

90.1-2004: An Overview of the Building Envelope Requirements
June 14, 2007

Building Envelope Chapter & Appendices – slide 3

- Chapter 5: Building Envelope
- Appendix A: Rated R-value of Insulation and Assembly U-factor, C-factor, and F-factor Determinations
- Appendix B: Building Envelope Climate Criteria
- Appendix C: Methodology for Building Envelope Trade-off Option in Subsection 5.6
- Appendix D: Climatic Data
- Appendix F: Addenda Description Information
- Appendix G: Performance Rating Method

Chapter 5: Building Envelope (outline) – slide 4

- 5.1: General
- 5.2: Compliance Paths
- 5.3: *(not used in this chapter)*
- 5.4: Mandatory Provisions
- 5.5: Prescriptive Building Envelope Option
- 5.6: Building Envelope Trade-Off Option
- 5.7: Submittals
- 5.8: Product Information and Installation Requirements

Space-Conditioning Categories (§5.1.2) – slide 5

- 5.1.2.1(a) nonresidential conditioned space:
“all occupancies other than residential”
- (b) residential conditioned space:
“spaces in buildings used primarily for living and sleeping. Residential spaces include, but are not limited to, dwelling units, hotel/motel guest rooms, dormitories, nursing homes, patient rooms in hospitals, lodging houses, fraternity/sorority houses, hostels, prisons, and fire stations”
- (c) semi-heated space:
“heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h·ft² of floor area but is not a conditioned space”

Space-Conditioning Definition – slide 6

- Conditioned space:
“a cooled space, heated space, or indirectly conditioned space defined as follows:
 - cooled space: an enclosed space within a building that is cooled by a cooling system whose sensible output capacity exceeds 5 Btu/h·ft² of floor area
 - heated space: an enclosed space within a building that is heated by a heating

system whose output capacity relative to the floor area is greater than or equal to the criteria in Table 3.1”

- Comment:
 - “conditioned” does not mean air-conditioned, it includes heated-only spaces
 - very few spaces qualify as semiheated

Space-Conditioning Categories (§5.1.2) – slide 7

- 5.1.2.2: Assumption of conditioned space:

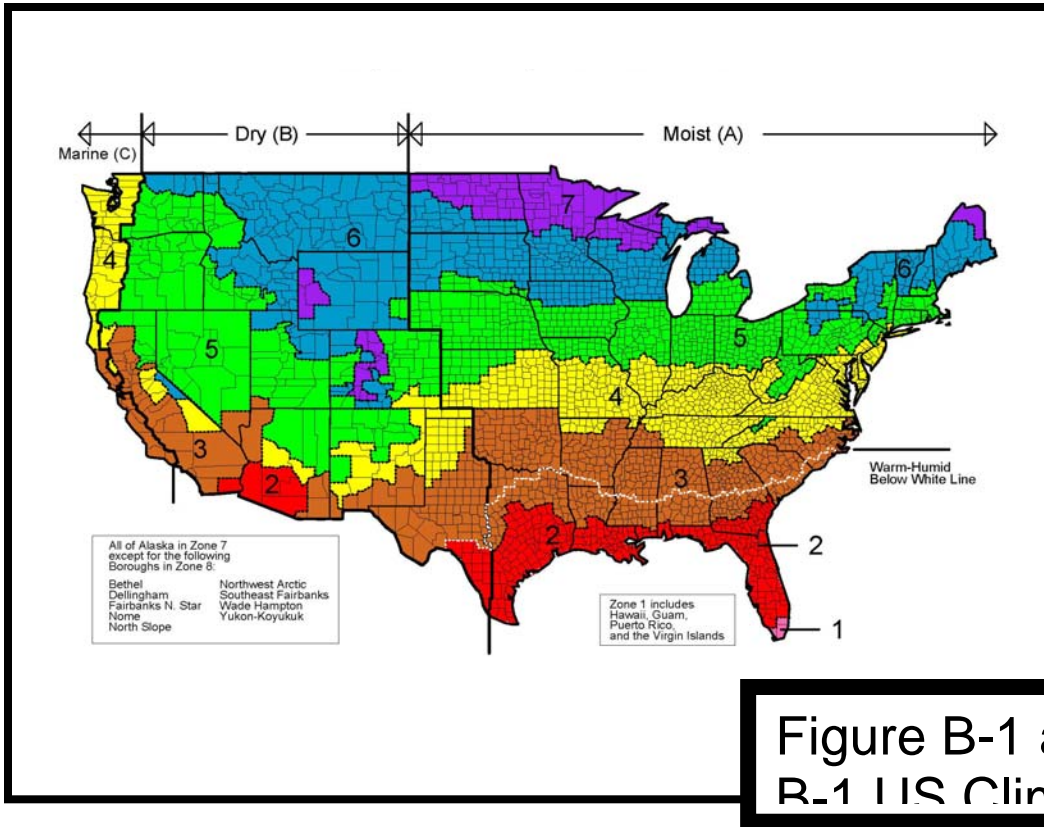
“Spaces shall be assumed to be conditioned space and shall comply with the requirements for conditioned space at the time of construction, regardless of whether mechanical or electrical equipment is included in the building permit application or installed at that time.”

except “...if approved by the building official”
- - meant to address problem of non-compliance in speculative buildings like warehouses where owners want to pass cost to tenants and it is more expensive to insulate later
 - example exception would be lumber storage

Climate (§5.1.4) continued – slide 8

- 5.1.4.1: United States locations:
 - Use Figure B-1 or Table B-1 in Appendix B to determine the required climate zone (climate zones are specified by county)
- 5.1.4.2: Canada and international locations:
 - For Canada, use Table B-2 in Appendix B,
 - For international, use Table B-3,
 - For locations not listed, use Table B-4
- ***Later examples show the criteria for nonresidential uses in Climate Zone 5: Boston, Pittsburgh, Chicago, Omaha, Denver, Flagstaff, Reno, Vancouver BC.***

Climate Zones and Climatic Data, Normative Appendices B and D – slide 9



Mandatory Provisions (§5.4) – slide 10

- Insulation (§5.4.1, 5.8.1)
to be discussed with Prescriptive Option
- Fenestration and Doors (§5.4.2, 5.8.2)
to be discussed with Prescriptive Option
- Air Leakage (§5.4.3)
- **Note: Standard 90.1 and LEED require compliance with these mandatory provisions regardless of how energy-efficient the building is or how great the energy savings are.**

Air Leakage (§5.4.3) – slide 11

- Building Envelope Sealing (§5.4.3.1)
- seal, caulk, gasket, weatherstrip all openings
- Fenestration and Doors (§5.4.3.2)
- air leakage < 1.0 cfm/ft² for glazed swinging doors & revolving doors, < 0.4 cfm/ft² for others
- Loading Dock Weatherseals (§5.4.3.3)
- in CZ 4-8 to limit leakage when truck parked

- Vestibules (§5.4.3.4)
 - for entrances in bldgs > 4 stories in CZ 3-8
 - exceptions for small spaces, revolving doors
 (Note: Criteria are more stringent in 90.1-2007.)

Prescriptive Option (§5.5) – slide 12

- Opaque assemblies (§5.5.3)
 - roofs (3 categories)
 - walls, above grade (4 categories)
 - walls, below grade (1 category)
 - floors (3 categories)
 - slab-on-grade floors (2 categories)
 - opaque doors (2 categories)
- Fenestration (§5.5.4)
 - vertical glazing (2 categories)
 - (4 different categories in 90.1-2007)
 - skylights (3 categories)

Opaque Assemblies (§5.5.3) – slide 13

- Two compliance options (§5.5.3)
- R-value of insulation alone:
 - “R-values of insulation for the thermal resistance of the added insulation in framing cavities and continuous insulation only”
 - does not include air films or building materials
 - sometimes only continuous insulation (ci)
- U-factor, C-factor, or F-factor for the entire assembly:
 - “The values ... listed in Normative Appendix A shall be used to determine compliance”

Opaque Assemblies (§5.5.3) – slide 14

**TABLE 5.5-5
Building Envelope Requirements For Climate Zone 5 (A,B,C)**

	Nonresidential		Residential		Semiheated	
	Assembly	Insulation Min.	Assembly	Insulation Min.	Assembly	Insulation Min.
Opaque Elements	Maximum	R-Value	Maximum	R-Value	Maximum	R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.063	R-15.0 ci	U-0.063	R-15.0 ci	U-0.173	R-5.0 ci
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.097	R-10.0
Attic and Other	U-0.034	R-30.0	U-0.027	R-38.0	U-0.053	R-19.0
<i>Walls, Above Grade</i>						
Mass	U-0.123	R-7.6 ci	U-0.090	R-11.4 ci	U-0.580	NR
Metal Building	U-0.113	R-13.0	U-0.057	R-13.0 + R-13.0	U-0.123	R-11.0
Steel Framed	U-0.08	R-13.0 + R-3.8 ci	U-0.064	R-13.0 + R-7.5 ci	U-0.124	R-13.0
Wood Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.089	R-13.0
<i>Wall, Below Grade</i>						
Below Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
<i>Floors</i>						
Mass	U-0.087	R-8.3 ci	U-0.074	R-10.4 ci	U-0.322	NR
Steel Joist	U-0.052	R-19.0	U-0.038	R-30.0	U-0.069	R-13.0
Wood Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.066	R-13.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-0.840	R-10 for 36 in.	F-0.840	R-10 for 36 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.700		U-0.700	
Non-Swinging	U-1.450		U-0.500		U-1.450	

Opaque Roofs (§5.5.3.1) – slide 15

- Roof w/ insulation above deck:
“all insulation installed above (outside of) the roof structure and continuous”
- Comments:
 - insulation R-value is a minimum for all locations, not acceptable to “average”
R-values for tapered insulation
 - assembly U-factors in Appendix A Table A2.2
 - exception allows reduction for cool roof

Climate Zone 5
2004: R-15 ci, U-0.063
2007: R-20 ci, U-0.048

Opaque Roofs (§5.5.3.1) – slide 16

- Metal building roof:
“metal, structural, weathering surface, no ventilated cavity, steel framing members”
- Comments:
 - exception to 5.8.1.2 allows metal building insulation to be compressed between roof skin and structure
 - assembly U-factors in Appendix A Table A2.3
 - exception allows reduction for cool roof

Climate Zone 5
2004: R-19, U-0.065
2007: addendum under review

Opaque Roofs (§5.5.3.1) – slide 17

- Attic and all other roofs:
“all other roofs”
- Comments:
 - 5.8.1.8 prohibits installing roof insulation on suspended ceiling with removable ceiling tiles
 - 5.8.1.6 prohibits recessing light fixtures into insulation unless area is < 1%
 - 5.8.1.4 requires baffles around eave vents
 - assembly U-factors in Appendix A in Tables A2.4 for wood joists, A2.5 for steel joists
 - possible reduction for single-rafter roofs

Climate Zone 5

2004: R-30, U-0.034

2007: R-38, U-0.027

Opaque Walls Above Grade (§5.5.3.2) – slide 18

- Wall above grade, mass:
“with a heat capacity exceeding 7 Btu/ft²·°F or a material unit weight of 5 Btu/ft²·°F if < 120 lb/ft³”
- Comments:
 - “ci” (§3.2 definitions) means insulation must be “continuous across all structural members without thermal bridges other than fasteners”
 - if metal or wood studs, then must use U-factor
 - assembly U-factors in Appendix A Table A3.1A
 - heat capacity in A3.1B, A3.1C, option in A3.1D

Climate Zone 5

2004: R-7.6 ci, U-0.123

2007: R-11.4 ci, U-0.090

Opaque Walls Above Grade (§5.5.3.2) – slide 19

- Wall above grade, metal building:
“metal spanning members supported by steel structural”
- Comments:
 - exception to 5.8.1.2 allows metal building insulation to be compressed between wall skin and structure
 - assembly U-factors in Appendix A Table A3.2

Climate Zone 5

2004: R-13, U-0.113

2007: addendum under review

Opaque Walls Above Grade (§5.5.3.2) – slide 20

- Wall above grade, steel-framed:
“typical steel stud walls and curtain wall systems”
- Comments:
 - cavity insulation must also be accompanied by continuous insulation due to thermal bridging
 - assembly U-factors in Appendix A Table A3.3
 - Table A9.2B shows that R-13 insulation only achieves an effective R-6.0 in metal studs
(R-19 in 6” stud only achieves R-7.1)

Climate Zone 5

2004: R-13 + R-3.8 ci,
U-0.084

2007: R-13 + R-7.5 ci,
U-0.064

Opaque Walls Above Grade (§5.5.3.2) – slide 21

- Wall above grade, wood-framed:
“all other wall types, including wood stud walls”
- Comments:
 - while wood studs perform better thermally than s
 - still beneficial
 - assembly U-factors in Appendix A Table A3.4
 - compressing insulation reduces R-value, Table A9.4C shows that R-19 insulation only has an effective R-13 when forced into 4” studs

Climate Zone 5

2004: R-13, U-0.089

2007: R-13 + R-3.8 ci,
U-0.064

Opaque Walls Above Grade (§5.5.3.3) – slide 22

- Wall below grade:
“that portion of a wall ...that is entirely below the finish grade and in contact with the ground”
- Comments:
 - insulation must be continuous across the wall
 - if metal or wood studs, then must use C-factor
 - assembly C-factors in Appendix A Table A4.2
(C-factor does not include R-values for exterior or interior air films or for soil)

Climate Zone 5

2004: NR, C-1.140

2007: R-7.5 ci, C-0.119

Opaque Floors (§5.5.3.4) – slide 23

- Mass floor:
“with a heat capacity exceeding 7 Btu/ft²·°F or a material unit weight of 5 Btu/ft²·°F if < 120 lb/ft³”
- Comments:
 - waffle-slab floors shall be insulated either on the interior above the slab or on all exposed surfaces of the waffle (A5.2.2.3)
 - similar for concrete beams (A5.2.2.4)
 - assembly U-factors in Appendix A Table A5.2

Climate Zone 5

2004: R-8.3 ci, U-0.087

2007: R-10.4 ci, U-0.074

Opaque Floors (§5.5.3.4) – slide 24

- Steel joist floors:
“steel joist members supported by structural members”
- Comments:
 - 5.8.1.5 requires floor insulation be installed
“in substantial contact with the inside surface”
 - assembly U-factors in Appendix A Table A5.3
 - Table A9.2A shows that R-30 insulation only achieves an effective R-23.7 when installed between metal framing 4 feet on center

Climate Zone 5

2004: R-19, U-0.052

2007: R-30, U-0.038

Opaque Floors (§5.5.3.4) – slide 25

- Wood framed and other floors:
“all other floor types, including wood joist floors”
- Comments:
 - 5.8.1.5 requires floor insulation have
“supports no greater than 24 in. on center”
 - assembly U-factors in Appendix A Table A5.4

Climate Zone 5
2004: R-30, U-0.033
2007: same

Opaque Slab-on-Grade (§5.5.3.5) – slide 26

Slab-on-grade floor:

“a slab floor...in contact with the ground and that is either above grade or is \leq 24 in. below the final elevation of the nearest exterior grade”

- Unheated slab-on-grade floor:
“a slab-on-grade that is not a heated slab-on-grade floor”
- Heated slab-on-grade floor:
“a slab-on-grade with a heating source either within or below it”

Climate Zone 5
2004: NR, F-0.730
2007: same

Climate Zone 5
2004: R-10 for 36 inches
F-0.840
2007: R-15 for 24 inches
F-0.860

Opaque Door (§5.5.3.6) – slide 27

Door:

“all operable opening areas (which are not fenestration) ...including swinging and roll-up doors, fire doors, and access hatches. Doors...more than one-half glass are... fenestration.”

- Swinging:
“all operable opaque panels with hinges on one side and opaque revolving doors”
- Non-swinging:
“roll-up, sliding, and...doors that are not swinging doors”

Climate Zone 5
2004: U-0.700
2007: same

Climate Zone 5
2004: U-1.450
2007: U-0.500

Fenestration (§5.5.4) – slide 28

	Assembly	Assembly Max.	Assembly	Assembly Max.	Assembly	Assembly Max.
	Max. U	SHGC (All	Max. U	SHGC (All	Max. U	SHGC (All
	(Fixed/	Orientations/	(Fixed/	Orientations/	(Fixed/	Orientations/
	Operable)	North-Oriented)	Operable)	North-Oriented)	Operable)	North-Oriented)
<i>Vertical Glazing, % of Wall</i>						
0-10.0%	U ^{fixed} -0.37	SHGC ^{all} -0.49	U ^{fixed} -0.37	SHGC ^{all} -0.49	U ^{fixed} -1.22	SHGC ^{all} -NR
	U ^{oper} -0.43	SHGC ^{north} -0.49	U ^{oper} -0.43	SHGC ^{north} -0.49	U ^{oper} -1.27	SHGC ^{north} -NR
10.1-20.0%	U ^{fixed} -0.37	SHGC ^{all} -0.39	U ^{fixed} -0.37	SHGC ^{all} -0.39	U ^{fixed} -1.22	SHGC ^{all} -NR
	U ^{oper} -0.43	SHGC ^{north} -0.49	U ^{oper} -0.43	SHGC ^{north} -0.49	U ^{oper} -1.27	SHGC ^{north} -NR
20.1-30.0%	U ^{fixed} -0.37	SHGC ^{all} -0.39	U ^{fixed} -0.37	SHGC ^{all} -0.39	U ^{fixed} -1.22	SHGC ^{all} -NR
	U ^{oper} -0.43	SHGC ^{north} -0.49	U ^{oper} -0.43	SHGC ^{north} -0.49	U ^{oper} -1.27	SHGC ^{north} -NR
30.1-40.0%	U ^{fixed} -0.37	SHGC ^{all} -0.39	U ^{fixed} -0.37	SHGC ^{all} -0.39	U ^{fixed} -1.22	SHGC ^{all} -NR
	U ^{oper} -0.43	SHGC ^{north} -0.49	U ^{oper} -0.43	SHGC ^{north} -0.49	U ^{oper} -1.27	SHGC ^{north} -NR
40.1-50.0%	U^{fixed}-0.46	SHGC^{all}-0.25	U^{fixed}-0.46	SHGC^{all}-0.25	U^{fixed}-0.98	SHGC^{all}-NR
<i>Skylight with Curb, Glass, % of Roof</i>						
0-2.0%	U ^{all} -1.17	SHGC ^{all} -0.49	U ^{all} -1.17	SHGC ^{all} -0.49	U ^{all} -1.58	SHGC ^{all} -NR
2.1-5.0%	U ^{all} -1.17	SHGC ^{all} -0.39	U ^{all} -1.17	SHGC ^{all} -0.39	U ^{all} -1.58	SHGC ^{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0-2.0%	U ^{all} -1.10	SHGC ^{all} -0.77	U ^{all} -1.10	SHGC ^{all} -0.77	U ^{all} -1.50	SHGC ^{all} -NR
2.1-5.0%	U ^{all} -1.10	SHGC ^{all} -0.62	U ^{all} -1.10	SHGC ^{all} -0.62	U ^{all} -1.50	SHGC ^{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0-2.0%	U ^{all} -0.66	SHGC ^{all} -0.49	U ^{all} -0.66	SHGC ^{all} -0.49	U ^{all} -1.56	SHGC ^{all} -NR
2.1-5.0%	U ^{all} -0.66	SHGC ^{all} -0.39	U ^{all} -0.66	SHGC ^{all} -0.39	U ^{all} -1.56	SHGC ^{all} -NR

Fenestration Definition (§3.2) – slide 29

- **Fenestration:**
“all areas (including the frames) in the building envelope that let in light, including windows, plastic panels, clerestories, skylights, glass doors that are more than one-half glass, and glass block walls”
- **Comments:**
- if it is not insulated roof, wall, or floor, then it is fenestration

Fenestration Ratings (§5.8.2) – slide 30

- **U-factor** (§5.8.2.4)
“U-factors shall be determined in accordance with NFRC 100.
U-factors for skylights shall be determined for a slope of 20 degrees above the horizontal.”
- **Comments:**
- ratings are for overall product including glass, sash, and frame (not center of glass)
- the overall product U-factor w/frame can be twice as high as the center-of-glass U-factor
- higher U-factor for products at a slope

Fenestration Ratings (§5.8.2) – slide 31

- NFRC 100
 - first published in 1991
 - certified by U.S. DOE as EAct-compliant
 - specifies standard rating conditions and sizes for apples-to-apples comparison
 - includes all product types: glazed wall systems (i.e. curtainwalls/storefronts), sloped glazing, skylights, casement, awning, picture, slider, pivoted, swinging doors, sliding doors, etc.
 - ratings are based on simulation, not testing (limited testing is done for validation)
 - further information at www.nfrc.org

Fenestration Ratings (§5.8.2) – slide 32

- Solar Heat Gain Coefficient (§5.8.2.5)
“SHGC for the overall fenestration area shall be determined in accordance with NFRC 200.”
- Exceptions to 5.8.2.5:
 - (a) allowable to use shading coefficient (SC) for the center of the glass multiplied by 0.86 provided that SC is from a spectral data file determined in accordance with NFRC 300

Fenestration Ratings (§5.8.2) – slide 33

- Exceptions to 5.8.2.5 (cont.):
 - (b) allowable to use SHGC for the center of the glass (instead of for the overall product)
- Comments:
 - using the exceptions does not give the full credit that the NFRC-certified SHGC does
 - though the SHGC for the frame is not zero
(ranges from 0.11-0.14 for metal frames and from 0.02 to 0.07 for wood/vinyl/ fiberglass), the SHGC for the frame is almost-always lower than the SHGC for the glass

Fenestration Ratings (§5.8.2) – slide 34

- Visible Light Transmittance (§5.8.2.6)
“Visible light transmittance shall be determined in accordance with NFRC 200.”
- Comments:
 - only necessary if using the EnvStd compliance option in §5.6
 - however, NFRC requires products to be rated for visible light transmittance as well as U-factor and SHGC, so information available

- important for daylighting, can now find products with VT more than twice as high as SHGC

Fenestration Ratings (§5.8.2) – slide 35

- Ratings (§5.8.2.1)
 “U-factor, solar heat gain coefficient (SHGC)... shall be determined by a laboratory accredited by a nationally recognized accreditation organization, such as the National Fenestration Rating Council ”
- - ratings done by a qualified, independent party
 (though software is helpful for designers and is used by manufacturers for product design)
 - Appendices A8.1 & A8.2 provide some limited default values for unlabeled products

Fenestration Ratings (§5.8.2) – slide 36

- Labeling (§5.8.2.2-3)
 “All manufactured fenestration products shall have a permanent nameplate, installed by the manufacturer, listing the U-factor, solar heat gain coefficient (SHGC)”
 OR
 “...certification for the installed fenestration listing the U-factor, SHGC”
- NFRC labeling for inspectors:
 - manufactured products, 4” x 4” label at factory
 - site-built products, 8-1/2” x 11” label certificate

Fenestration Labeling (§5.8.2) – slide 37

	World's Best Window Co. Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: Vertical Slider	
	ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient	
0.35	0.32	
ADDITIONAL PERFORMANCE RATINGS		
Visible Transmittance	Air Leakage (U.S./I-P)	
0.51	0.2	
<small>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. www.nfrc.org</small>		

Fenestration Labeling (§5.8.2) – slide 38

<p>NFRC PRODUCT CERTIFICATION PROGRAM</p> <hr/> <p>NFRC Label Certificate for Site-Built Products</p> <p>Project Location</p> <p>Street Address: _____</p> <p>City: _____ State: _____ Zip Code: _____</p> <p>Project Name (Optional): _____ Designer (Optional): _____</p> <hr/> <p>Product Line Information</p> <p>Operator Type (per Table 4-3 of NFRC 100) _____</p> <p>Product Line ID No. _____ Individual Product ID No. _____</p> <p>How many of this individual product _____ Location in building _____</p> <p>Elevation drawing page _____ Fenestration (window & door) schedule page _____</p> <hr/> <p>Frame Material Supplier Company name: _____</p> <p>City: _____ State: _____ Zip Code: _____</p> <p>Street Address: _____</p> <p>Contact: _____ Phone: _____ Fax: _____</p> <hr/> <p>Glazing Material Supplier Company name: _____</p> <p>City: _____ State: _____ Zip Code: _____</p> <p>Street Address: _____</p> <p>Contact: _____ Phone: _____ Fax: _____</p> <hr/> <p>Glazing Contractor/Installer Comp. name: _____</p> <p>City: _____ State: _____ Zip Code: _____</p> <p>Street Address: _____</p> <p>Contact: _____ Phone: _____ Fax: _____</p> <hr/> <p>Certification Authorization</p> <p>Independent Certification & Inspection Agency (IA): _____</p> <p>Date Certification Authorization Issued: _____</p>	 <div style="text-align: center;"> <p>World's Best Window Co.</p> <p>Millennium 2000+ Vinyl Clad Wood Frame Double Glazing - Argon Fill - Low E Product Type: Vertical Slider</p> </div> <table border="1" style="width: 100%; text-align: center;"> <tr> <th colspan="2">ENERGY PERFORMANCE RATINGS</th> </tr> <tr> <td>U-Factor (U.S./I-P)</td> <td>Solar Heat Gain Coefficient</td> </tr> <tr> <td style="font-size: 1.5em;">0.35</td> <td style="font-size: 1.5em;">0.32</td> </tr> <tr> <th colspan="2">ADDITIONAL PERFORMANCE RATINGS</th> </tr> <tr> <td>Visible Transmittance</td> <td>Air Leakage (U.S./I-P)</td> </tr> <tr> <td style="font-size: 1.5em;">0.51</td> <td style="font-size: 1.5em;">0.2</td> </tr> </table> <p style="font-size: 0.8em;">Manufacturers stipulate that these ratings conform to applicable NFRC procedures for determining what product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product use. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. www.nfrc.org</p>	ENERGY PERFORMANCE RATINGS		U-Factor (U.S./I-P)	Solar Heat Gain Coefficient	0.35	0.32	ADDITIONAL PERFORMANCE RATINGS		Visible Transmittance	Air Leakage (U.S./I-P)	0.51	0.2
ENERGY PERFORMANCE RATINGS													
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient												
0.35	0.32												
ADDITIONAL PERFORMANCE RATINGS													
Visible Transmittance	Air Leakage (U.S./I-P)												
0.51	0.2												

Fenestration General (§5.5.4.1) – slide 39

- Calculation methodology:
 “Gross wall areas and gross roof areas shall be calculated separately for each space-conditioning category for the purposes of determining compliance.”
- - for mixed-use buildings, must do separate calculations for nonresidential, residential, and semiheated spaces.
 - within these subcategories, an exception allows area-weighted averaging for U-factor, SHGC

Fenestration Area Definition (§3.2) – slide 40

Fenestration area:

“total area of the fenestration measured using the rough opening and including the glazing, sash, and frame. For doors where the glazed vision area is less than 50% of the door area, the fenestration area is the glazed vision area. For all other doors, the fenestration area is the door area.”

- - must use rough opening, not glass area

Fenestration Area Definition (§3.2) – slide 41

- Vertical glazing:
“all fenestration other than skylights”
- Skylights:
“a fenestration surface having a slope of less than 60 degrees from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered vertical fenestration”
- - clerestories and roof monitors are considered vertical fenestration

Fenestration Area (§5.5.4.2) – slide 42

- Vertical:
“total vertical fenestration area shall be less than 50% of the gross wall area”
- Skylights:
“total skylight area shall be less than 5% of the gross roof area”
- - exception allows up to 75% area for the street-side of street-level retail provided it has projection factor (overhang) > 0.5

Climate Zone 5
2004: 50% max.
2007: 40% max.

Climate Zone 5
2004: 5% max.
2007: same

Fenestration U-Factor (§5.5.4.3) – slide 43

- Vertical, fixed (curtainwall):
2004: all frame materials, < 40%
2007: metal/other
- Vertical, operable:
2004: all frame materials, < 40%
2007: metal/other
- - for 2004, typically achieve with double-glazing with a very-good low-emissivity coating
- for 2007, also need thermal-break in the frame

Climate Zone 5
2004: U-0.57 max.
2007: U-0.45/0.35 max.

Climate Zone 5
2004: U-0.67 max.
2007: U-0.55/0.35 max.

Fenestration SHGC (§5.5.4.4) – slide 44

- Vertical, north-oriented:
2004: varies by area, 30-40%
2007: same for all areas
- Vertical, other-oriented:
2004: varies by area, 30-40%
2007: same for all areas
- - exception allows credit for “each fenestration product shaded by permanent projections that will last as long as the building itself”

Climate Zone 5

2004: SHGC-0.49 max.

2007: SHGC-0.40 max.

Climate Zone 5

2004: SHGC-0.39 max.

2007: SHGC-0.40 max.

Fenestration U-Factor (§5.5.4.3) – slide 45

- Skylight, glass with curb and plastic with curb:
- Skylight, all materials without curb:
- - skylights with curbs can have a surface area that is double the rough opening area
- - skylights without curbs are sloped glazing like curtainwalls but higher heat loss due to slope

Climate Zone 5

2004: U-1.17/1.10 max.

2007: same

Climate Zone 5

2004: U-0.69 max.

2007: same

Fenestration SHGC (§5.5.4.4) – slide 46

- Skylight, glass with curb and plastic with curb:
- Skylight, all materials without curb:
- - glass skylights can achieve the same SHGC as vertical fenestration with same low-e coating
- - plastic skylights must use other technologies
- - for 2010, may require w/auto daylighting control

Climate Zone 5

2004: SHGC-0.39/0.62

2007: same

Climate Zone 5

2004: SHGC-0.39 max.

2007: same

EnvStd Trade-Off Option (§5.6) – slide 47

- More flexibility, but more work
- Trade-offs limited to envelope components - no lighting or HVAC
- Includes daylighting – need good VT
- Methodology and assumptions in Appendix C
- See Users Manual with EnvStd

More Building Envelope Energy Efficiency – slide 48

- ASHRAE/IESNA Standard 90.1-2007:
 - requires increased insulation, better fenestration
 - to be published this summer
- ASHRAE/USGBC/IESNA Standard 189P, *Design for High-Performance Green Buildings Except Low-Rise Residential Buildings*:
 - available for public review through July 9th
 - goal of 30% additional energy savings
 - requires increased insulation, better fenestration
 - addresses fenestration orientation, exterior shading

More Information – slide 51

- Standard 90.1-2004, the Users Manual, and more detailed training opportunities are available from:

www.ashrae.org

- More information on the standard and compliance tools available from:

www.energycodes.gov