CHOOSING WINDOWS IN VERMONT

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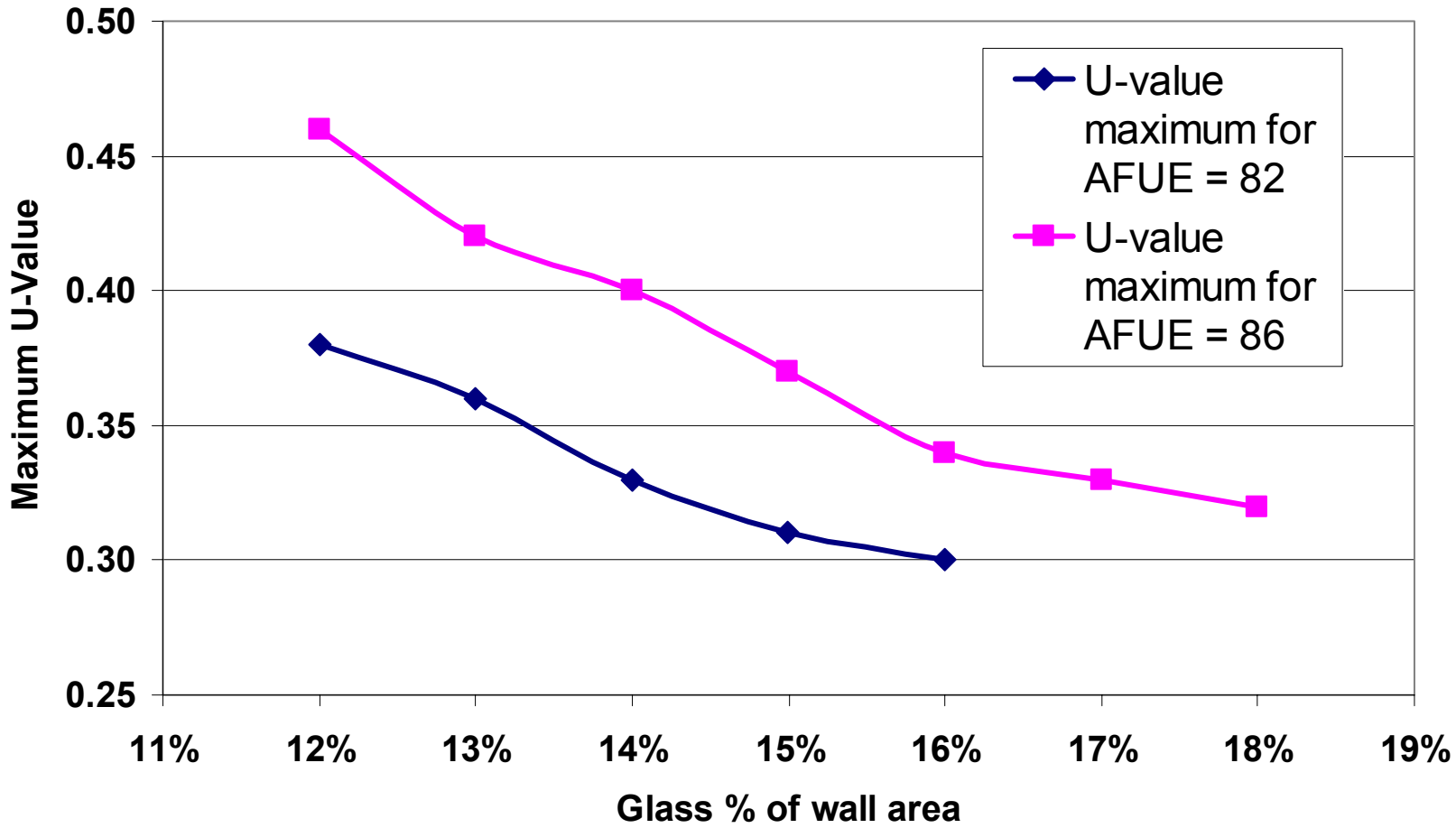
- Residential Windows
  - Vermont Residential Energy Code
  - How Do Residential Windows Meet the Code?
- Commercial Windows
  - Vermont Commercial Energy Code (ASHRAE 90.1)
  - How do Commercial Windows Meet the Code?
- Going Beyond the Code -- High Performance Windows

Single Family Home,
Typically Insulated

Vermont Residential Energy Code, Typical Window U-value Requirements



Typical Residential Window Performance

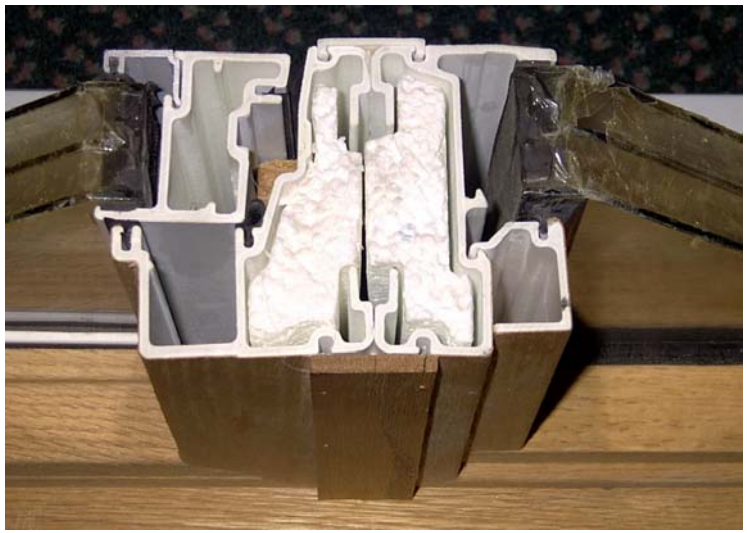
Double Hung, 3-0 x 5-0
Casement, 2-0 x 4-0

	U-Value	R-Value	Solar Heat Gain Coefficient (SHGC)	Air leakage rate	
Wood or vinyl window, default	0.56	1.8	0.7	??	double glass
Wood or vinyl window, default	0.40	2.5	.30 - .60	??	double low-e, air
Wood or vinyl window, default	0.37	2.7	.30 - .60	??	double low-e, argon
Marvin metal clad casement	0.38	2.6	0.30	0.02	double "Low-e-II" air
Marvin metal clad casement	0.35	2.9	0.30	0.02	double "Low-e-II" argon
Marvin metal clad double hung	0.35	2.9	0.28	0.18	double "Low-e-II" argon
Anderson clad casement	0.35	2.9	0.25	0.04	double low-e argon
Anderson clad double hung	0.35	2.9	0.25	0.17	double low-e argon

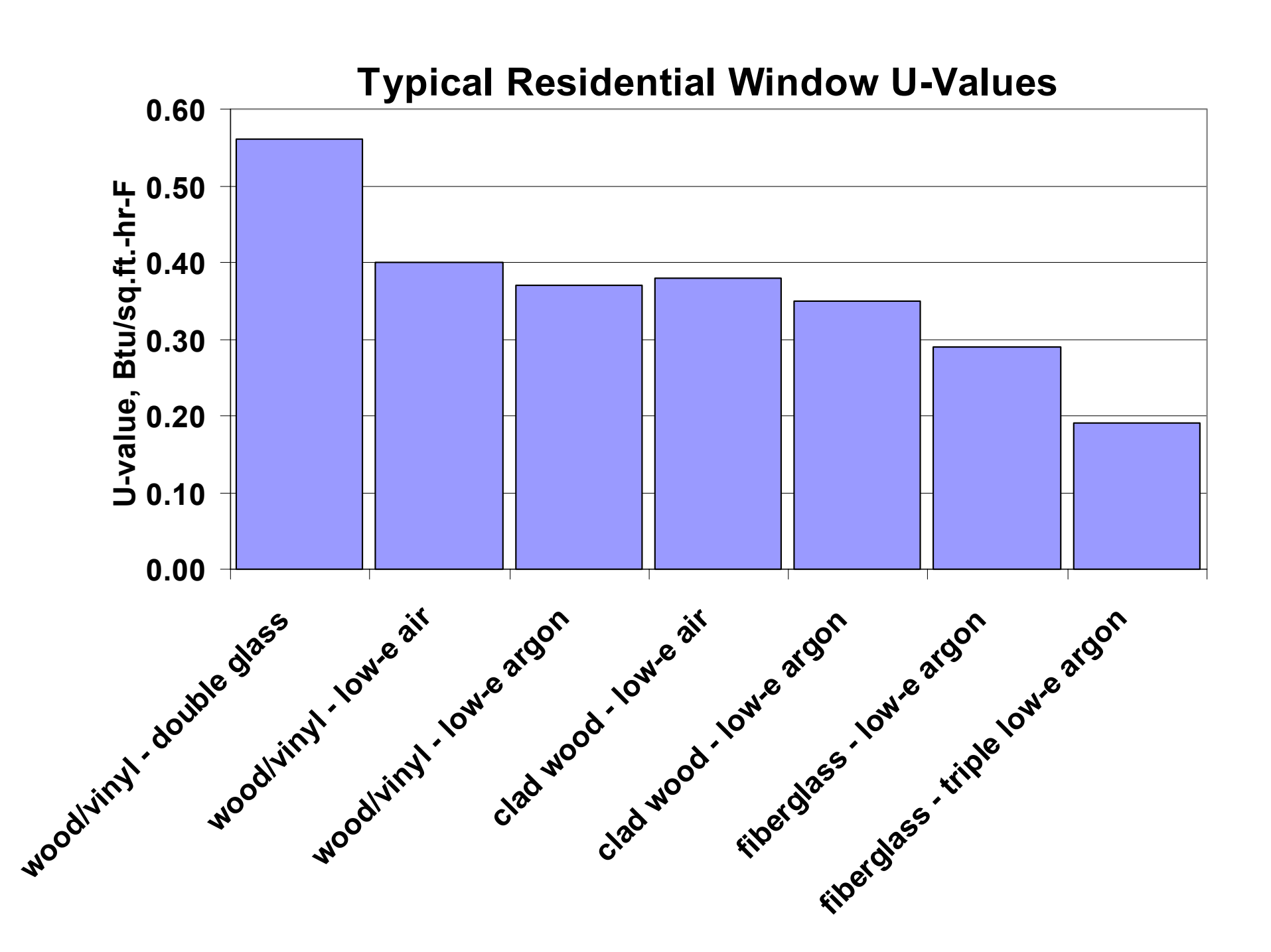
Typical Residential Window Performance

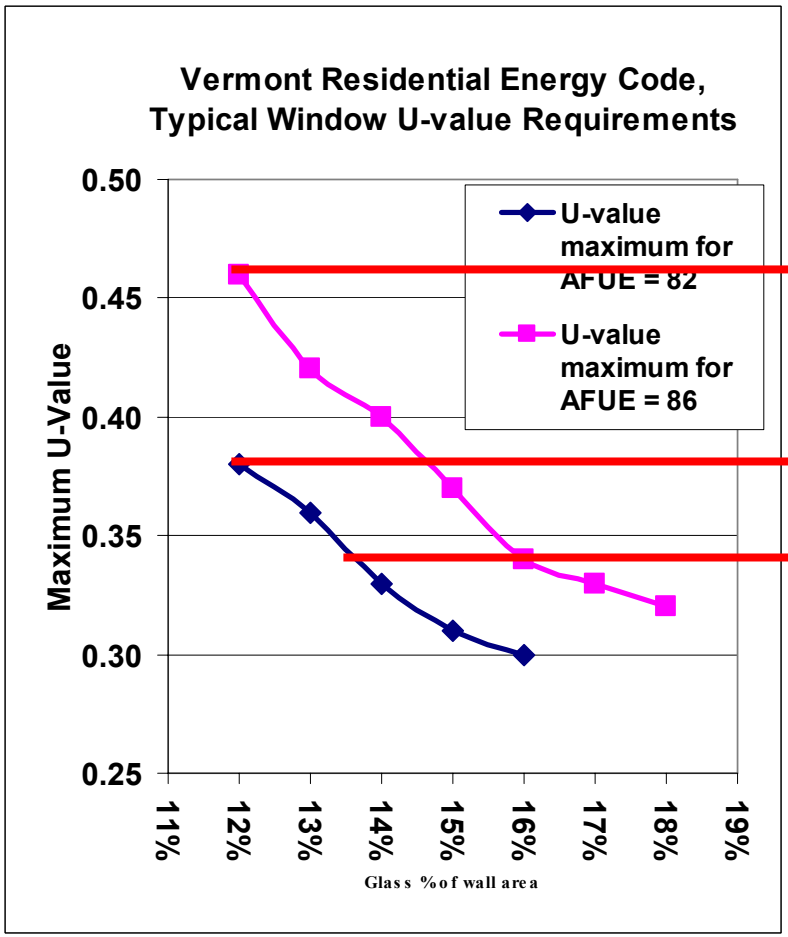
Double Hung, 3-0 x 5-0
Casement, 2-0 x 4-0

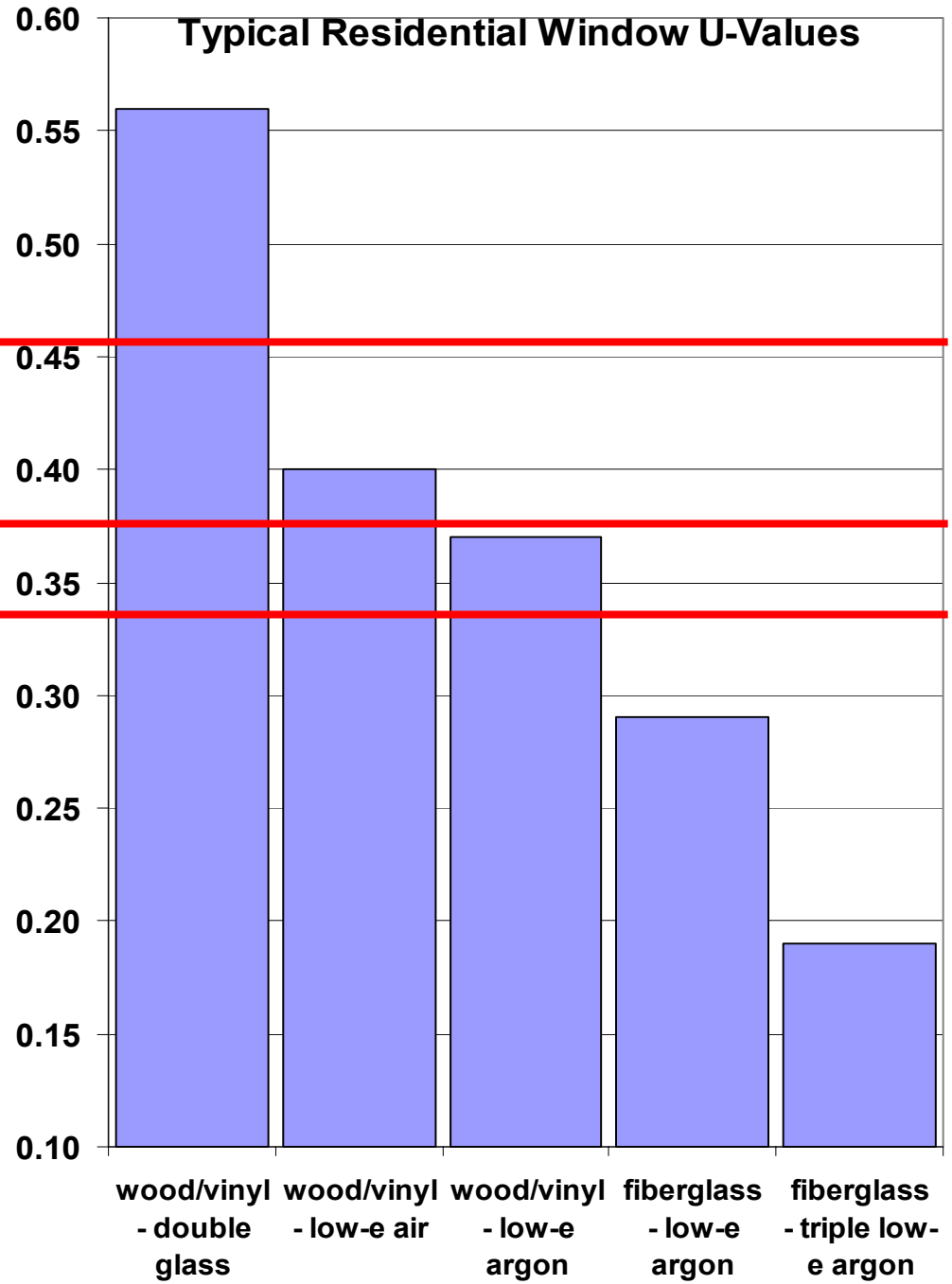
	U-Value	R-Value	Solar Heat Gain Coefficient (SHGC)	Air leakage rate	
Acc. Dorwin, fiberglass, casement	0.34	2.9	0.50	0.014	double low-e argon, high solar gain
Acc. Dorwin, fiberglass, casement	0.29	3.4	0.34	0.014	double low-e argon, low solar gain
Acc. Dorwin, fiberglass, casement	0.23	4.3	0.40	0.014	triple, low-e argon, 2x-low-e
Acc. Dorwin, fiberglass, casement	0.20	5.0	0.24	0.014	triple, low-e argon, 2x-low-e
Acc. Dorwin, fiberglass, SH	0.29	3.4	0.38	0.005	double low-e argon, low solar gain
Acc. Dorwin, fiberglass, SH	0.19	5.3	0.27	0.005	triple, low-e argon, 2x-low-e



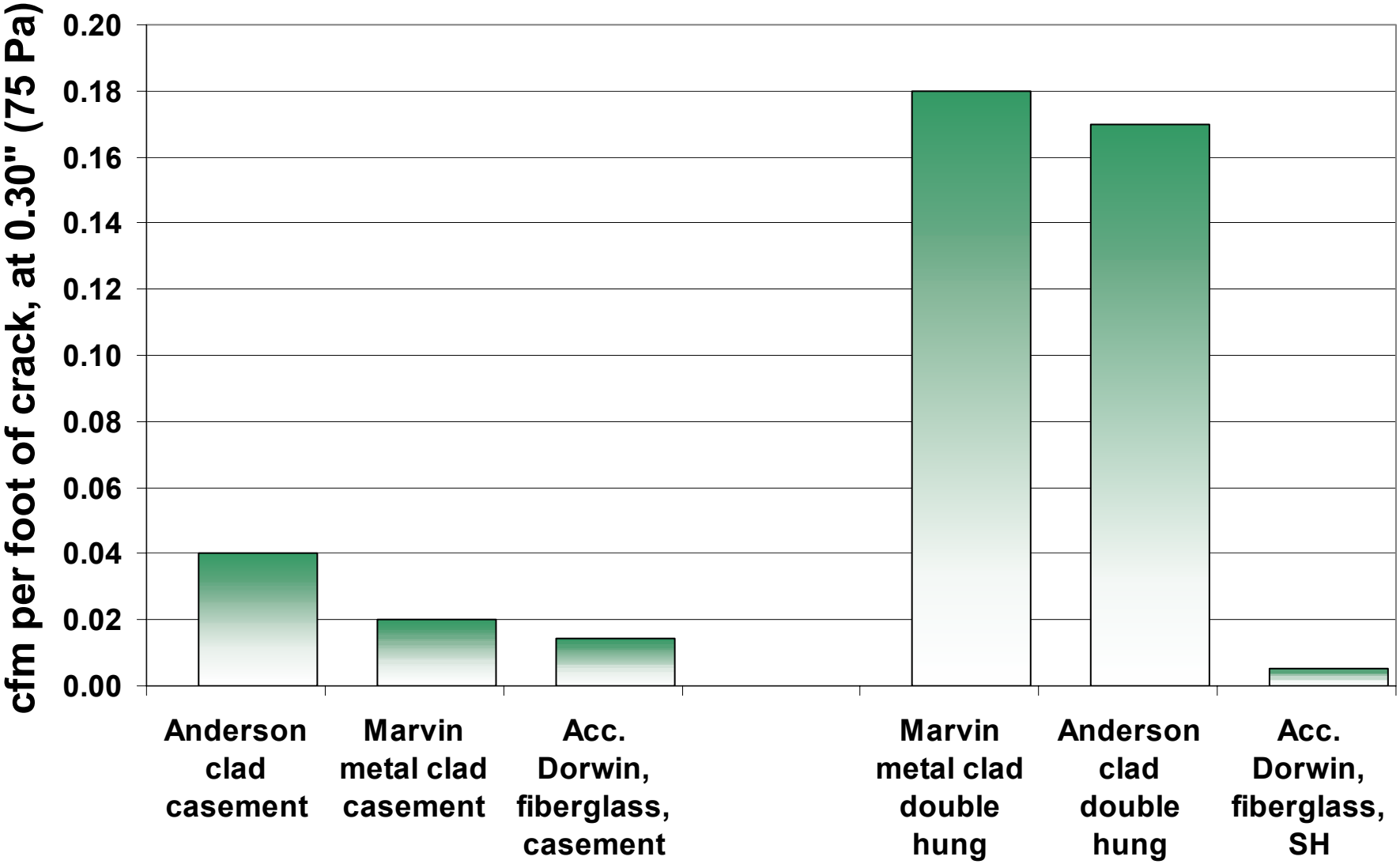
Fiberglass frame window -- ALL thermal break! (Accurate Dorwin, Thermotech, others)


Typical Residential Window U-Values
U-value, Btu/sq.ft.-hr-F
0.60
0.50
0.40
0.30
0.20
0.10
0.00
wood/vinyl - double glass
wood/vinyl - low-e air
wood/vinyl - low-e argon
clad wood - low-e air
clad wood - low-e argon
fiberglass - low-e argon
fiberglass - triple low-e argon


Vermont Residential Energy Code,
Typical Window U-value Requirements
Maximum U-Value
0.50
0.45
0.40
0.35
0.30
0.25
U-value maximum for AFUE = 82
U-value maximum for AFUE = 86
11%
12%
13%
14%
15%
16%
17%
18%
19%
Glass %of wall area


Typical Residential Window U-Values
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
wood/vinyl - double glass
wood/vinyl - low-e air
wood/vinyl - low-e argon
fiberglass - low-e argon
fiberglass - triple low-e argon

Air Leakage Rates for Selected Residential Windows



Commercial Windows

Energy Code Requirements for Window Performance
VT Commercial Energy Code

Glass % of Wall Area, up to	U-value, maximum	R-value, minimum	Solar Heat Gain Coefficient, maximum		
			PF<0.25	0.25<pf<.50	PF>0.5 or north-facing
Up to 10%	0.47	2.1	0.46	0.55	0.64
10% to 25%	0.47	2.1	0.46	0.55	0.64
25% to 40%	0.40	2.5	0.36	0.50	0.64
40% to 50%	0.40	2.5	0.32	0.48	0.64

Air leakage rate: 1 cfm/sq.ft. @ 0.30" (75 Pa)

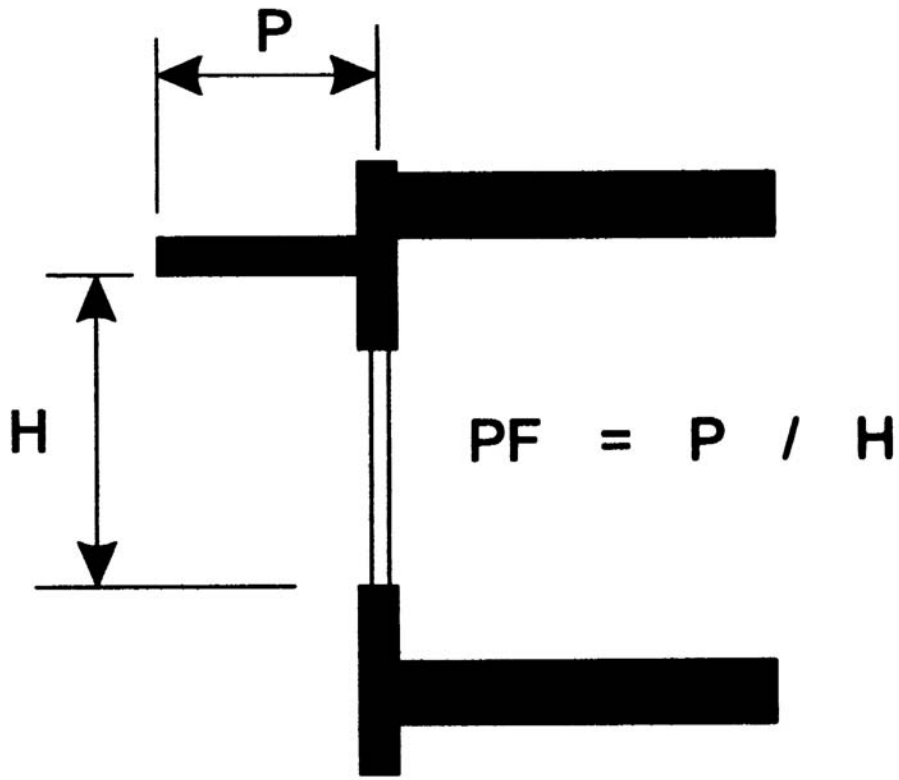


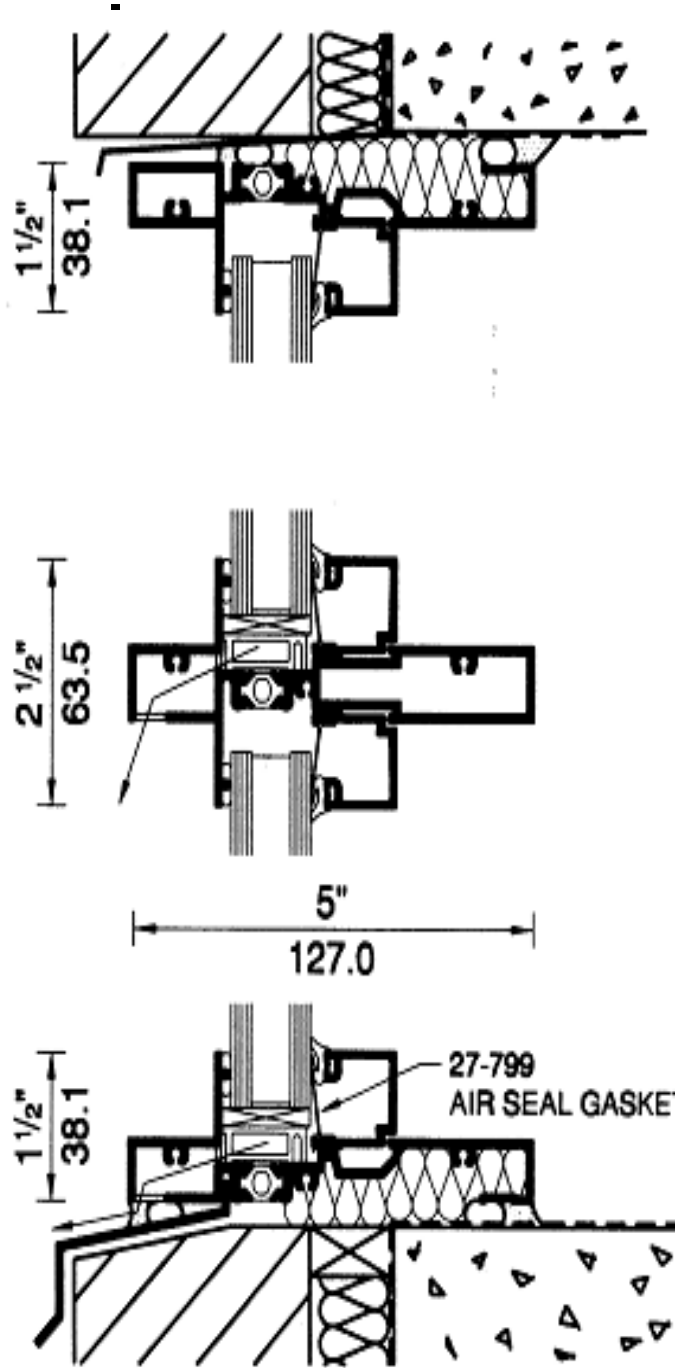
Figure 5-M – Overhang Projection

Typical Commercial Window Performance

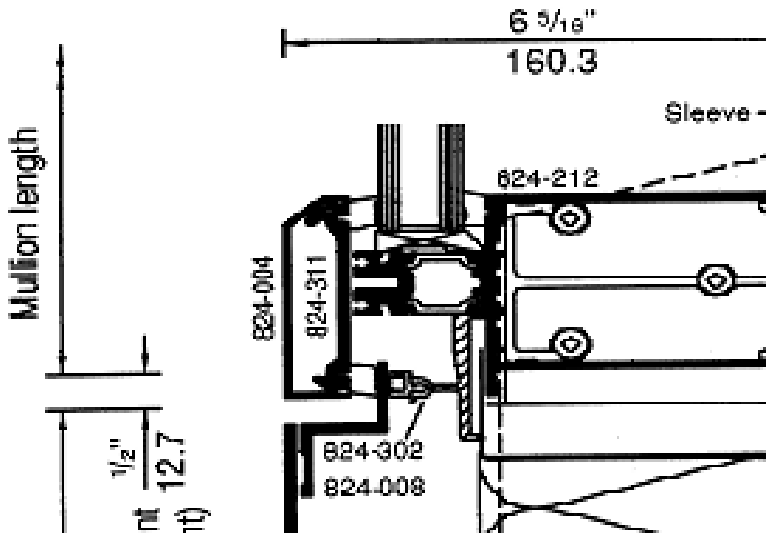
All Values for Whole Window!! window size: 4-0 x 3-0

	U-Value	R-Value
Aluminum typical thermal break (Kawneer 518 Isoport)		
double glass	0.62	1.6
low-e argon	0.45	2.2
low-e argon, 5 sq.ft. window	*0.50*	*2.0*
triple, 2x low-e argon, good spacer	0.40	2.5
Aluminum, superior thermal break (Kawneer 5525)		
low-e argon	0.40	2.5
triple, 2x low-e argon, good spacer	0.24	4.2
Fiberglass windows (Accurate Dorwin)		
double glass	0.48	2.1
low-e argon	0.29	3.4
triple, 2x low-e argon, Super-Spacer	0.17	5.9

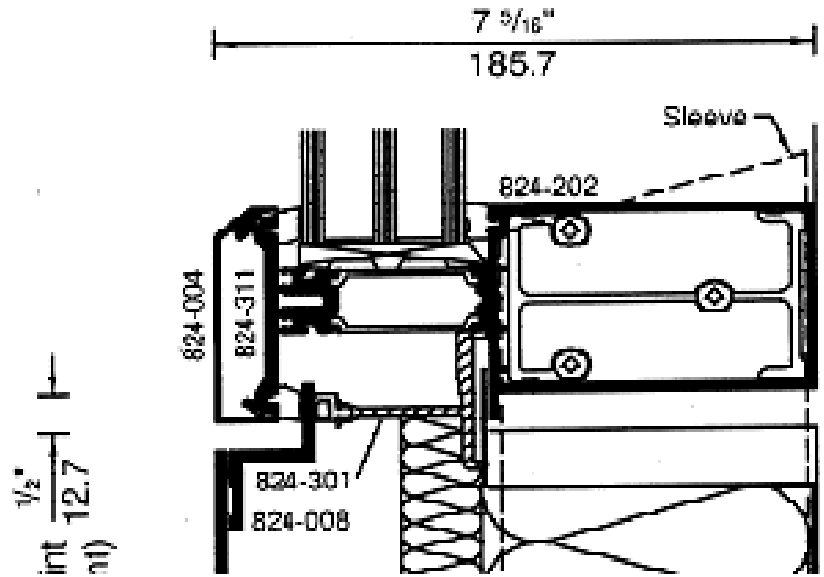
Aluminum window with typical ther break (Kawneer 418)



7525 - 25mm DOUBLE GLAZED



7550 - 50mm TRIPLE GLAZED

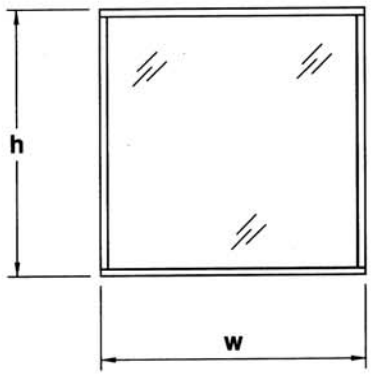


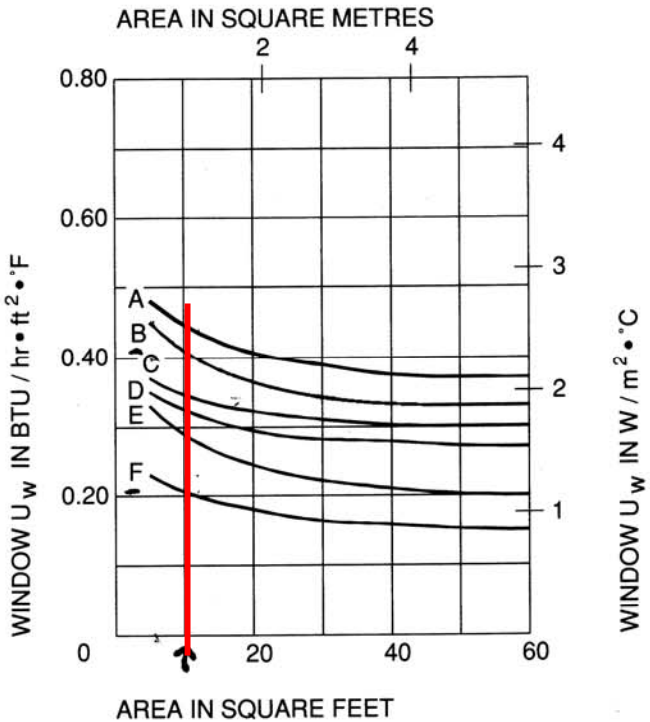
Aluminum window with excellent thermal break (Kawneer 7500 series)

Kawneer 5525 ISOWEB Window Performance

OVERALL WINDOW U-VALUE (U_W)

For fixed and operating window configurations as shown with height (h) equal to width (w).





SEALED UNIT GLAZING TYPE

A = 6mm clear / 1/2" air / 6mm low-e[1] / metal spacer

B = 6mm clear / 1/2" argon / 6mm low-e[1] / metal spacer

C = 6mm clear / 1/2" argon / 6mm low-e[1] / warm edge spacer[3]

D = 6mm clear / 1/2" argon / 6mm low-e[2] / warm edge spacer[3]

E = 6mm clear / 1/2" argon / 6mm low-e[1] / 1/2" argon / 6mm low-e[1] / metal spacer

F = 6mm clear / 1/2" argon / 6mm low-e[2] / 1/2" argon / 6mm low-e[2] / warm edge spacer[3]

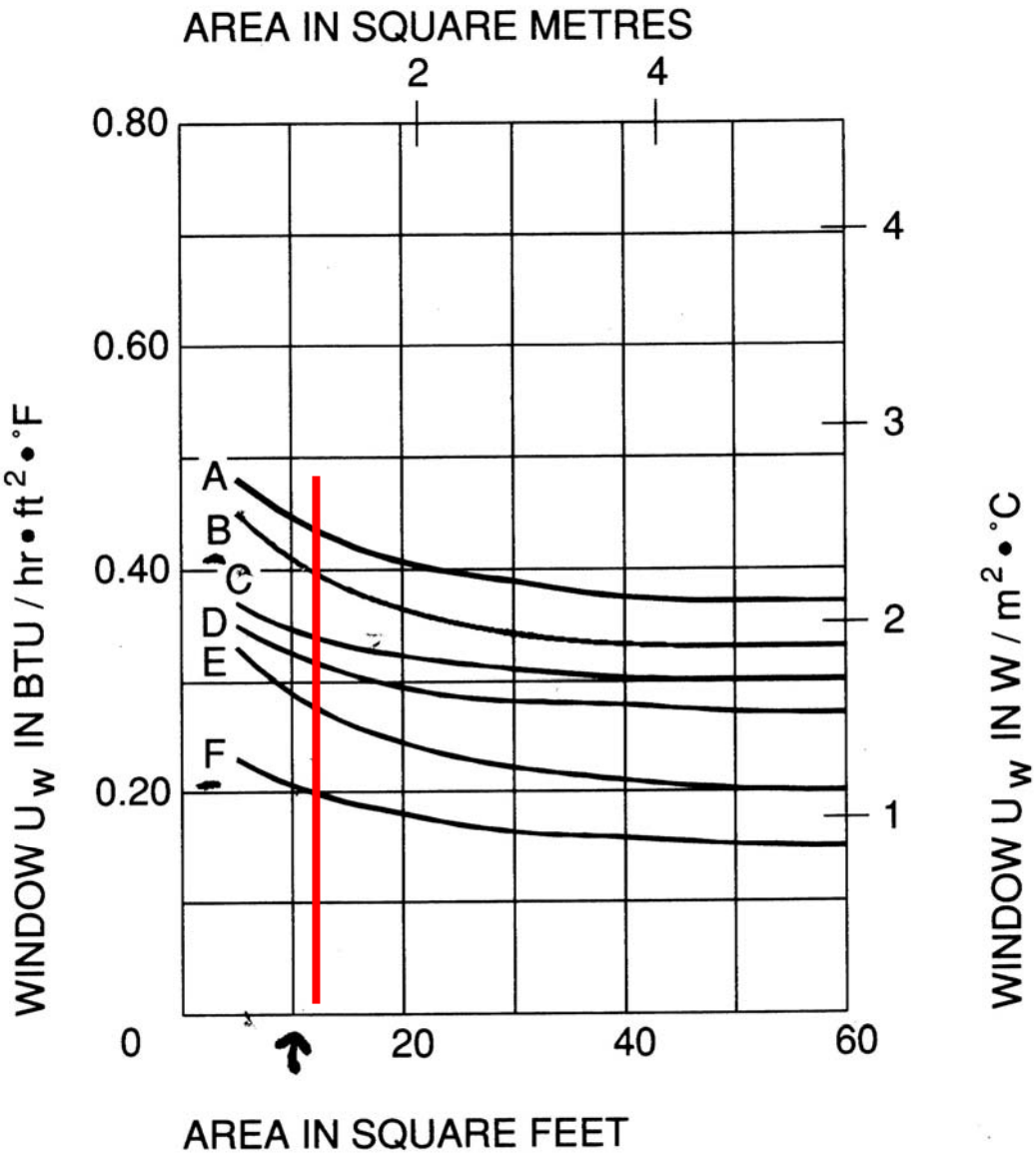
1 - low-e coating emittance = 0.1 - more typical -
2 - low-e coating emittance = 0.03 - AFG Comfort Sunbelt ES - used with tinted glass
3 - Edgetech Super "U" Spacer®
Use also Helima, broken metal spacer -

NOTES: THE ABOVE SEALED UNIT GLAZING OPTIONS ARE PRESENTED FOR THE PURPOSES OF ILLUSTRATING THERMAL PERFORMANCE CAPABILITIES.

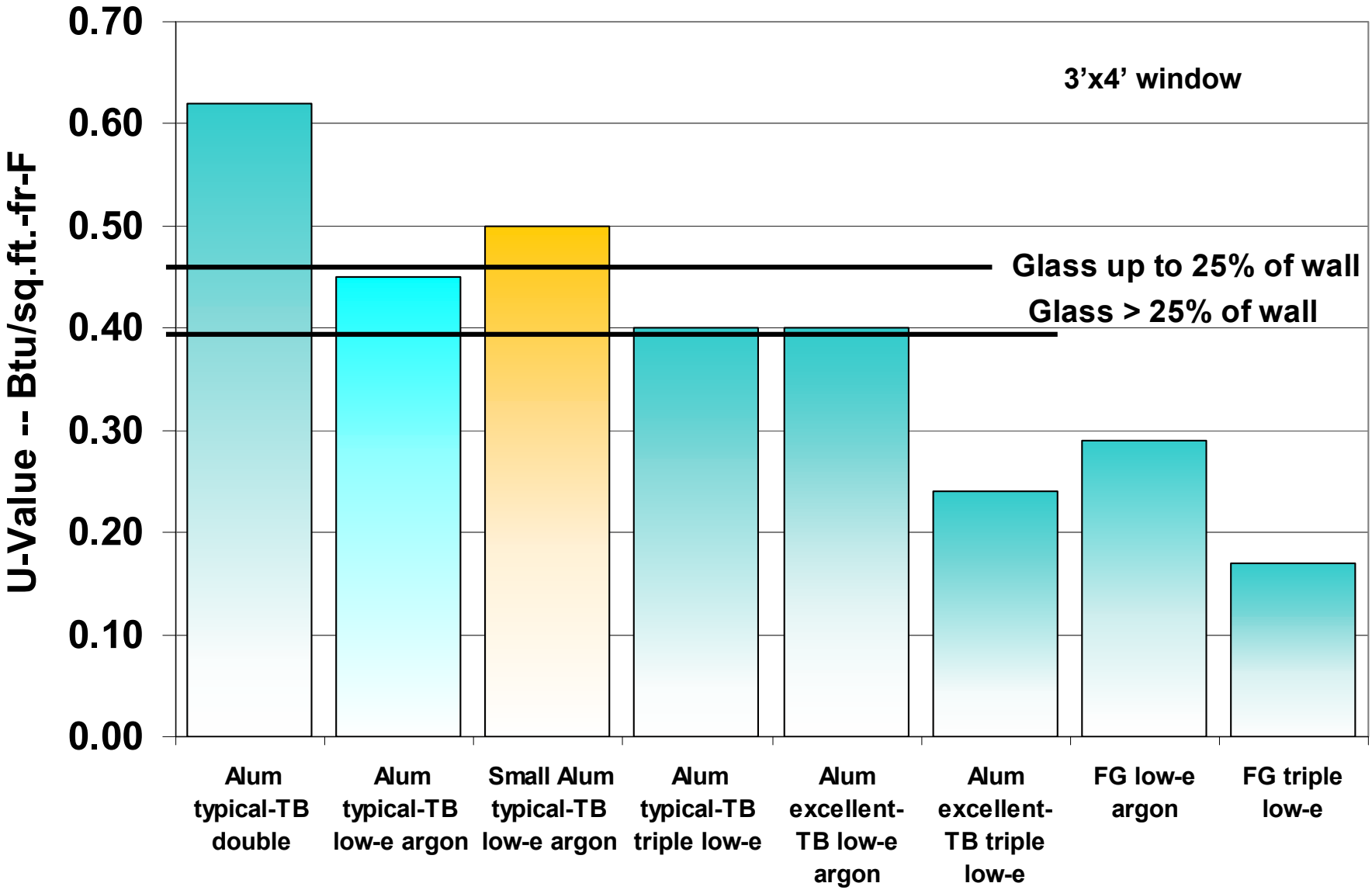
FOR WINDOWS WITH HEIGHT NOT EQUAL TO WIDTH, WHEN ADDING INTERMEDIATE VERTICALS OR HORIZONTALS, OR DIFFERENT GLASS INFILL, THE OVERALL WINDOW U - VALUE MAY VARY.

THE SPECIFIER SHOULD SELECT GLASS TO MEET THE PERFORMANCE REQUIREMENTS OF THE PROJECT.

Kawneer 5525 ISOWEB Window Performance



Typical Commercial Window U-values vs. Code



Solar Heat Gain Coefficient

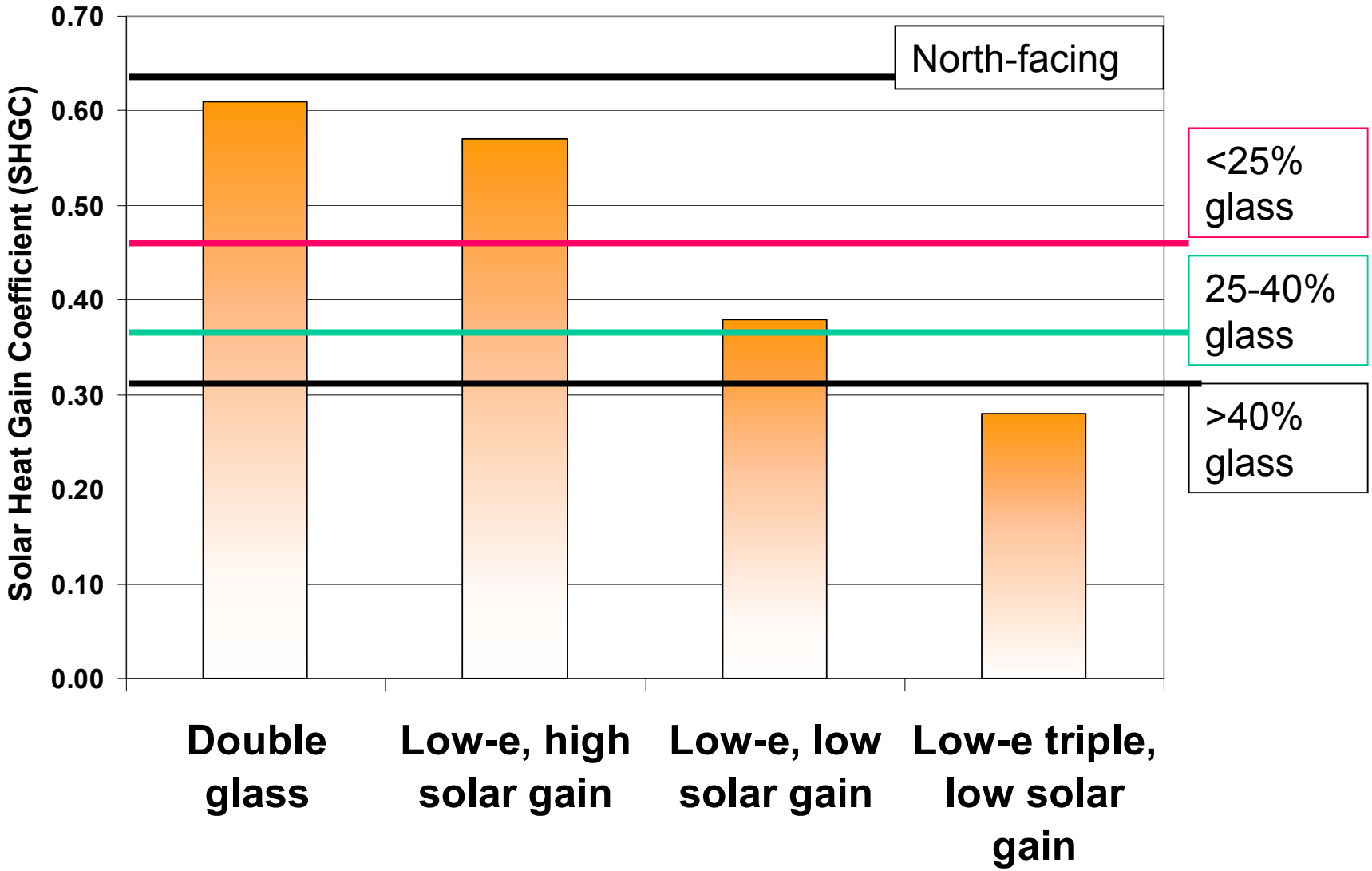
"the amount of sun that gets in compared to what is shining on the window"

window size: 4-0 x 3-0

Glass type	SHGC, glass only	SHGC, Whole window
Double glass	0.81	0.61
Low-e, high solar gain	0.73	0.55
Low-e, low solar gain	0.51	0.38
Low-e triple, low solar gain	0.37	0.28

SHGC, Whole window

4'x3' unit, PF <0.25



Energy Code Requirements for Window Performance
VT Commercial Energy Code

Glass % of Wall Area, up to	**Solar Heat Gain Coefficient, maximum**		
	PF<0.25	0.25<pf<.50	PF>0.5 or north-facing
Up to 10%	0.46	0.55	0.64
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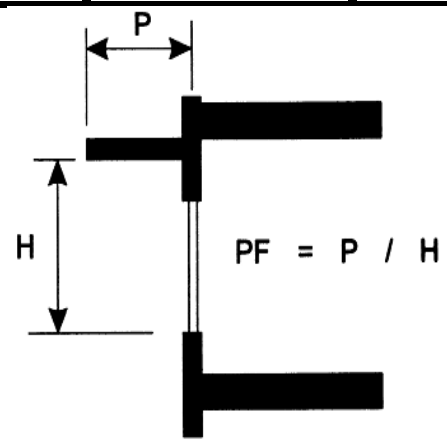
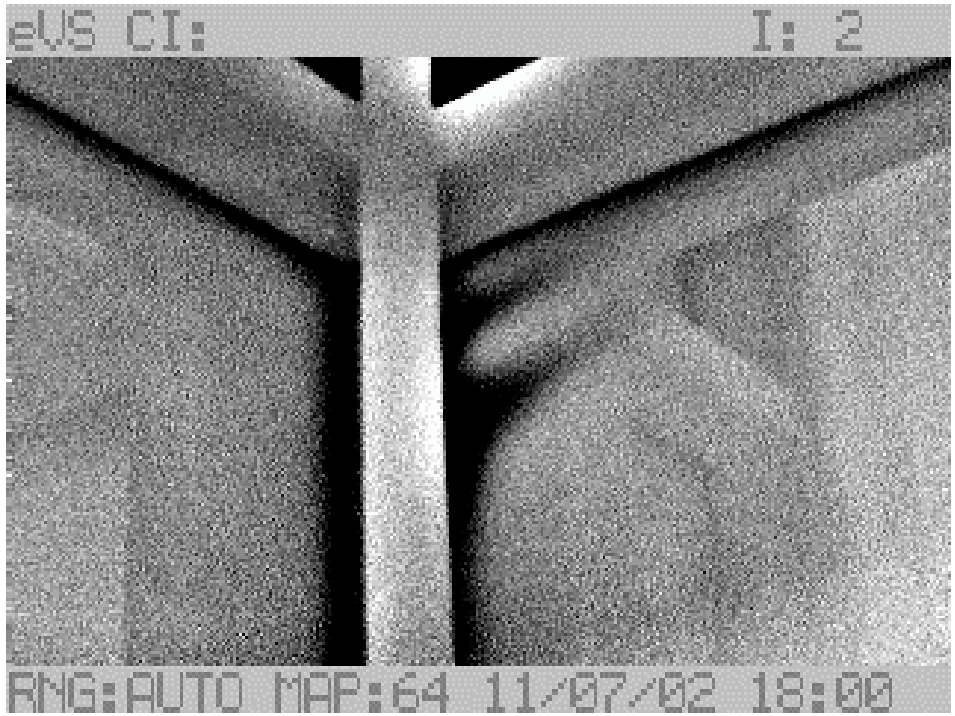


High performance curtain wall at the Leahy Center for the Lake, Burlington. *Smith, Alvarez, Sienkiewycz Architects*, ~2,000 sq.ft. glass curtain wall -- ~ R-4.5 !!!



Blower door test with infra - red imaging to identify air leaks in glazing installation

What Windows in Vermont? --The Short Version

- ***To Meet (prescriptive) Codes*** --
  - Residential: use R-3 windows -- get windows with high solar heat gain coefficient where you want the sun (sometimes hard to find)
  - Commercial: Use R-2.5 windows -- need good thermal break
    - Don't put in too much glass -- And use low solar gain glass -- SHGC < .46 -- for 25% of wall that is glass.
  - Always: pay attention to air leakage rates and installation.

- ***High Performance Windows -- Beyond the Code***
  - Residential: R-5 triple glass, double low-e, argon fill, high-performance edge spacers, fiberglass frames
  - Commercial: Optimize glass areas for heating, cooling and daylighting with modeling, R-5 fiberglass or R-4+ aluminum with best thermal break, usually low solar gain glass.