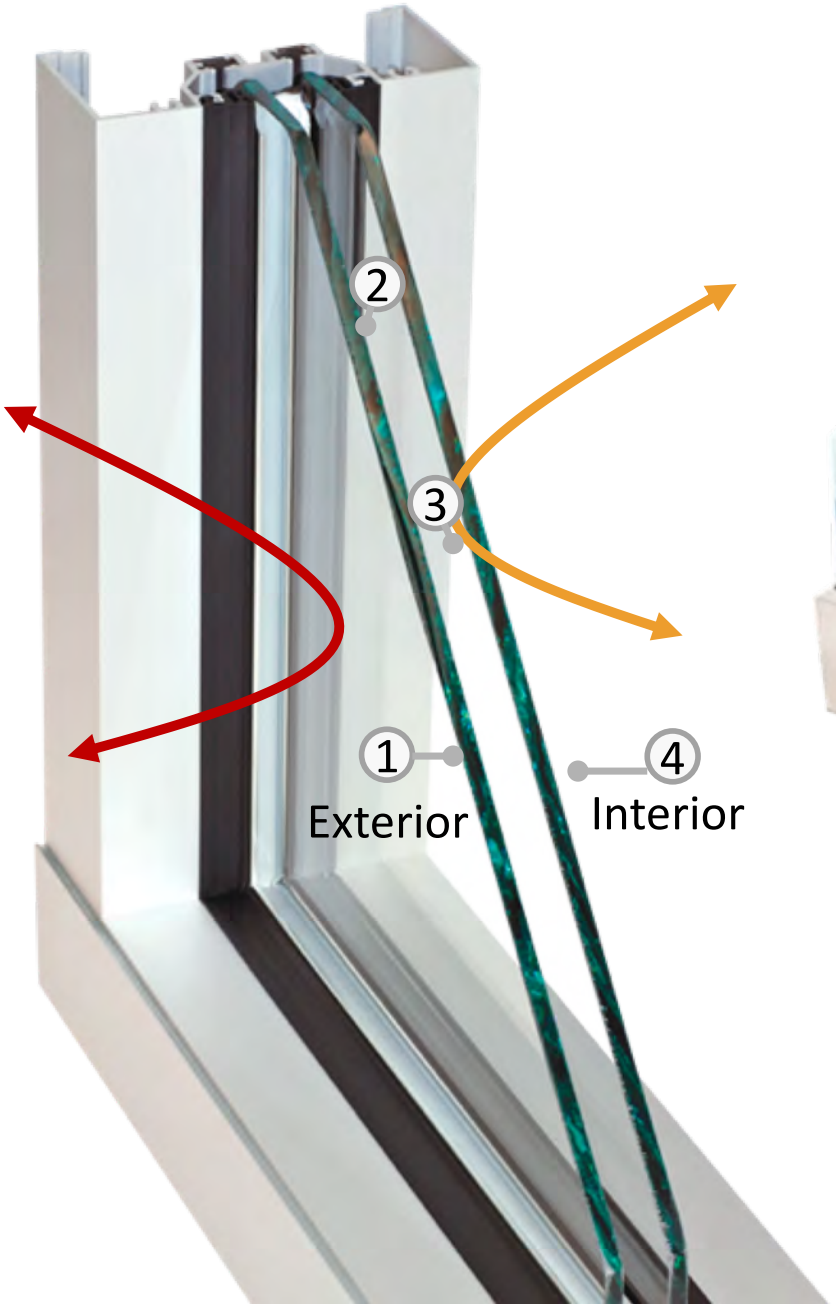
U-factor=0.39 U-factor=0.39

Insulating glass for commercial buildings

Low-E coating on surface ② helps reflect heat to the outside, reducing solar heat gain and cooling costs

Low-E coating on surface ③ reflects infrared heat back into interior space reducing heating costs

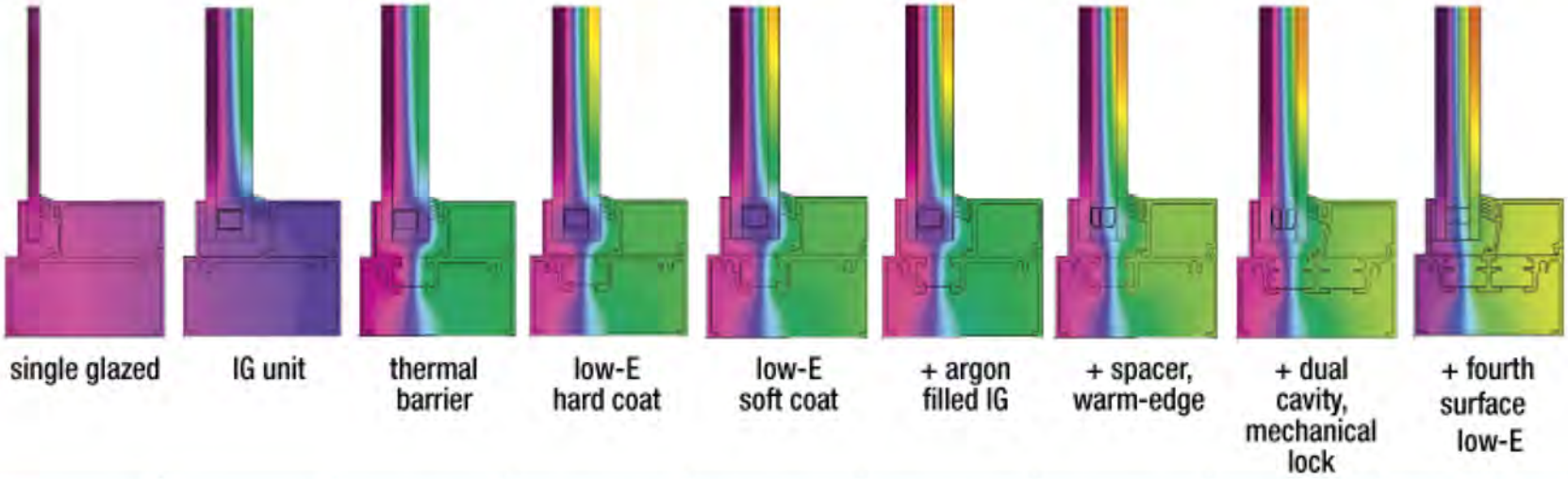
Some IGU will have **Low-E** on surface ④



Low-E with gas filling outperforms clear glass, triple-glazing outperforms both—with some trade-offs

Changes in fenestration performance over time

innovation timeline



	1950	1960	1970	1980	1990	2000	2005	2010	2015
U-factor	1.00	0.66	0.50	0.44	0.41	0.39	0.37	0.32	0.29
Condensation Resistance*	16	28	52	54	55	56	61	65	64
U-cog (Btu/h ft²F)	1.03	0.49	0.49	0.36	0.29	0.24	0.24	0.24	0.20

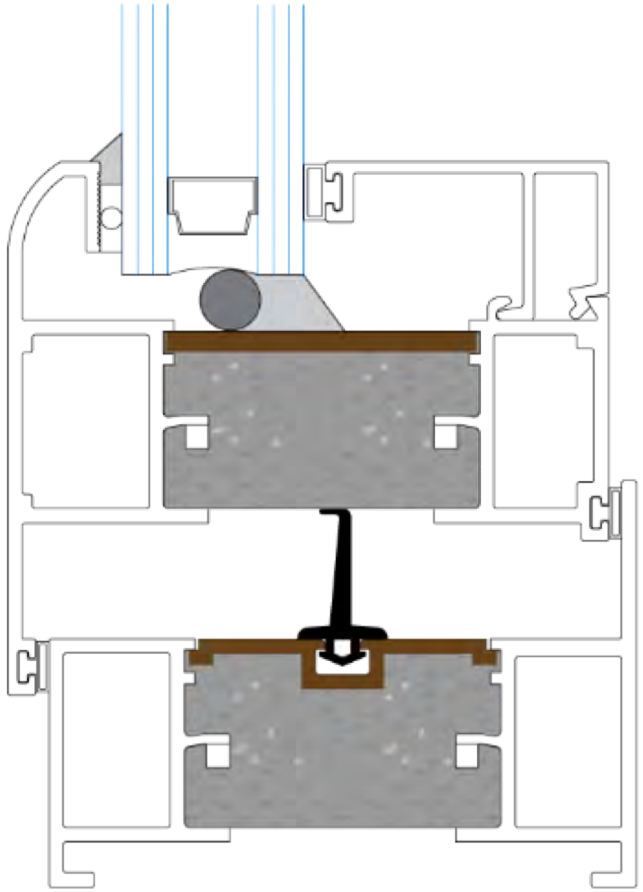
Image courtesy of ©Azon

THERM and WINDOW are trade names of Lawrence Berkeley National Laboratory

High-density polyurethane foam

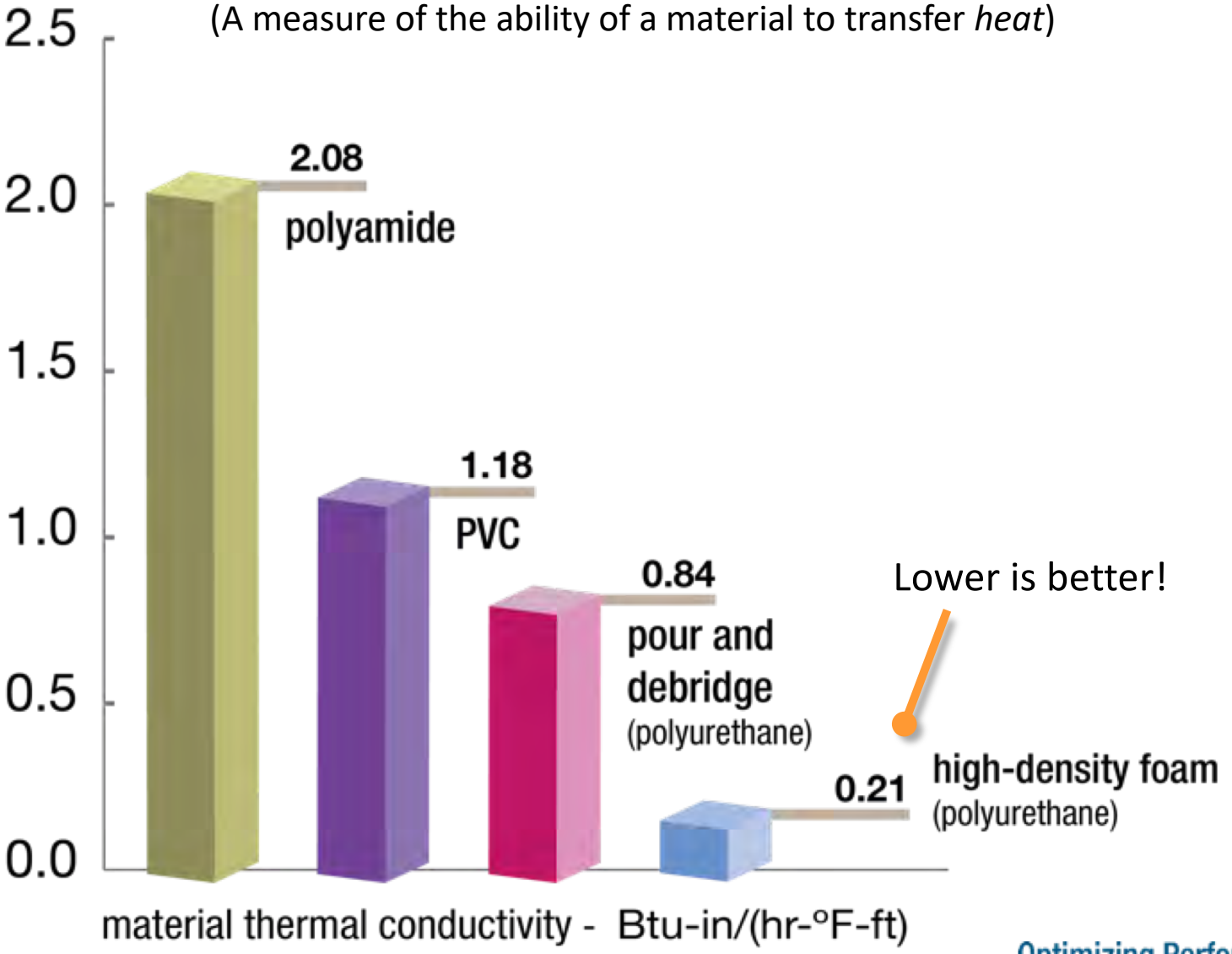
significant performance improvement

- High-density polyurethane foam core for commercial windows and doors
- *Major breakthrough* in thermal performance for aluminum fenestration products.
- Thermal barrier system with the lowest conductivity
- Meeting stringent global energy standards including Energy Star, PassiveHouse, and International Energy Conservation Code (IECC).



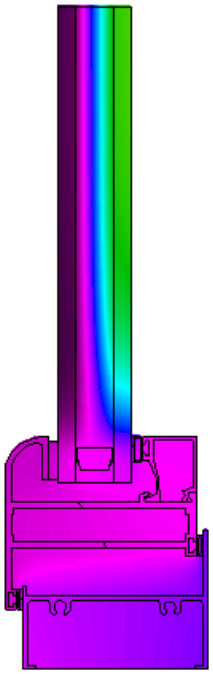
Thermal conductivity

(A measure of the ability of a material to transfer *heat*)



Changes in commercial fenestration performance over time

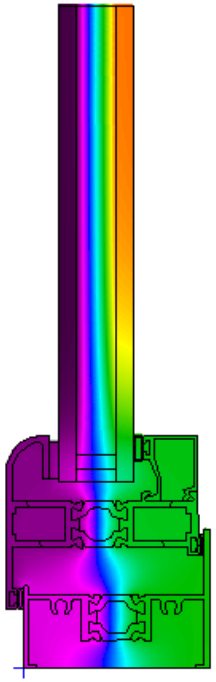
Non- thermal



OVERALL U-FACTOR
.75 Btu/Hr-ft²-°F

Glazing = 1”-6mm Clear Glass
½” Alum. Spacer/Air
6mm Clear Glass

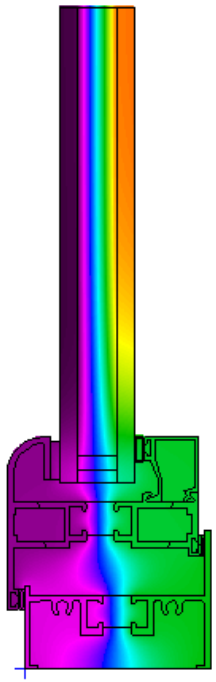
Polyamide



OVERALL U-FACTOR
.41 Btu/Hr-ft²-°F

Glazing = 1”-6mm Low-E Glass
½” Warm Edge Spacer/Argon
6mm Clear Glass

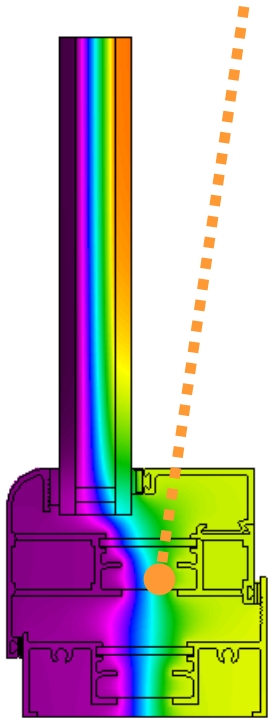
Polyurethane
(pour and debridge)



OVERALL U-FACTOR
.39 Btu/Hr-ft²-°F

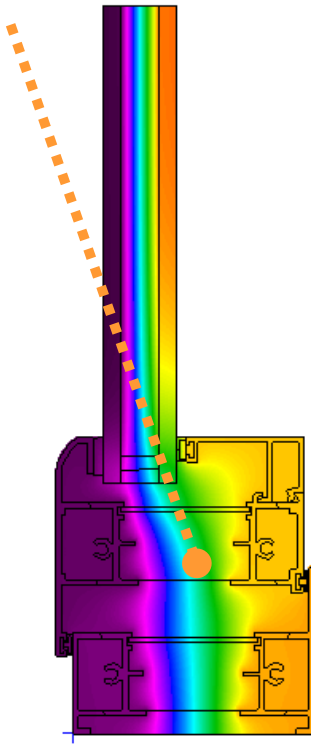
Glazing = 1”-6mm Low-E Glass
½” Warm-Edge Spacer/Argon
6mm Clear Glass

High-density
polyurethane foam



OVERALL U-FACTOR
.34 Btu/Hr-ft²-°F

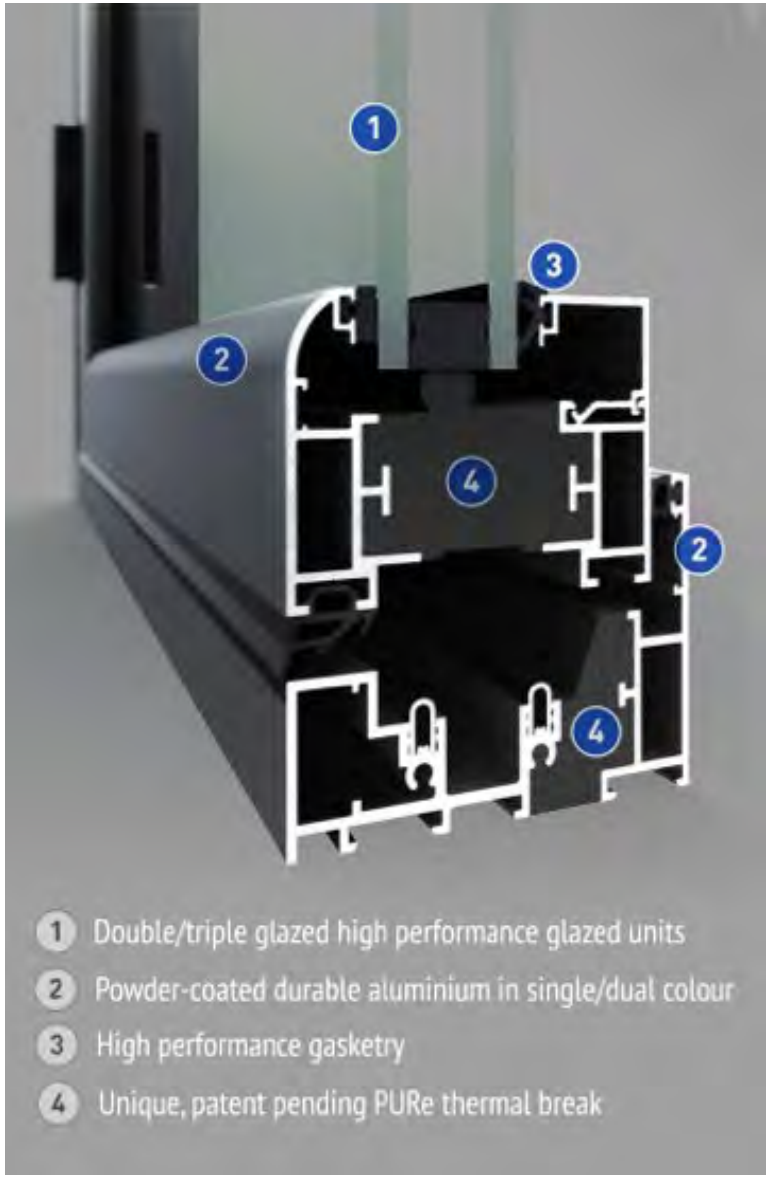
Glazing = 1”-6mm Low-E Glass
½” Warm-Edge Spacer/Argon
6mm Clear Glass



OVERALL U-FACTOR
.29 Btu/Hr-ft²-°F

Glazing = 1”-6mm Low-E Glass
½” Warm-Edge Spacer/Argon
6mm Clear Glass

Creative and innovative product



High-density polyurethane foam

After two year of intense research, the largest, privately-owned provider of fenestration solutions in the UK develops high-density polyurethane foam thermal barrier to cope with extreme weather conditions.

- Simple, cost effective and lowest U-Factor
- 100% recyclable and has been designed to meet the Passivhaus (Europe)standard.
- Green Guide rating of ‘A’ for use in commercial projects and a life expectancy in excess of 40 years
- Able to receive double or triple glazing up to for maximum thermal and acoustic performance

Manufacturer: Senior Architectural Systems (UK)

Creative and innovative product

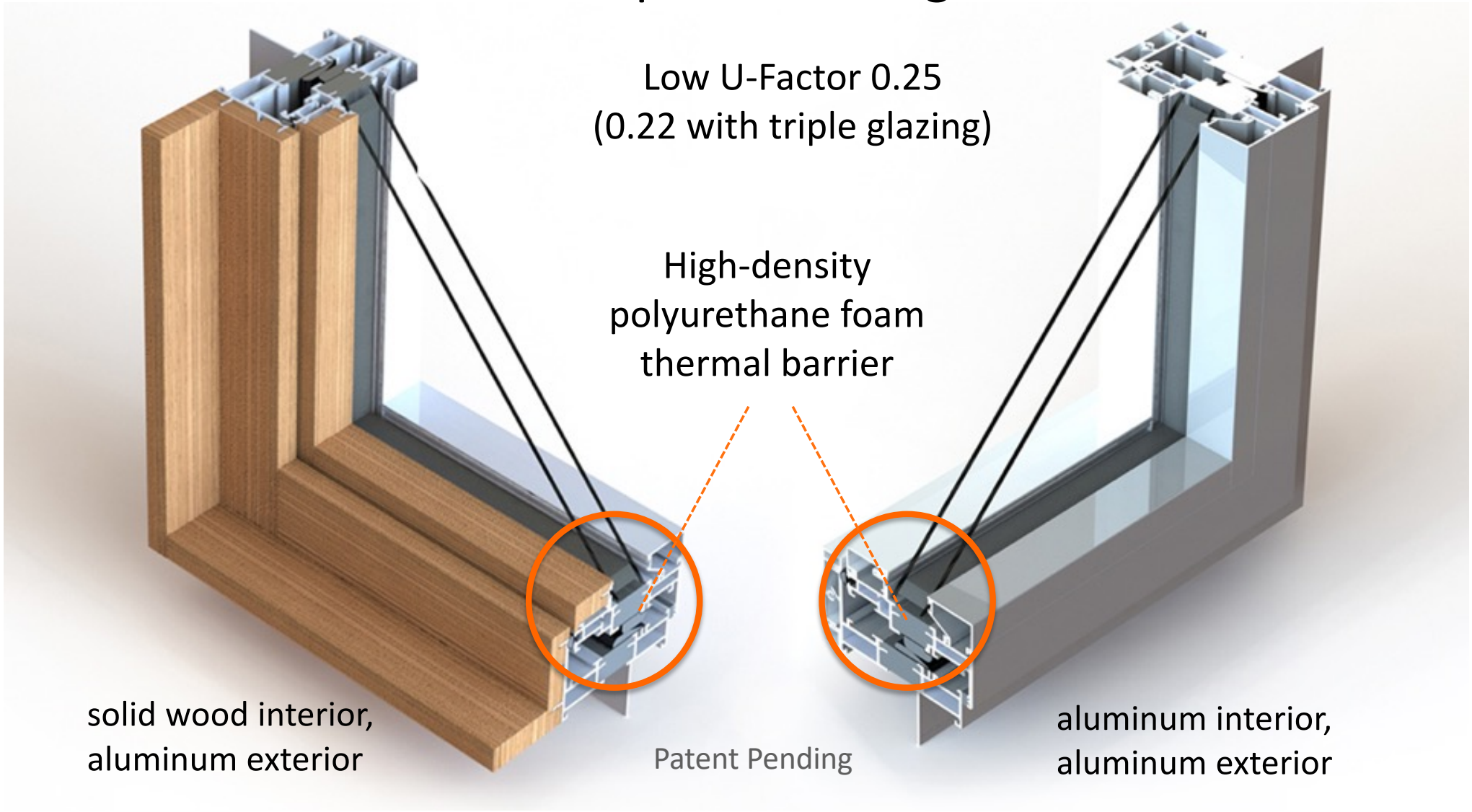
Introduced in 2016 at a major UK Window and Door Expo

Rigorous Passivhaus standard for residential windows in the United Kingdom states:
U-Factor must be 0.80 W/m^2*K (0.14 Btu*in/h*ft^2*F) or below.

- Triple glazed casement = 0.80
- Triple glazed fixed = 0.77

Utilizing high-density polyurethane foam thermal barrier

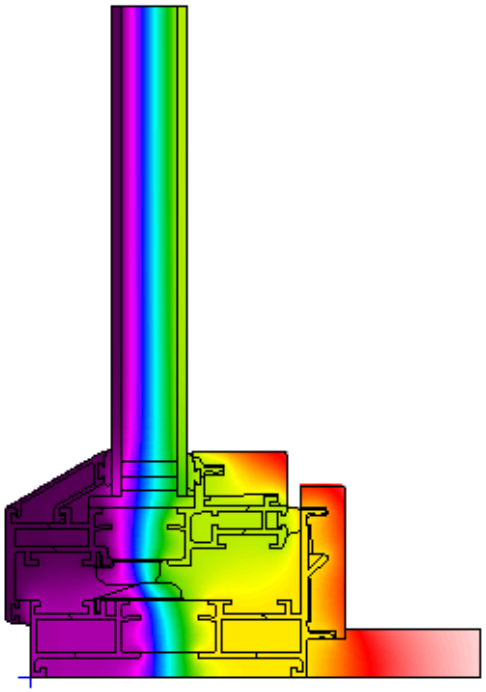
Creative and innovative product design



Manufacturer: Quaker Window

Comparing U-factor of casement or awning windows

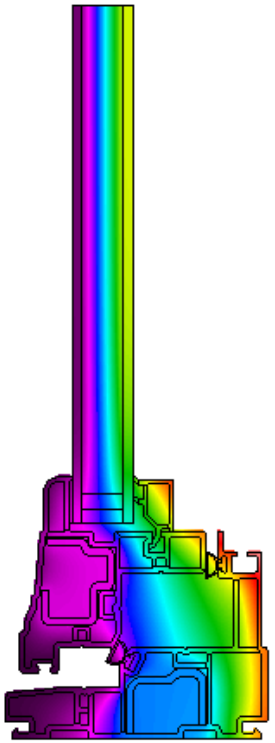
Aluminum clad wood casement with polyurethane foam thermal barrier



Casement U-factor - .25 Btu/hr-ft² - F
Awning U-factor - .25 Btu/hr-ft² - F

Glazing = 1” IG
- 3mm 366 Low-E –
- ¾” Super Spacer + Argon
- 3mm I89 Low-E

PVC casement



Casement U-factor - .23 Btu/hr-ft² - F
Awning U-factor - .25 Btu/hr-ft² - F

Glazing = 3/4” IG
- 3mm 366 Low-E
- 1/2” Super Spacer + Argon
- 3mm I89 Low-E

CASE STUDY

Pure Michigan

Fixed and operable windows provide natural light in the summer and maximum energy efficiency during Michigan's long, cold winters.

Photos: todd zawistowski | tzawistowski.com

Midcentury Modern *(renovation)* thermal barrier window wall

Location: **Glen Lake Michigan**

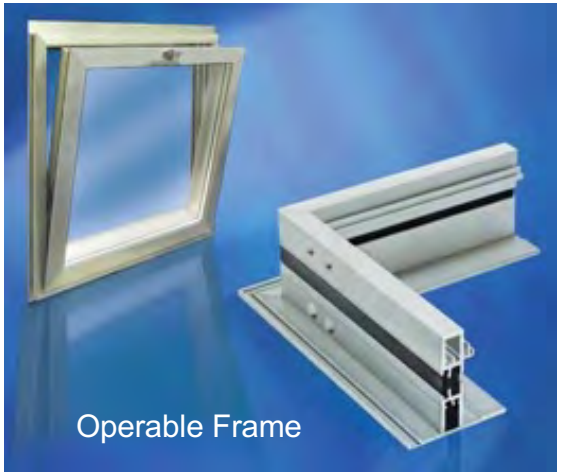
Architect: **Ray Kendra,** *Environment Architects*

Manufacturer: **Western Window Systems**

- Series 600 Window Wall
- Series 670 Casement and Awning
- Series 900 Hinged Door

Storefront, window and curtain wall systems

High performance thermal barrier windows, storefront and curtain wall systems are available in dual or single cavity designs



Storefront, dual cavity

Storefront, single cavity

Curtain wall, dual cavity

Curtain wall, single cavity

Window Project: Empire State Building

Opened in 1931

Worlds tallest building at the time

Steel framed windows with single pane glass

1994 renovation

- 5,460 new windows
- Polyurethane thermal barrier
- Insulating glass
- Project cost $5.5mm
- Annual energy savings $948,000
- Payback period 6 years

ENERGY USER NEWS

NEWS FOR BUILDING MANAGERS & ENGINEERS

VOL. 19 NO. 11 • NOVEMBER 1994 • $7.00

Windows Save Empire State Bldg. $948K

By JENNIFER A. GORDON

NEW YORK—A 5,460-window retrofit that was completed in June at the Empire State Building here is expected to cut the facility's annual energy costs by at least $948,000.

The project is the first of three phases during which all the building's windows will be replaced, according to Charles Guigno, director of operations for the Empire State Building and vice-president of property management firm Helmsley-Spear Inc. The entire $5.5 million project cost was paid from the capital budget and received no utility rebates, he noted.

The new windows are expected to cut the 102-floor, 2.25 million-square-foot office building's annual electricity costs by at least $848,000, Guigno told EUN, adding that electricity consumption is expected to drop by 6,974,311 kilowatt hours a year. In addition, the window replacement is expected to cut costs for steam purchased from local utility Consolidated Edison by about $100,000 a year, he continued. Yearly steam savings are expected to total 10,764,000 pounds.

The savings estimates represent a 16 percent reduction in energy consumption and costs, Guigno observed. However, he claimed the projections are conservative and savings could actually approach 25 percent. Based on the most conservative estimate, payback would be achieved in about six years.

Phase 1 of the retrofit involved installing 5,460 TR-9000 heavy commercial double-hung windows by Traco, Pittsburgh, Pa. The 60-by-85-inch aluminum-frame windows utilize one-inch-thick insulated tempered safety glass, according to Dell Granlund, Traco's special projects manager. The TR-9000 has an R-value of 1.6, while the building's original single-pane windows had an R-value of 1.4. The new windows can also be tilted in to allow them to be washed from inside the building, Granlund noted.

continued on page 6

In the first portion of a three-phase retrofit, owners of New York's Empire State Building replaced over 5,000 windows with energy-efficient models that are expected to provide steam and electricity cost savings amounting to almost $1 million a year.

Retrofits Cut Elec. Use by 32MMKwh/Yr.

By MIKE RANDAZZO

FORT POLK, La.—Thanks to a shared savings deal, Fort Polk Army Base here expects to

NEW CONSTRUCTION PROFILE: SCHOOLS

District to Use New Bldgs. as Future Models

By KESSEL L. NELSON

SPOKANE—Three new energy-efficient elementary school buildings completed here in February will be used as templates for future facilities built by Spokane School District 81.

Hamblen, Logan, and Stevens Elementary Schools

PSI Opens Wheeling Tariff to 25 Users

PLAINFIELD, Ind.—PSI Energy here has told 25 large customers they qualify for a transmission tariff that lets them buy power from other suppliers. Rider 19 was created in connection with a contract signed with Newcor Steel in 1990 a spokeswoman said.

Each Rider 19 contract must be negotiated individually. It is open to users with at least five megawatts (Mw) of nonfirm load at one location. PSI can wheel a total of up to 300 Mw at Rider 19 rates. Minimum contract term is 10 years, with five years' termination notice.

"This would have been a greater act of courage for a more expensive utility," she admitted; PSI has an industrial rate around three cents a kwh. "We're doing this because our largest customers told us they want choice. The utilities who will succeed in a more competitive world will be the ones who are good at serving customers. We have to learn to operate more like a business and Rider 19 will allow us to gain valuable experience in dealing with the day-to-day realities of competition. We think end

CASE STUDY

Waldorf Astoria

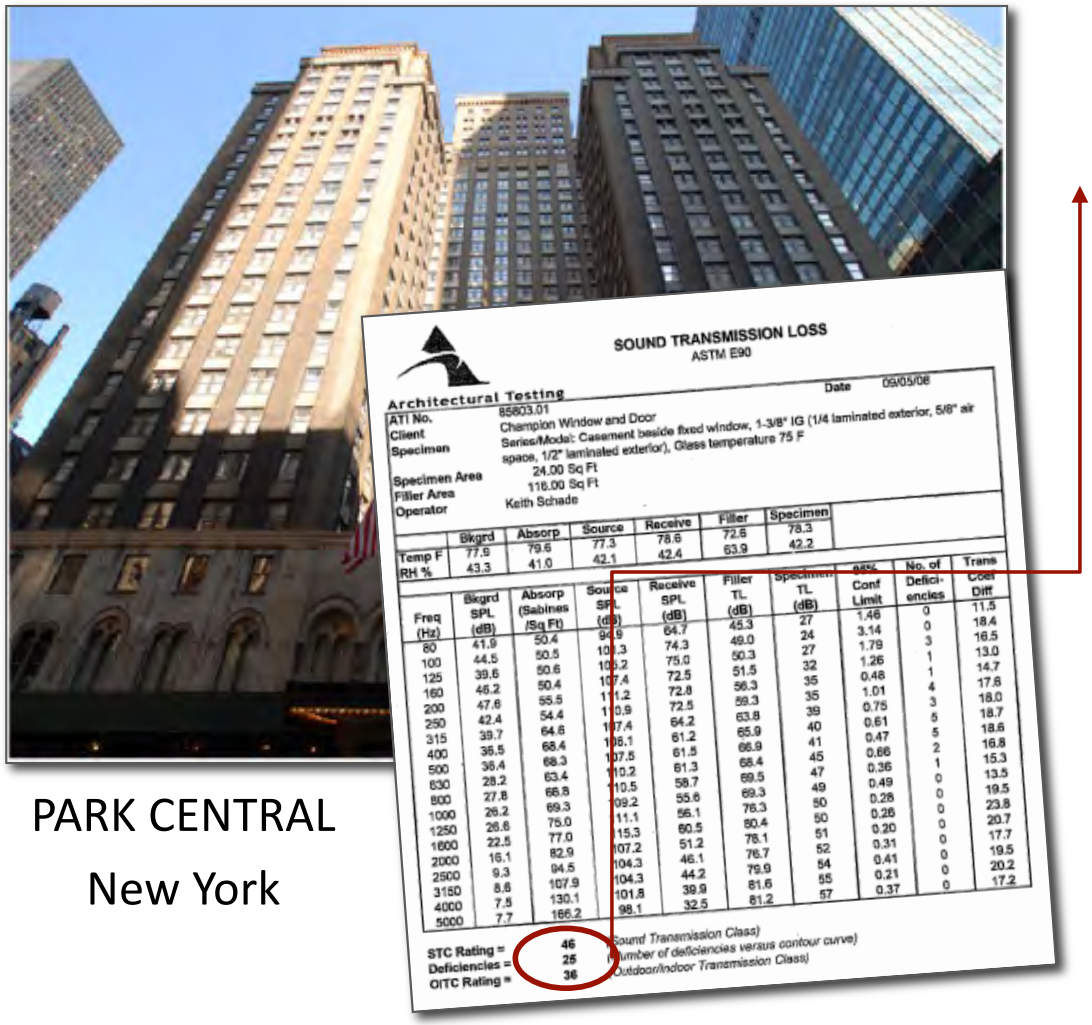
Chicago, Illinois, USA

Few locations in the world have more extreme wind and temperature fluctuations than Chicago—recognized by it's nickname— "The Windy City". Tall buildings have a propensity to sway during high winds. Exposed to nature's extremes, facades become structural systems capable of withstanding the sideward force of wind and the downward forces of gravity.

The role of the thermal barrier in commercial fenestration is to interrupt the flow of energy through the aluminum frame and to provide exceptional structural strength in the envelope. The thermal barrier aluminum fenestration composite with a Lancer mechanical lock exceeds industry standards for high shear and tensile strength.

- 60-stories, Hotel/Residential - 700 feet
- Architect: Lucien Lagrange
- Developer: Elysian Development
- Lanced mechanical lock with pour and debridge (qualifies for 10-year warranty)
- Manufacturer: Kawneer North America

Sound control



SOUND TRANSMISSION LOSS
ASTM E90

Architectural Testing

Date 09/05/08

ATI No. 85803.01
Client Champion Window and Door
Specimen Series/Model: Casement beside fixed window, 1-3/8" IG (1/4 laminated exterior, 5/8" air space, 1/2" laminated exterior), Glass temperature 75 F
Specimen Area 24.00 Sq Ft
Filler Area 116.00 Sq Ft
Operator Keith Schade

	Bkgrd	Absorp	Source	Receive	Filler	Specimen
Temp F	77.9	79.6	77.3	78.6	72.6	78.3
RH %	43.3	41.0	42.1	42.4	63.9	42.2

Freq (Hz)	Bkgrd SPL (dB)	Absorp (Sabines /Sq Ft)	Source SPL (dB)	Receive SPL (dB)	Filler TL (dB)	Specimen TL (dB)	Conf Limit	No. of Defici-encies	Trans Coef Diff
80	41.9	50.4	99.9	64.7	45.3	27	1.46	0	11.5
100	44.5	50.5	101.3	74.3	49.0	24	3.14	0	18.4
125	39.6	50.6	103.2	75.0	50.3	27	1.79	3	16.5
160	46.2	50.4	107.4	72.5	51.5	32	1.26	1	13.0
200	47.6	55.5	111.2	72.8	56.3	35	0.48	1	14.7
250	42.4	54.4	110.9	72.5	59.3	35	1.01	4	17.6
315	39.7	64.6	107.4	64.2	63.8	39	0.75	3	18.0
400	36.5	68.4	108.1	61.2	65.9	40	0.61	5	18.7
500	36.4	68.3	107.5	61.5	66.9	41	0.47	5	18.6
630	28.2	63.4	110.2	61.3	68.4	45	0.66	2	16.8
800	27.8	66.8	110.5	58.7	69.3	47	0.36	1	15.3
1000	26.2	69.3	109.2	55.6	69.5	49	0.49	0	13.5
1250	26.6	75.0	111.1	56.1	76.3	50	0.28	0	19.5
1600	22.5	77.0	115.3	60.5	80.4	50	0.26	0	23.8
2000	16.1	82.9	107.2	51.2	78.1	51	0.20	0	20.7
2500	9.3	94.5	104.3	46.1	76.7	52	0.31	0	17.7
3150	8.6	107.9	104.3	44.2	79.9	54	0.41	0	19.5
4000	7.5	130.1	101.8	39.9	81.6	55	0.21	0	20.2
5000	7.7	166.2	98.1	32.5	81.2	57	0.37	0	17.2

STC Rating = 46 (Sound Transmission Class)
Deficiencies = 25 (Number of deficiencies versus contour curve)
OITC Rating = 36 (Outdoor/Indoor Transmission Class)

PARK CENTRAL
New York

Manufacturer: Champion Window and Door

Window composition

Polyurethane thermal barrier
1-3/8”Insulating Glass

- ½” Laminated exterior
- ⅝” Warm edge spacer
- ¼” Interior light

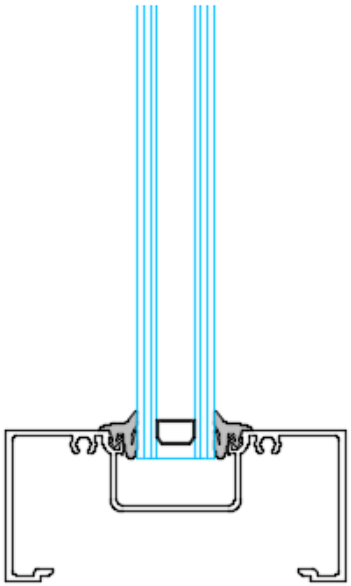
STC Rating	46
OITC Rating	36

Fenestration system components affect outdoor-indoor sound transmission in the exterior wall

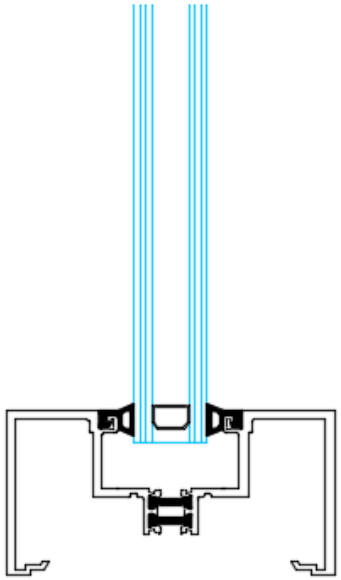
Sound transmission OITC (Outdoor Indoor Transmission Class)

Storefront: framing types

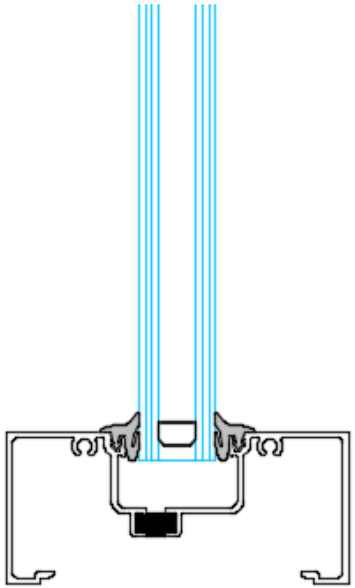
Non-thermal storefront



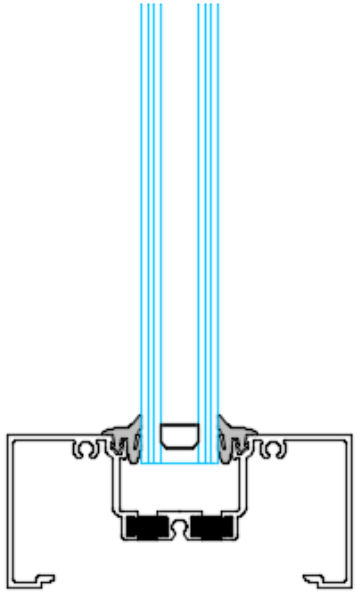
Polyamide thermal barrier storefront



Single cavity pour and debridge thermal barrier storefront

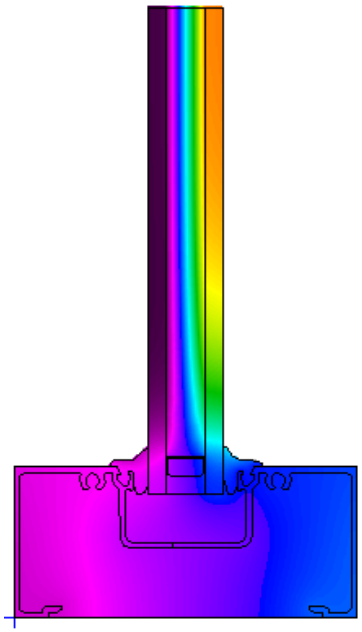


Dual cavity pour and debridge thermal barrier storefront



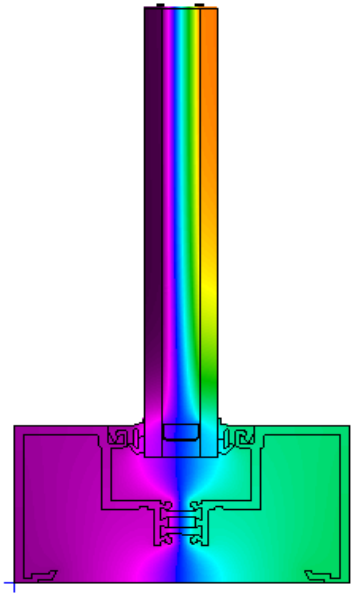
Storefront: performance comparison

Non-thermal storefront



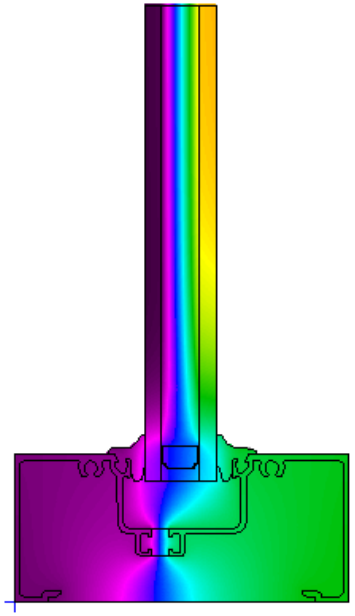
Overall U-factor = .63
Btu/hr-ft² - °F
Glazing – 1” Overall
Clear / Alum. Spacer+
Air/Clear

Polyamide thermal barrier storefront



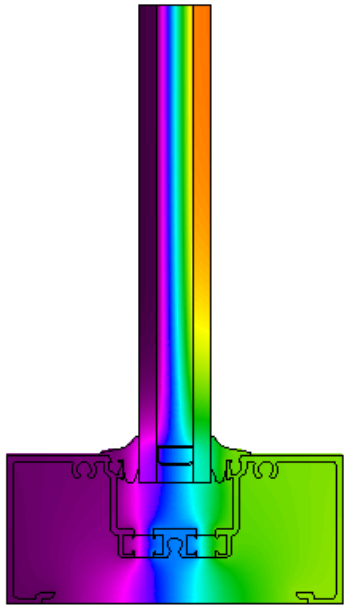
Overall U-factor = .38
Btu/hr-ft² - °F
Glazing – 1” Overall
Low-E / Warm-Edge
Spacer+ Argon/Clear

Single cavity pour and debridge thermal barrier storefront



Overall U-factor = .36
Btu/hr-ft² - °F
Glazing – 1” Overall
Low-E / Warm-Edge
Spacer+ Argon/Clear

Dual cavity pour and debridge thermal barrier storefront



Overall U-factor = .32
Btu/hr-ft² - °F
Glazing – 1” Overall
Low-E / Warm-Edge
Spacer+ Argon/Clear

Impact resistant thermal barrier window wall

Architect: **Morris Adjmi**
G.C : **Woodward Design + Build**
Glazing Contractor: **Zinsel Glass**
Manufacturer: **YKK AP America Inc.**

Price-point between storefront and curtain wall

- Completely factory glazed and assembled, or inside glazing at jobsite
- Hurricane and blast mitigating
- Window wall for mid-rise

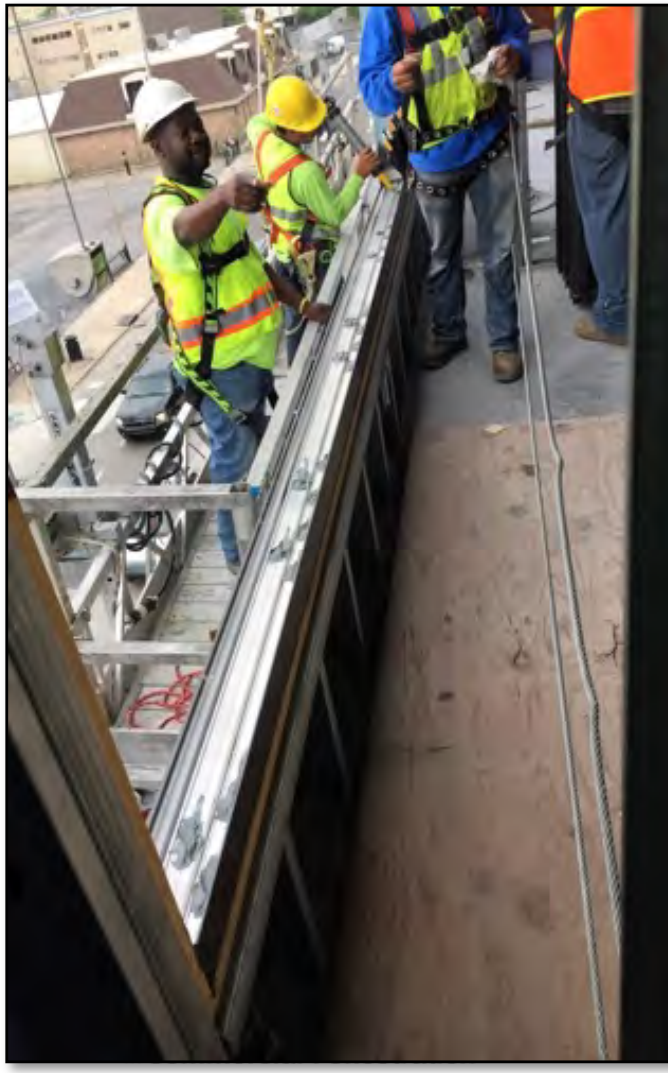
(Products: YHW 60TU, YTD 350TH, YES SSG TUH, Model 35H)

CASE STUDY

The STANDARD

New Orleans, Louisiana

Pre-glazed in shop or inside glazed at job site



CASE STUDY

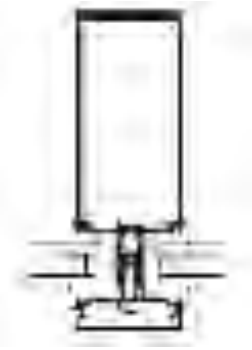
Colorado State University Engineering II Building

Fort Collins, Colorado

Manufacturer: Kawneer, an Arconic Company

Products Used:

Trifab 451UT (Ultra Thermal Framing)



1600UT Curtain Wall

Versoleil SunShade

GLASSvent Windows

Baker Center

Minneapolis, Minnesota

The Baker Center in downtown Minneapolis boasts more than 1 million square feet of office and retail space.

Baker Center

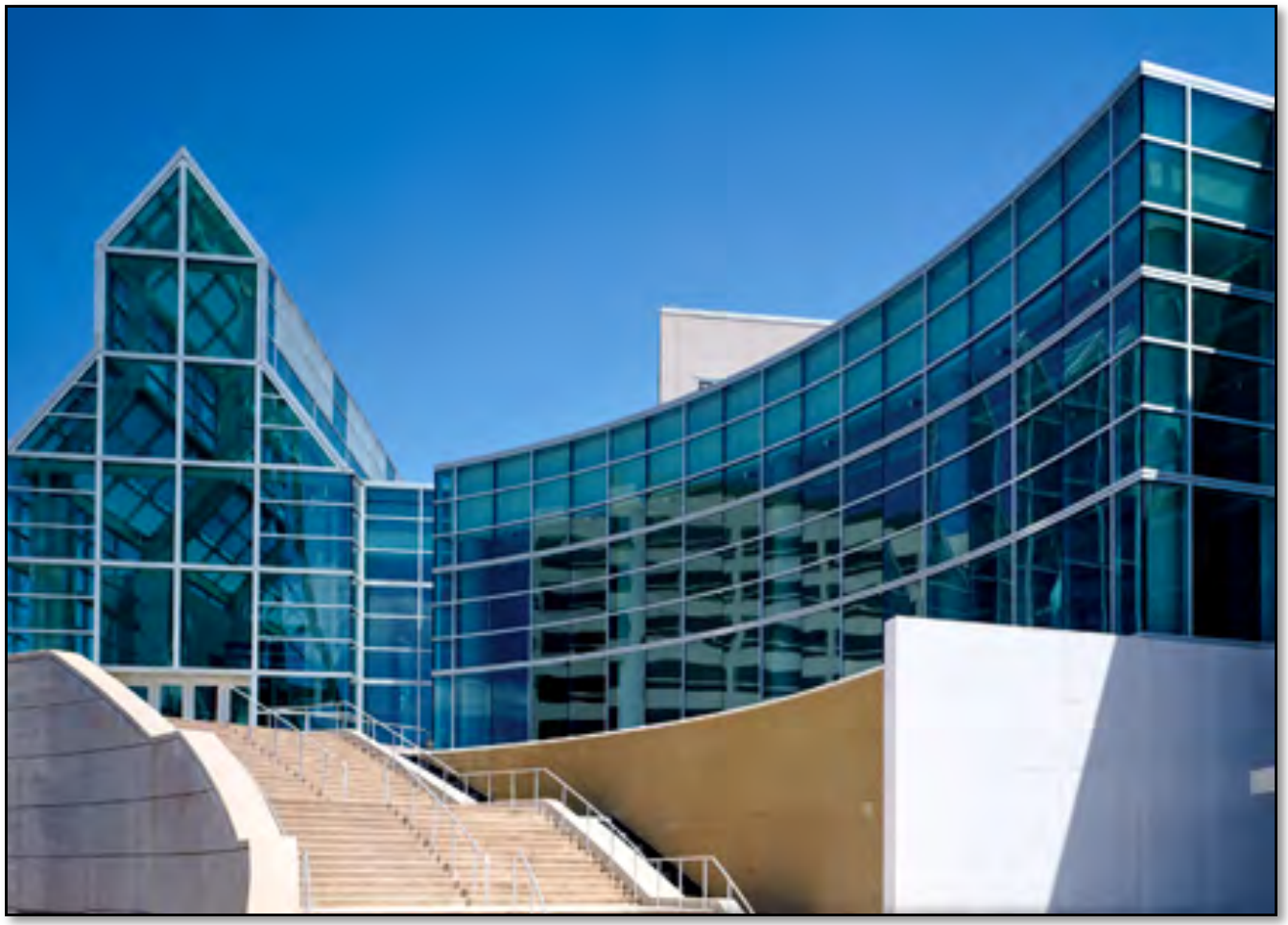
Contractor: **JE Dunn Group**
Erector: **Brin Contract Glazing**
Architect: **RSP Architects**
Manufacturer: **Tubelite**
Product category: **Curtainwall, Storefront**

Products Used:

Storefront, dual cavity

400TU
Curtain wall

Curtain wall thermal barrier systems



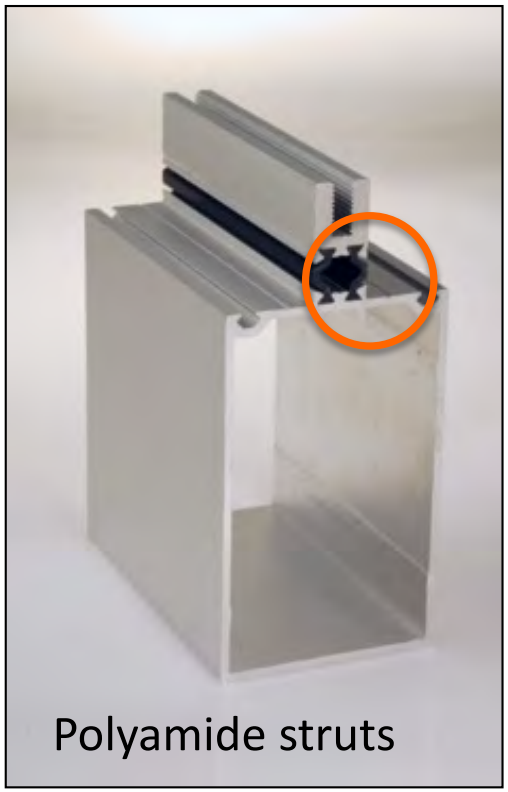
Manufacturer: CRL U.S. Aluminum

Curtain wall, dual cavity

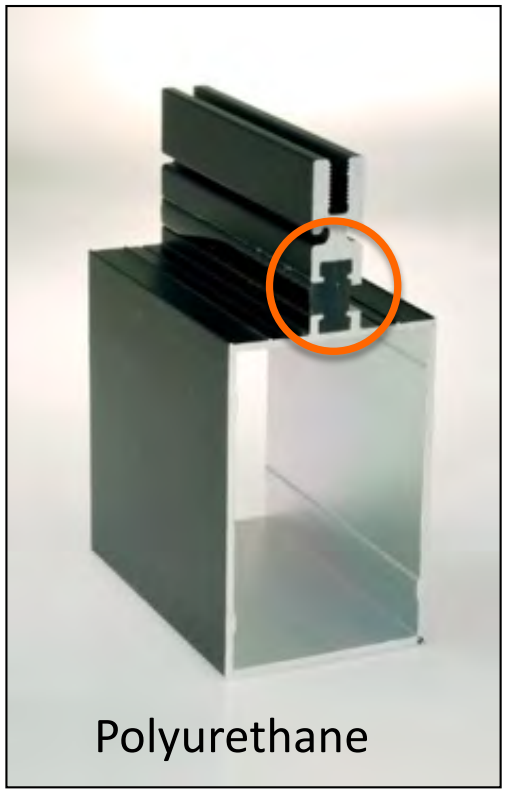
Thermal barrier types and comparisons

Structural performance:
A critical characteristic in curtain wall

Deflection: weight force required to deflect a 4-inch x 84-inch extrusion 1/2-inch)



Torsion:	519 lbf
Shear:	1,437 lbf
Deflection	1,821 lbf



Torsion:	1,519 lbf
Shear:	1,901 lbf
Deflection	2,206 lbf

Willis Tower

- Completed in 1973
- Tallest building in Western Hemisphere
- High-tech for it's time, but low-tech compared to today's available technology
  - Non-thermal aluminum framing
  - Very high thermal conductivity
  - 9/16-inch laminated glass (non-thermal)
  - High energy consumption & carbon emissions
  - Frost & condensation
  - **U-Value 0.78**

Willis Tower (thermal barrier frame, triple insulating glass)

simulation size = 40-in x 80-in

OPTIONS	DESCRIPTION	U-FACTOR
#1	POUR and DEBRIDGE FRAME WITH THERMAL BARRIER SPACER	.334 Btu/hr-ft²-F
#2	POUR and DEBRIDGE FRAME WITH STAINLESS STEEL SPACER	.342 Btu/hr-ft²-F
#3 *	POUR and DEBRIDGE FRAME WITH ALUMINUM SPACER	.353 Btu/hr-ft²-F
#4 ******	POLYAMIDE FRAME WITH THERMAL BARRIER SPACER	.373 Btu/hr-ft²-F
#5	POLYAMIDE FRAME WITH STAINLESS STEEL SPACER	.378 Btu/hr-ft²-F
#6	POLYAMIDE FRAME WITH ALUMINUM SPACER	.386 Btu/hr-ft²-f
EXISTING	ALUMINUM FRAME 9/16” SINGLE LAMINATED GLASS	.780 Btu/hr-ft²-F

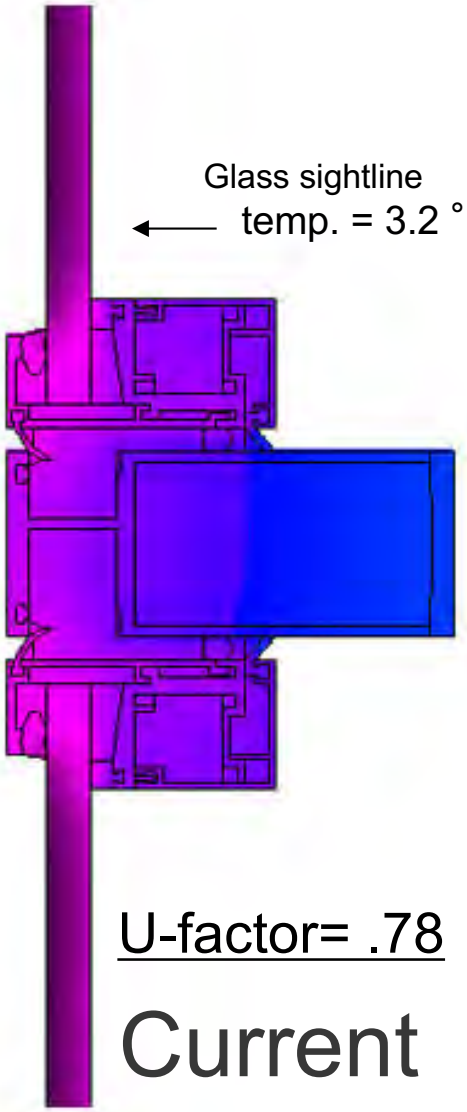
*Least Expensive Option / ******Most Expensive Option

CASE STUDY

Transforming a Chicago icon

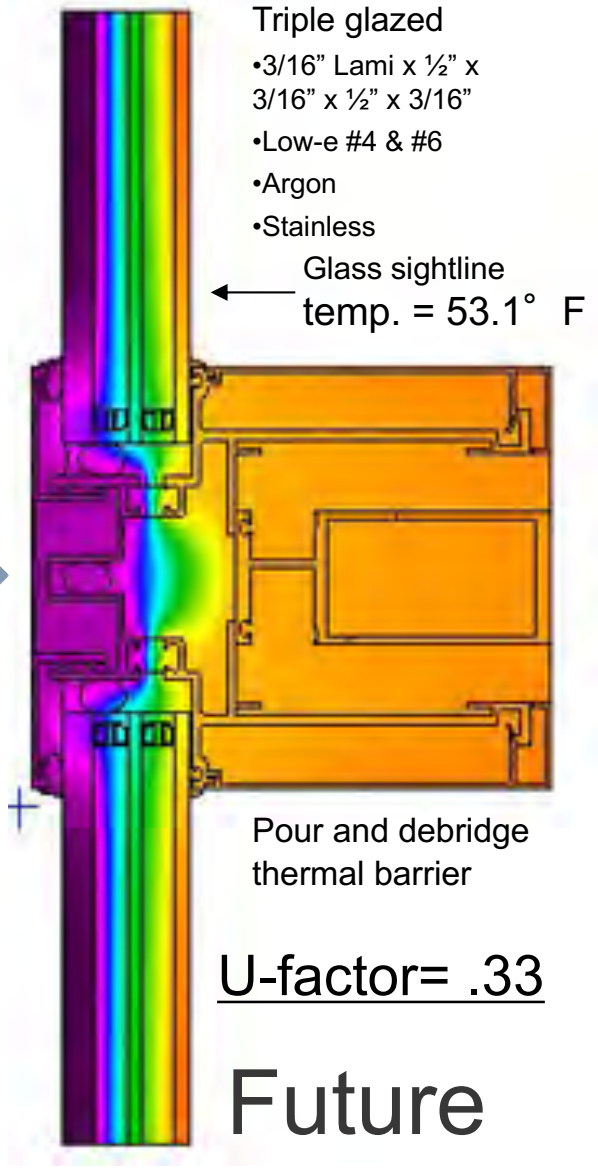
Willis Tower

turn the existing structure from a cold and inefficient building, to a thermally efficient building



U-factor= .78

Current



U-factor= .33

Future

Willis Tower

modernization project

Up to 80% less base building electricity usage

Savings of 50,000 barrels of oil per year

Savings of 50% of heating energy with exterior wall upgrades, including panels and replacing 16,000 windows

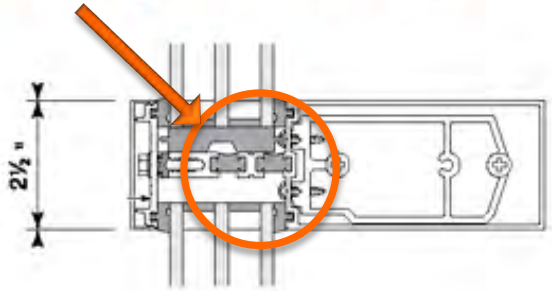
Source: www.willistower.com/icon


MEC (Mountain Equipment Co-op)
• Headquarters - Vancouver, British Columbia
LEED Platinum
MEC
MEC
HEAD OFFICE

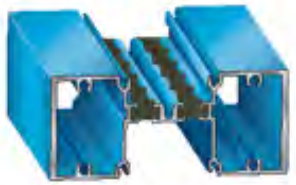
CASE STUDY

LEED Platinum

Dual-cavity thermal barrier



pour and debridge



MEC Headquarters - Vancouver, BC

CRL-U.S. Aluminum Series HP3253 High Performance Curtain Wall System Architect: Proscenium Architecture + Interiors Inc.
Size: 112,000 sq ft
Completion: 2014
Pursuing LEED Platinum

MEC Outfitters

climbing, cycling, running, yoga and more

MEC Roots

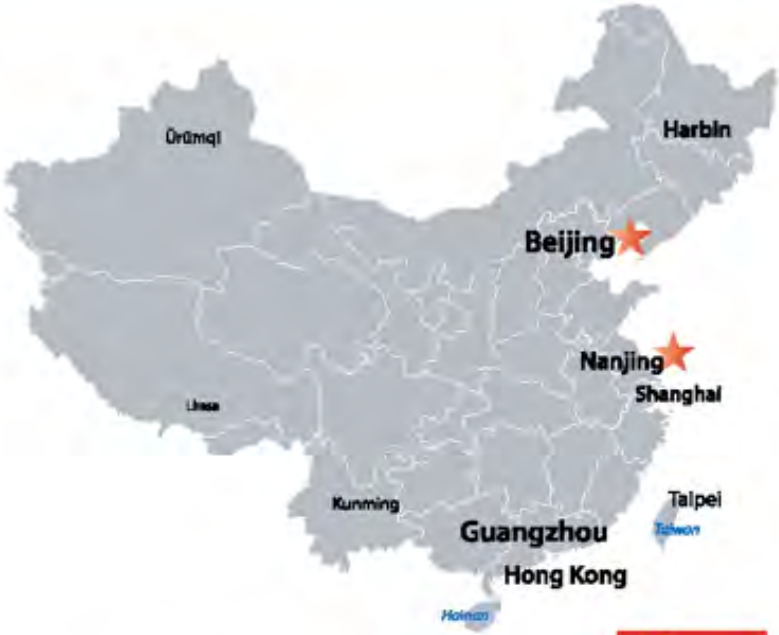
In 1971, a group of west coast mountaineers made a decision to do business differently, and they turned an unconventional retail model into a thriving business. We strive to make great products that lessen our impact on the environment and improve the lives of people we touch—*deal fairly, find strength in community, and inspire adventure.*

International applications

CASE STUDY

Nanjing Shimao Hilton Hotel

Location: Nanjing



China National Convention Center (CNCC)

Location: Beijing

Architecture firm: RMJM (UK-based)

Owner: Beijing North Star Group

Polyurethane

Award winning - sustainable

Land and Housing Corporation

Monumental Korean master plan project exceeding the ***Passive House*** standards for Korea in implemented in 2016

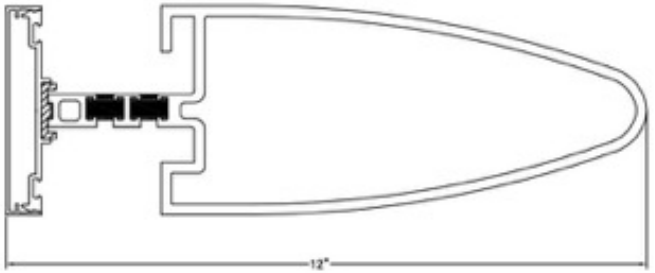
project implements numerous sustainable products and methods including high-performance triple glazing and building envelope materials

System manufacturer: Wonjin Aluminum
(Wan Ju-goon / Jeon La Buk Province)

CASE STUDY

Incheon Airport Terminal 2

Curtain wall, dual cavity

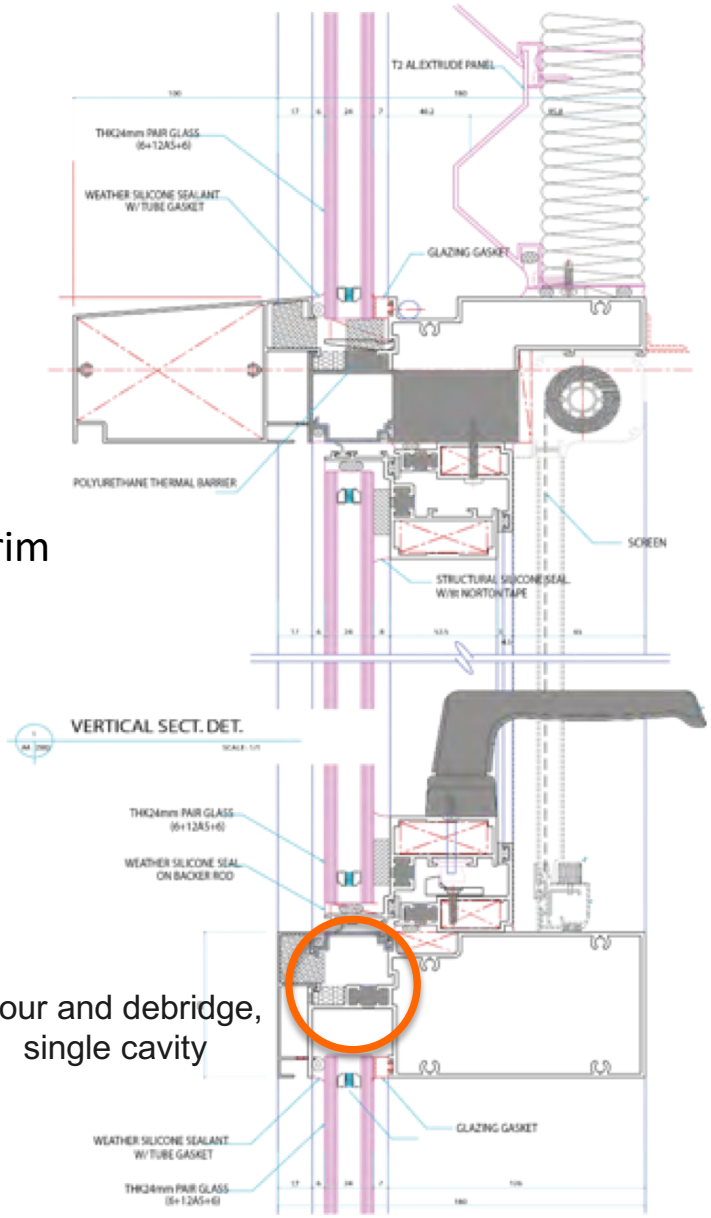


Songdo City

NEATT
Tallest building in Korea
68-story
Incheon, Korea

Architect: Kohn Pederson Fox/Heerim
Contractor: Daewoo/POSCO E&C
Owner: Gale International
Completion: 2014

LEED CS Silver



Pour and debridge, single cavity

World's first "Smart City" built with technology in mind,
A $35 billion *Master Plan* setting new benchmarks for
sustainable urban development.

This concludes the American Institute of Architects
Continuing Education Systems Program

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