BRAUN INTERTEC

The Science You Build On.

SPECIFYING COMMERCIAL WINDOWS AND GLAZING SYSTEMS TO SUIT YOUR PROJECT

Presenters

- Steve Flaten, AIA
  Principal, Senior Architect

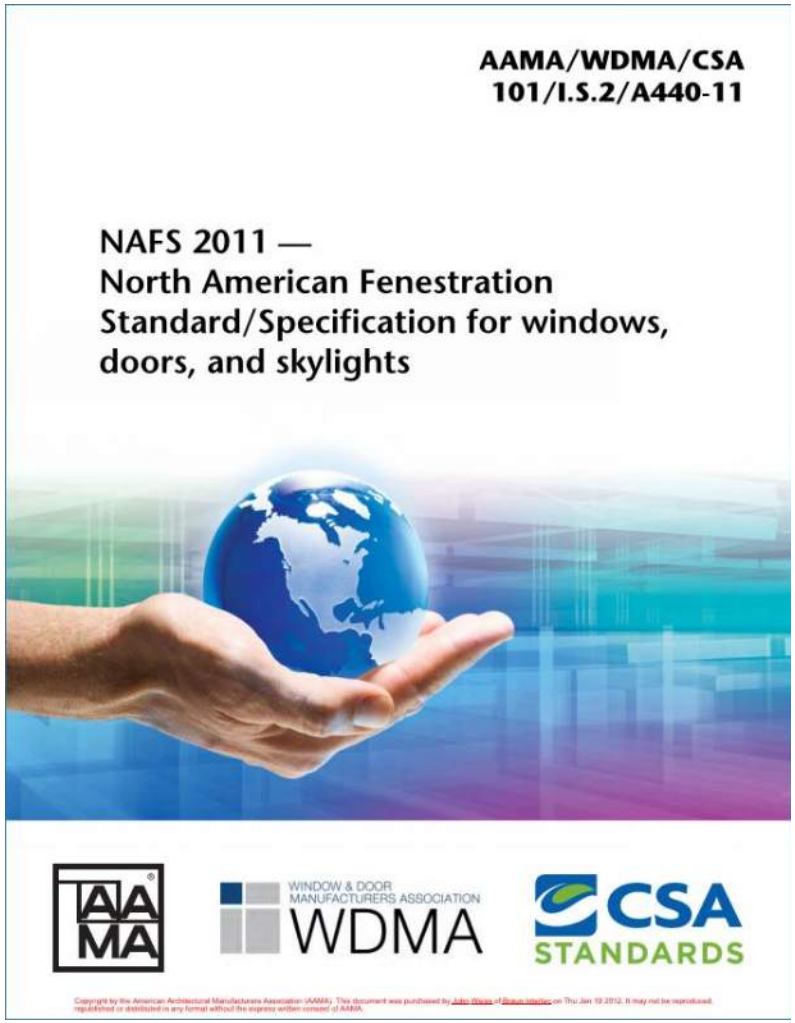
- Jack R. Rasmussen, AIA, NCARB
  Associate Principal, Senior Architect
  Enclosure Consulting & Forensics Manager

What We Are Going to Cover Today

- Differences in window types
- Performance criteria and grades
- Installation of windows
- Quality Assurance: Field Window testing
- Specifying Window Systems and Testing
- Examples – The Good, the Bad, the Ugly

Differences in Window Types

- Definitions
- Terminology



Definitions

- Fenestration: Openings in the building envelope, such as *windows*, doors, secondary storm products, *curtain walls*, *storefronts*, roof windows, tubular daylighting devices, sloped glazing and skylights, designed to permit the passage of air, light, or people.

Definitions

- Window: An operable or non-operable assembly that is installed in an opening within an exterior wall or roof intended to admit light or air to an enclosure, and is usually framed and glazed.
  - Typically flashed opening controls water penetration directing back to exterior
  - Wind load transferred through nailing flange or direct attachment through perimeter frame
  - Typically pre-glazed factory unit

Definitions

- Windows – Sealed direct to weather barrier with perimeter sealant joint or tapes

Flanged

Non-Flanged

Definitions

- Storefront: A non-residential, non-load-bearing assembly of commercial entrance systems and windows usually spanning between the floor and the structure above.
  - Control water by diverting it through the system and out through the sill.
  - Wind load transferred to perimeter where framing anchored to wall
  - Inside or outside glazed

Definitions

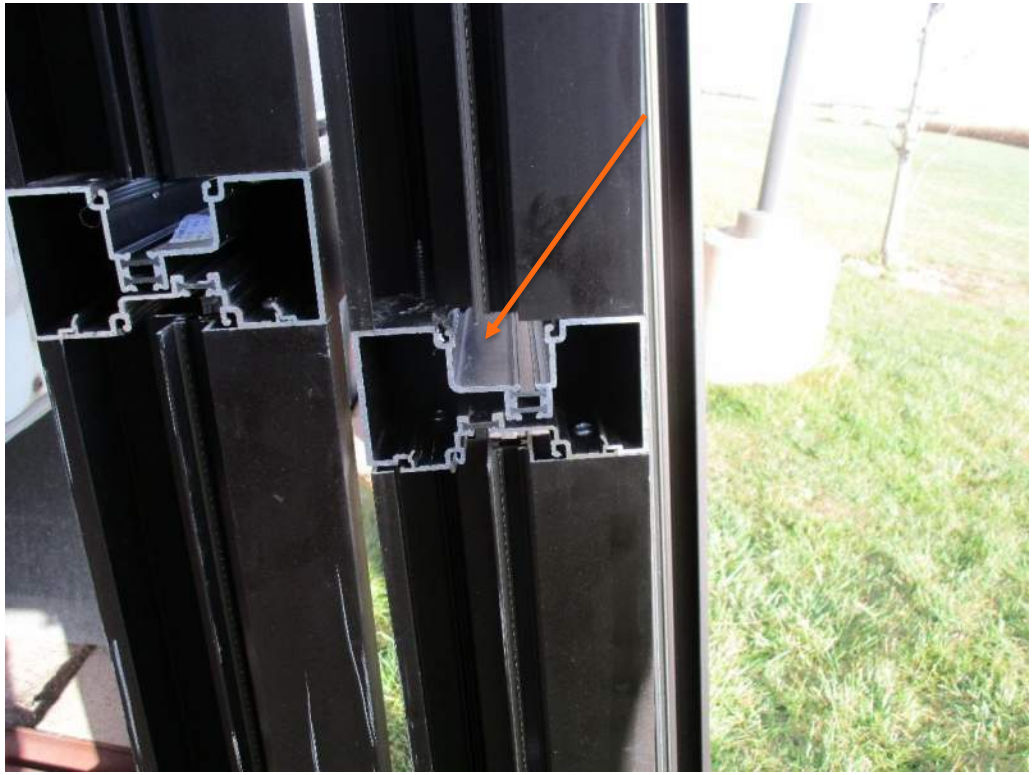
- Storefront

Definitions

- Storefront – water penetration diverted through glazing pocket

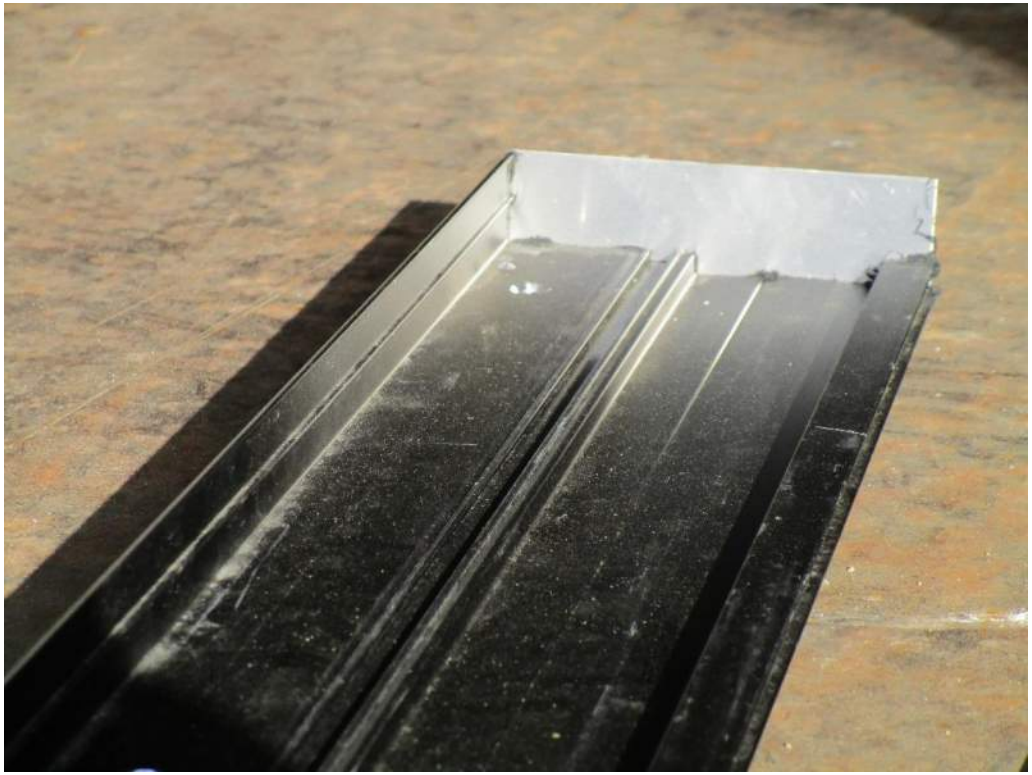
Definitions

- Storefront – water drains down glazing pocket along vertical mullion



Definitions

- Storefront – water is deposited into sub-sill



Definitions

- Storefront – water weeps out of sub-sill

Definitions

- Curtain Wall: A non-load bearing exterior wall cladding that is hung to the exterior of the building usually spanning floor to floor.
  - Each piece of glass is an individual self-contained zone and weeps water outside the main framing
  - Wind load transferred to vertical mullions which are anchored to structure at top, bottom, and intermediate points (typically floor line)
  - Inside or outside glazed

Definitions

- Curtain Wall

Definitions

- Curtain Wall – Vertical framing is a single extrusion, or 2-piece, with a thermal break nose gasket

Definitions

- Curtain Wall – framing assembled

Definitions

- Curtain Wall – framing anchored to structure

Definitions

- Curtain Wall – sealants and gaskets at each glazed lite opening

Definitions

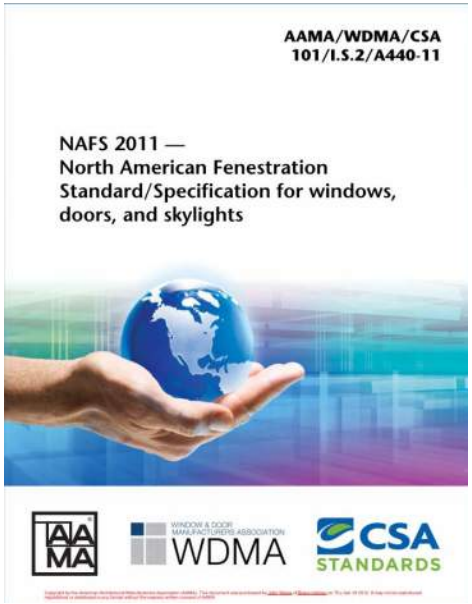
- Curtain Wall – glass and pressure plates installed

Definitions

- Curtain Wall – decorative snap covers and aesthetic sealant joint installed

Performance Criteria

- Uniform Load Deflection Test
- Uniform Load Structural Test
- Air Leakage Resistance
- Water Penetration Resistance
- Energy Performance: U-value
- Condensation Resistance Factor
- Operating Force (if applicable)
- Forced-Entry Resistance (if applicable)



Performance Criteria

- Uniform Load Deflection
  - Displacement due to flexure of a member under an applied load
- Uniform Load Structural Test:
  - 150% of the design pressure for windows and doors, and for uplift on unit skylights and roof windows.
  - 200% of the design pressure for download on unit skylights and roof windows.

Performance Criteria

- Air Leakage
  - The flow of air that passes through fenestration products.
- Water Penetration
  - Penetration of water beyond the plane intersecting the innermost projection of the test specimen, not including the interior trim and hardware, under the specified conditions of air pressure difference across the specimen.

Performance Criteria

- U-Factor
  - Code Requirements (Prescriptive)
  - Residential:

TABLE R402.1.1 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC[b,e]	CEILING[j] R-VALUE	WOOD FRAME WALL R-VALUE[f]	MASS WALL R-VALUE[i,g,h]	FLOOR R-VALUE	BASEMENT WALL R-VALUE[c,i]	SLAB R-VALUE AND DEPTH[d]	CRAWL SPACE WALL R-VALUE[c,i]
6	0.32	0.55	NR	49	20, 13+5	15/20	30e	15	10, 3.5 ft	15
7	0.32	0.55	NR	49	21	19/21	38e	15	10, 5 ft	15

Performance Criteria

- U-Factor
  - Code Requirements (Prescriptive)
  - Commercial:

TABLE C402.3 BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

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

NR = No requirement.

Performance Criteria

- U-Factor
  - Review Energy Code for requirements
  - Affected by climate zone
  - In MN – IECC or ASHRAE?
  - Remember, U-Factor is a maximum value – Lower is Better.

Performance Criteria

- Condensation
  - The deposition of moisture (liquid water or frost) on the surface of an object caused by warm, moist air coming in contact with a colder object.

Performance Criteria

- Condensation Resistance
  - CR vs. CRF – not “Apples to Apples”

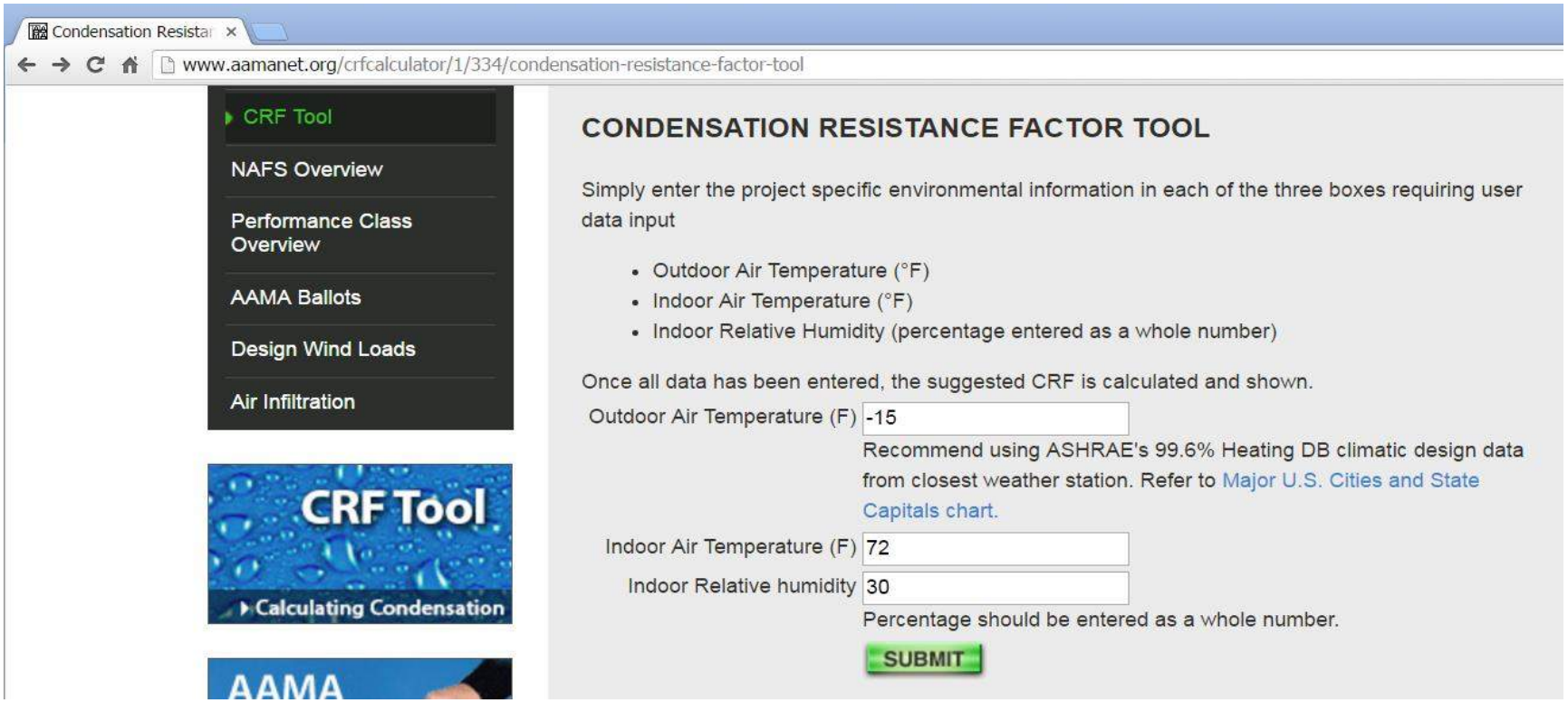
Performance Criteria

- Condensation Resistance
  - CR vs. CRF – not “Apples to Apples”
  - Condensation Resistance (CR)
    - NFRC – National Fenestration Rating Council
    - Scale of 1 to 100 – higher is better

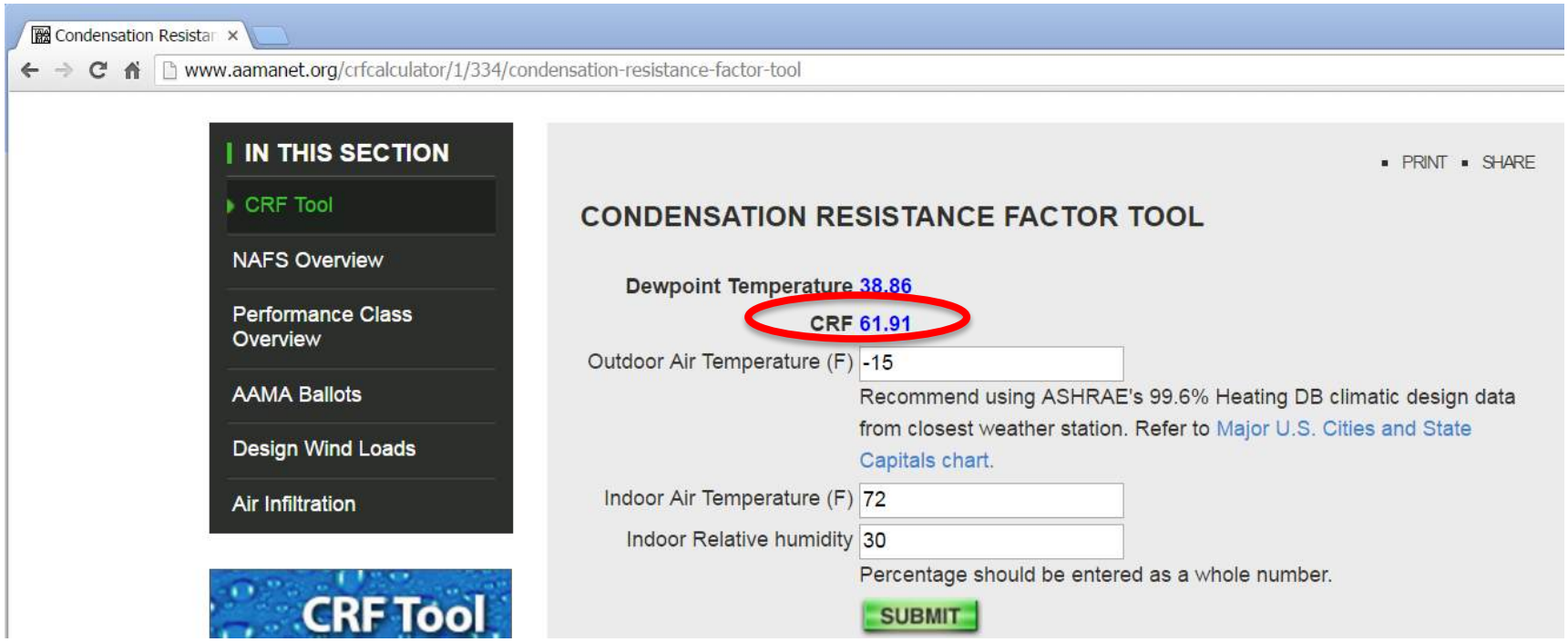
Performance Criteria

- Condensation Resistance
  - CR vs. CRF – not “Apples to Apples”
  - Condensation Resistance (CR)
    - NFRC – National Fenestration Rating Council
    - Scale of 1 to 100
  - Condensation Resistance Factor (CRF) – AAMA
    - AAMA – American Architectural Manufacturers Association
    - Scale of 30 to 80
    - Condensation Resistance Factor Tool
      - http://www.aamanet.org/crfcalculator/1/334/crf-tool

Performance Criteria



Performance Criteria



Performance Criteria

- Operating Force
  - The force required to initiate or maintain a sash, leaf, or panel in motion in either the opening or closing direction.
- Forced-Entry Resistance
  - The ability of a window or door in the locked position to resist entry under specified load and conditions.

Performance Classes

- R (Residential): Commonly used in one- and two-family dwellings

- LC (Light Commercial): Commonly used in low-rise and mid-rise multi-family dwellings and other buildings where larger sizes and higher loading requirements are expected

Performance Classes

- CW (Commercial Window): Commonly used in low-rise and mid-rise buildings were larger sizes, higher loading requirements, limits on deflection, and heavy use are expected

Performance Classes

- AW (Architectural Window): Commonly used in high-rise and mid-rise buildings to meet increased loading requirements and limits on deflection, and in buildings where frequent and extreme use of the fenestration product is expected

Product Types

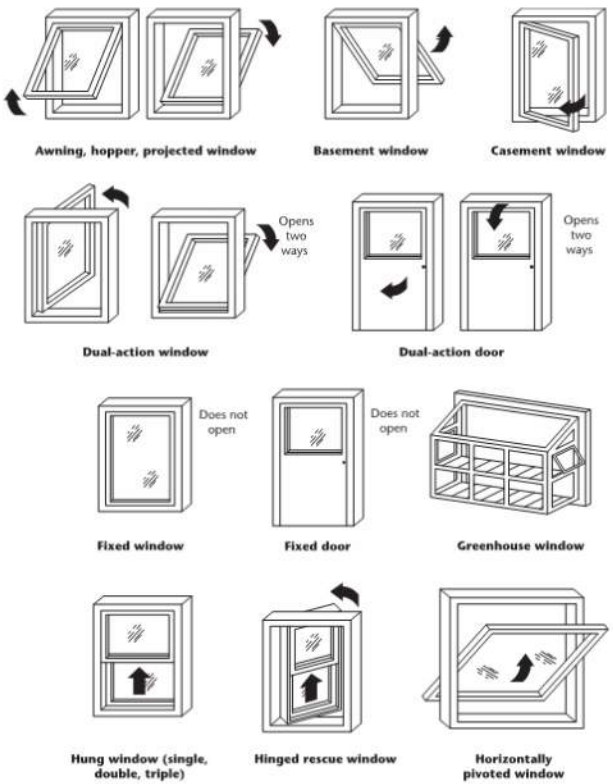


Figure 4.3
Product type illustrations
(See Clause 4.4.2.2.)

(Continued)

Product Types

Table 4.1
Product types
(See Clauses 4.4.2.1, 4.4.2.2, 12.1, and 12.3.2.)

AP	=	Awning, hopper, projected window	POW	=	Parallel opening window
ATD	=	Architectural terrace door	RWG	=	Roof window — glass glazed
BW	=	Basement window	RWP	=	Roof window — plastic glazed
C	=	Casement window	SD	=	Sliding door
DASHD	=	Dual-action side-hinged door	SHD	=	Side-hinged door
DAW	=	Dual-action window	SHW	=	Side-hinged (inswinging) window
FD	=	Fixed door	SKG	=	Unit skylight — glass glazed
FW	=	Fixed window	SKP	=	Unit skylight — plastic glazed
GH	=	Greenhouse window	SLT	=	Side lite
H	=	Hung window	SP	=	Specialty product
HE	=	Hinged rescue window	SSP	=	Secondary storm product
HP	=	Horizontally pivoted window	TA	=	Tropical awning window
HS	=	Horizontal sliding window	TDDCC	=	Tubular daylighting device — closed ceiling
J	=	Jalousie window	TDDOC	=	Tubular daylighting device — open ceiling
JA	=	Jal-awning window	TH	=	Top-hinged window
LW DASHD	=	Limited water dual-action side-hinged door	TR	=	Transom
LW SHD	=	Limited water side-hinged door	VP	=	Vertically pivoted window
MA	=	Mullion assembly	VS	=	Vertical sliding window

Performance Grades

- Gateway Performance Requirements: Each product type has a defined “gateway,” or minimum, set of primary requirements for the applicable product type. They are the minimum allowable performance levels that a gateway test specimen shall achieve, which translates into the Performance Grade.

Gateway Performance (Minimum)

- Class R & LC

Table 5.7
Gateway requirements
(See Clauses 0.2.5.1, 4.3.2.2, 4.4.3.2, 4.4.3.3, 4.4.3.4, 5, 5.3.1, 6.4.4, 9.3.4.2, and 9.3.4.3 and Table 0.1.)

Performance Class	Minimum Performance Grade (PG)	Minimum design pressure (DP)		Minimum structural test pressure (STP)		Minimum water penetration resistance test pressure	
		Pa	(~psf)	Pa	(~psf)	Pa	(~psf)
R	15	720	(15.04)	1080	(22.56)	140	(2.92)
LC	25	1200	(25.06)	1800	(37.59)	180	(3.76)

Note: *The IP equivalents identified are for approximate reference only and do not in any way imply accuracy of the measurement or the equipment. See Clause 1.3. Precision and bias statements are provided in the applicable test methods referenced in this Standard/Specification.*

- Class CW & AW

Table 7.7
Gateway requirements
(See Clauses 0.2.5.1, 4.3.2.2, 4.4.3.2, 4.4.3.3, 4.4.3.4, 6.4.4, 7, 7.3.1, 9.3.4.2, and 9.3.4.3 and Table 0.1.)

Windows and doors							
Performance Class	Minimum Performance Grade (PG)	Minimum design pressure (DP)		Minimum structural test pressure (STP)		Minimum water penetration resistance test pressure	
		Pa	(~psf)	Pa	(~psf)	Pa	(~psf)
CW	30	1440	(30.08)	2160	(45.11)	220	(4.59)
AW	40	1920	(40.10)	2880	(60.15)	390	(8.15)

Note: *The IP equivalents identified are for approximate reference only and do not in any way imply accuracy of the measurement or the equipment. See Clause 1.3. Precision and bias statements are provided in the applicable test methods referenced in this Standard/Specification.*

Optional Performance

- Class R & LC

Table 5.1
U.S. (only) optional Performance Grades (PG)
(See Clauses 0.2.5.1, 4.3.2.2, 4.4.3.2, 4.4.3.3, 4.4.3.4, 5.1.1, 6.4.4, 9.3.4.2, and 9.3.4.3, and Table 0.1.)

Performance Class and optional Performance Grades (PG)		Design pressure (DP)		Structural test pressure (STP)		Water penetration resistance test pressure	
R	LC	Pa	(~psf)	Pa	(~psf)	Pa	(~psf)
20	—	960	(20.05)	1440	(30.08)	150	(3.13)
25	—	1200	(25.06)	1800	(37.59)	180	(3.76)
30	30	1440	(30.08)	2160	(45.11)	220	(4.59)
35	35	1680	(35.09)	2520	(52.63)	260	(5.43)
40	40	1920	(40.10)	2880	(60.15)	290	(6.06)
45	45	2160	(45.11)	3240	(67.67)	330	(6.89)
50	50	2400	(50.13)	3600	(75.19)	360	(7.52)
55	55	2640	(55.14)	3960	(82.71)	400	(8.35)
60	60	2880	(60.15)	4320	(90.23)	440	(9.19)
65	65	3120	(65.16)	4680	(97.74)	470	(9.82)
70	70	3360	(70.18)	5040	(105.26)	510	(10.65)
75	75	3600	(75.19)	5400	(112.78)	540	(11.28)
80	80	3840	(80.20)	5760	(120.30)	580	(12.11)
85	85	4080	(85.21)	6120	(127.82)	580	(12.11)
90	90	4320	(90.23)	6480	(135.34)	580	(12.11)
95	95	4560	(95.24)	6840	(142.86)	580	(12.11)
100	100	4800	(100.25)	7200	(150.38)	580	(12.11)

Notes:

(1) *The IP equivalents identified are for approximate reference only and do not in any way imply accuracy of the measurement or the equipment. See Clause 1.3. Precision and bias statements are provided in the applicable test methods referenced in this Standard/Specification.*

(2) *Where products are subjected to increased risks of wind-driven rain events, or for other reasons, the water penetration resistance test pressure specified in this Table may be increased to a maximum of 720 Pa (~15.04 psf). Refer to AAMA TIR A13 for guidance.*

Optional Performance

- Class R & LC

Example:

R-PG30-H

Table 5.1
U.S. (only) optional Performance Grades (PG)
(See Clauses 0.2.5.1, 4.3.2.2, 4.4.3.2, 4.4.3.3, 4.4.3.4, 5.1.1, 6.4.4, 9.3.4.2, and 9.3.4.3, and Table 0.1.)

Performance Class and optional Performance Grades (PG)		Design pressure (DP)		Structural test pressure (STP)		Water penetration resistance test pressure	
R	LC	Pa	(~psf)	Pa	(~psf)	Pa	(~psf)
20	—	960	(20.05)	1440	(30.08)	150	(3.13)
25	—	1200	(25.06)	1800	(37.59)	180	(3.76)
30	30	1440	(30.08)	2160	(45.11)	220	(4.59)
35	35	1680	(35.09)	2520	(52.63)	260	(5.43)
40	40	1920	(40.10)	2880	(60.15)	290	(6.06)
45	45	2160	(45.11)	3240	(67.67)	330	(6.89)
50	50	2400	(50.13)	3600	(75.19)	360	(7.52)
55	55	2640	(55.14)	3960	(82.71)	400	(8.35)
60	60	2880	(60.15)	4320	(90.23)	440	(9.19)
65	65	3120	(65.16)	4680	(97.74)	470	(9.82)
70	70	3360	(70.18)	5040	(105.26)	510	(10.65)
75	75	3600	(75.19)	5400	(112.78)	540	(11.28)
80	80	3840	(80.20)	5760	(120.30)	580	(12.11)
85	85	4080	(85.21)	6120	(127.82)	580	(12.11)
90	90	4320	(90.23)	6480	(135.34)	580	(12.11)
95	95	4560	(95.24)	6840	(142.86)	580	(12.11)
100	100	4800	(100.25)	7200	(150.38)	580	(12.11)

Notes:

(1) *The IP equivalents identified are for approximate reference only and do not in any way imply accuracy of the measurement or the equipment. See Clause 1.3. Precision and bias statements are provided in the applicable test methods referenced in this Standard/Specification.*

(2) *Where products are subjected to increased risks of wind-driven rain events, or for other reasons, the water penetration resistance test pressure specified in this Table may be increased to a maximum of 720 Pa (~15.04 psf). Refer to AAMA TIR A13 for guidance.*

Optional Performance

- Class CW & AW

7 Class CW and AW windows and doors

Note: *See Table 7.7 for gateway performance requirements and Clause 6 for side-hinged doors.*

7.1 Class CW and AW requirements (specific to the U.S.)

Tables 7.1 and 7.2 provide requirements specific to the U.S.

Table 7.1
U.S. (only) optional Performance Grades (PG)
(See Clauses 0.2.5.1, 4.3.2.2, 4.4.3.2, 4.4.3.3, 4.4.3.4, 6.4.4, 7.1, 9.3.4.2, and 9.3.4.3 and Table 0.1.)

Performance Class and optional Performance Grades (PG)		Design pressure (DP)		Structural test pressure (STP)		Water penetration resistance test pressure			
						CW		AW	
CW	AW	Pa	(–psf)	Pa	(–psf)	Pa	(–psf)	Pa	(–psf)
35	—	1680	(35.09)	2520	(52.63)	260	(5.43)	—	
40	—	1920	(40.10)	2880	(60.15)	290	(6.06)	—	
45	45	2160	(45.11)	3240	(67.67)	330	(6.89)	440	(9.19)
50	50	2400	(50.13)	3600	(75.19)	360	(7.52)	480	(10.03)
55	55	2640	(55.14)	3960	(82.71)	400	(8.35)	530	(11.07)
60	60	2880	(60.15)	4320	(90.23)	440	(9.19)	580	(12.11)
65	65	3120	(65.16)	4680	(97.74)	470	(9.82)	580	(12.11)
70	70	3360	(70.18)	5040	(105.26)	510	(10.65)	580	(12.11)
75	75	3600	(75.19)	5400	(112.78)	540	(11.28)	580	(12.11)
80	80	3840	(80.20)	5760	(120.30)	580	(12.11)	580	(12.11)
85	85	4080	(85.21)	6120	(127.82)	580	(12.11)	580	(12.11)
90	90	4320	(90.23)	6480	(135.34)	580	(12.11)	580	(12.11)
95	95	4560	(95.24)	6840	(142.86)	580	(12.11)	580	(12.11)
100	100	4800	(100.25)	7200	(150.38)	580	(12.11)	580	(12.11)
—	No limit*	No limit*		1.5 × design pressure (DP)		580	(12.11)	580	(12.11)

**There is no limit for optional Performance Grades (PG) in the AW Performance Class.*

Notes:

(1) *The IP equivalents identified are for approximate reference only and do not in any way imply accuracy of the measurement or the equipment. See Clause 1.3. Precision and bias statements are provided in the applicable test methods referenced in this Standard/Specification.*

(2) *Where products are subjected to increased risks of wind-driven rain events, or for other reasons, the water penetration resistance test pressure specified in this Table may be increased to a maximum of 720 Pa (–15.04 psf). Refer to AAMA TIR A13 for guidance.*

Optional Performance

- Class R & LC

Example:

AW-PG50-F

7 Class CW and AW windows and doors

Note: *See Table 7.7 for gateway performance requirements and Clause 6 for side-hinged doors.*

7.1 Class CW and AW requirements (specific to the U.S.)

Tables 7.1 and 7.2 provide requirements specific to the U.S.

Table 7.1
U.S. (only) optional Performance Grades (PG)
(See Clauses 0.2.5.1, 4.3.2.2, 4.4.3.2, 4.4.3.3, 4.4.3.4, 6.4.4, 7.1, 9.3.4.2, and 9.3.4.3 and Table 0.1.)

Performance Class and optional Performance Grades (PG)		Design pressure (DP)		Structural test pressure (STP)		Water penetration resistance test pressure			
						CW		AW	
CW	AW	Pa	(−psf)	Pa	(−psf)	Pa	(−psf)	Pa	(−psf)
35	—	1680	(35.09)	2520	(52.63)	260	(5.43)	—	
40	—	1920	(40.10)	2880	(60.15)	290	(6.06)	—	
45	45	2160	(45.11)	3240	(67.67)	330	(6.89)	440	(9.19)
50	50	2400	(50.13)	3600	(75.19)	360	(7.52)	480	(10.03)
55	55	2640	(55.14)	3960	(82.71)	400	(8.35)	530	(11.07)
60	60	2880	(60.15)	4320	(90.23)	440	(9.19)	580	(12.11)
65	65	3120	(65.16)	4680	(97.74)	470	(9.82)	580	(12.11)
70	70	3360	(70.18)	5040	(105.26)	510	(10.65)	580	(12.11)
75	75	3600	(75.19)	5400	(112.78)	540	(11.28)	580	(12.11)
80	80	3840	(80.20)	5760	(120.30)	580	(12.11)	580	(12.11)
85	85	4080	(85.21)	6120	(127.82)	580	(12.11)	580	(12.11)
90	90	4320	(90.23)	6480	(135.34)	580	(12.11)	580	(12.11)
95	95	4560	(95.24)	6840	(142.86)	580	(12.11)	580	(12.11)
100	100	4800	(100.25)	7200	(150.38)	580	(12.11)	580	(12.11)
—	No limit*	No limit*		1.5 × design pressure (DP)		580	(12.11)	580	(12.11)

**There is no limit for optional Performance Grades (PG) in the AW Performance Class.*

Notes:

(1) *The IP equivalents identified are for approximate reference only and do not in any way imply accuracy of the measurement or the equipment. See Clause 1.3. Precision and bias statements are provided in the applicable test methods referenced in this Standard/Specification.*

(2) *Where products are subjected to increased risks of wind-driven rain events, or for other reasons, the water penetration resistance test pressure specified in this Table may be increased to a maximum of 720 Pa (−15.04 psf). Refer to AAMA TIR A13 for guidance.*

Optional Performance

- Class R & LC

Table 5.3
Maximum allowable air leakage
(See Clauses 5.1.1, 9.3.2.1, and 9.3.2.4, and Table 0.1.)

Performance Class	Positive test pressure		Maximum allowable leakage	
	Pa	(~psf)	L/s•m²	(~cfm/ft²)
R (jalousie windows only)	75	(1.57)	6.0	(1.18)
R, LC (except jalousie windows)	75	(1.57)	1.5	(0.30)

Note: *The IP equivalents identified are for approximate reference only and do not in any way imply accuracy of the measurement or the equipment. See Clause 1.3. Precision and bias statements are provided in the applicable test methods referenced in this Standard/Specification.*

- Class CW & AW

Table 7.3
Maximum allowable air leakage
(See Clauses 9.3.2.1 and 9.3.2.4 and Table 0.1.)

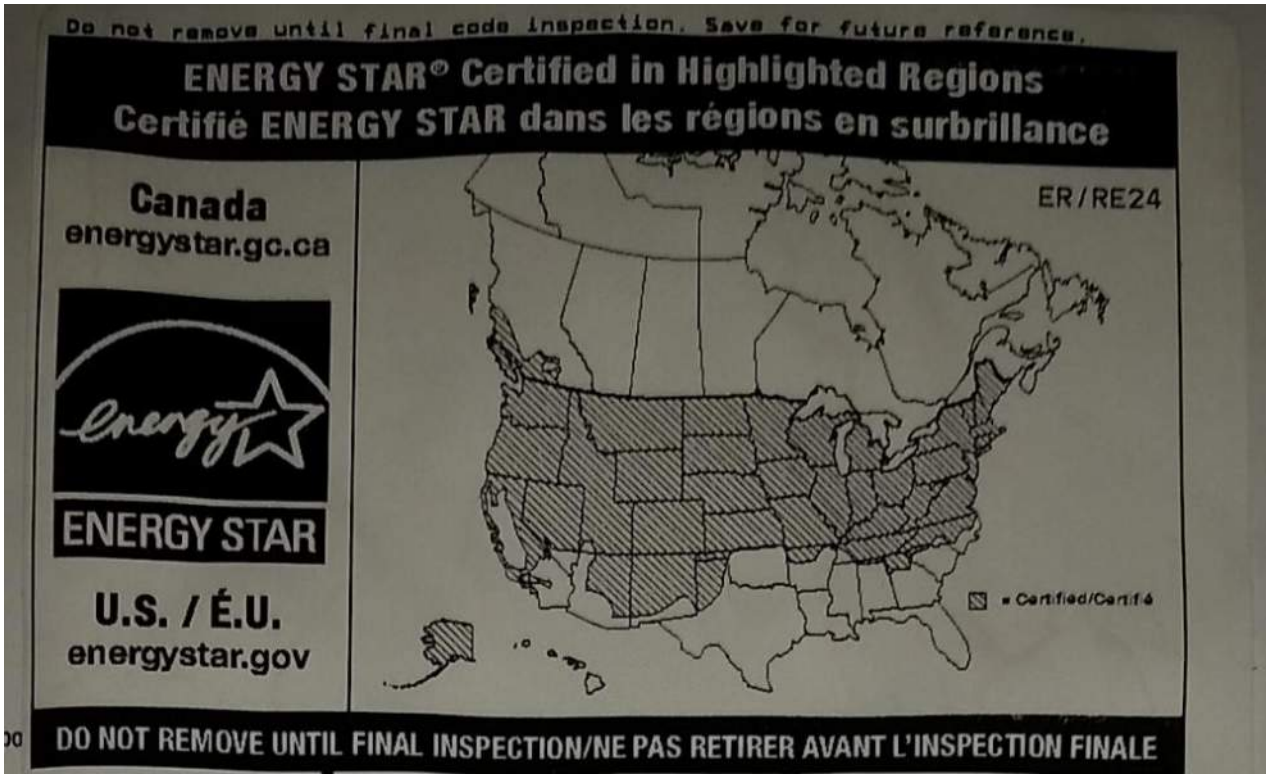
Performance Class	Positive test pressure		Maximum allowable leakage	
	Pa	(~psf)	L/s•m²	(~cfm/ft²)
CW	75	(1.57)	1.5	(0.30)
AW (sliding seal products)	300	(6.27)	1.5	(0.30)
AW (compression seal and fixed products)	300	(6.27)	0.5	(0.10)

Note: *The IP equivalents identified are for approximate reference only and do not in any way imply accuracy of the measurement or the equipment. See Clause 1.3. Precision and bias statements are provided in the applicable test methods referenced in this Standard/Specification.*

Product Labeling

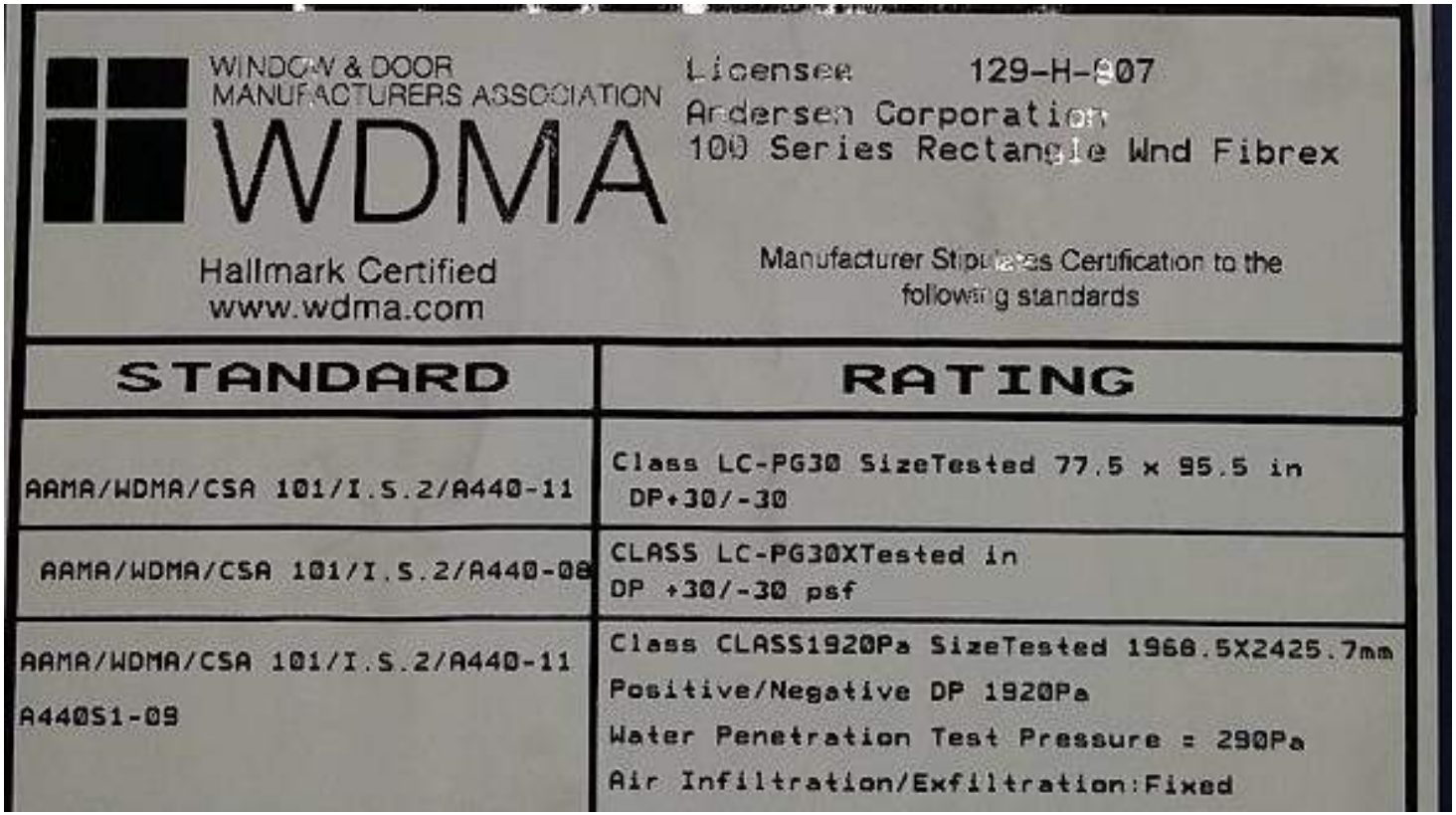
- Photo of Label from a recent field test

Product Labeling



Product Labeling

Product Labeling



WINDOW & DOOR MANUFACTURERS ASSOCIATION
WDMA
Hallmark Certified
www.wdma.com

Licensee 129-H-007
Andersen Corporation
100 Series Rectangle Wnd Fibrex

Manufacturer Stipulates Certification to the following standards

STANDARD	RATING
AAMA/WDMA/CSA 101/I.S.2/A440-11	Class LC-PG30 SizeTested 77.5 x 95.5 in DP+30/-30
AAMA/WDMA/CSA 101/I.S.2/A440-08	CLASS LC-PG30XTested in DP +30/-30 psf
AAMA/WDMA/CSA 101/I.S.2/A440-11 A440S1-09	Class CLASS1920Pa SizeTested 1968.5X2425.7mm Positive/Negative DP 1920Pa Water Penetration Test Pressure = 290Pa Air Infiltration/Exfiltration:Fixed

Specifying Window Systems

- Identify which type or types of windows required on the project.
  - Residential or Commercial Application
  - Window, Storefront, Curtain wall
  - Materials: Wood, PVC, Fiberglass, Aluminum, etc
  - Operation: Fixed, hung, casement, awning, etc

Specifying Window Systems

- What is the Design Pressure requirement?
  - Correlates to the Performance Grade
  - Consult with the Building Code and Structural Engineer
    - Example:

Wind Loads

ASCE 7-10 Envelope Procedure Parameters

Exposure B
Ultimate design wind speed 115 MPH (3 second gust)
Nominal design wind speed 90 MPH
Risk Category II
Wind Directionality Factor (Kd) 0.85
Topographic Factor (Kzt) 1.0

Specifying Window Systems

- Identify the Performance Class Required
  - Residential (R)
  - Light Commercial (LC)
  - Commercial Window (CW)
  - Architectural Window (AW)

Specifying Window Systems

- MasterFormat, Division 08 – Openings
  - 08 43 00 – Storefronts
  - 08 44 00 – Curtain Wall and Glazed
  - 08 50 00 – Windows (Metal, Wood, Composite)

Specifying Window Systems

- Specification – Design Requirements
  - Typically in Part 1 of Specification Section
  - Design Requirements: Design exterior systems to withstand:
    - Design wind pressure in accordance with [ASCE 7,] [Building Code,] with maximum allowable deflection of [L/175,] tested in accordance with ASTM E330, but not less than [30] psf
    - Grade: AAMA/WDMA/CAS 101/I.S.2/A440 requirements for specific window type:
      - Performance Grade: [CW-PG50-F] [Equivalent to or greater than the design wind load.]
      - Performance Class (PC): [R], [LC], [CW], [AW]

Note: [Values] subject to change based on requirements.

Specifying Window Systems

- Specification – Design Requirements
  - Design Requirements Continued:
    - Movement caused by an ambient temperature range of [120] degrees F and a surface temperature range of [160] degrees F.
    - Movement between system and adjacent construction.
    - Dynamic loading and release of loads.
    - Deflection of supports.
    - Overhead structure deflection of [1/2] inch.

Note: [Values] subject to change based on requirements.

Specifying Window Systems

- Specification – Performance Requirements
  - Typically in Part 1 of Specification Section
  - Performance Requirements:
    - Uniform structural loading: No glass breakage or permanent damage to fasteners or system components, tested to ASTM E330 at 1.5 times design pressure.
    - Thermal transmittance due to conduction (Uc): Maximum [0.36] BTU/(hr sq ft deg F) tested to AAMA 1503.
    - Condensation resistance factor (CRF): Minimum [60,] tested to AAMA 1503.

Note: [Values] subject to change based on requirements.

Specifying Window Systems

- Specification - Performance Requirements
  - Performance Requirements Continued:
    - Air infiltration, tested to ASTM E283.
      - [0.06] CFM per square foot of fixed area at static pressure differential of [6.24] PSF.
    - Water infiltration: No uncontrolled water leakage, tested to ASTM E331 at minimum test pressure of [8.0] PSF.
    - Operating Force: Based on PC & PG
    - Forced Entry: Based on PC & PG

Note: [Values] subject to change based on requirements.

Specifying Window Systems

- Specification (Product)
  - Typically in Part 2 of Specification Section
  - If specifying a Basis-of-Design Product, confirm that the Design and Performance Requirements of the specified product are the same as the Design and Performance Requirements
  - Do not specify different Design and Performance Requirements than a Basis-of-Design product's laboratory tested rating as it creates confusion for the Contractor(s) and the bids will not be comparable.

Proper Window Installation

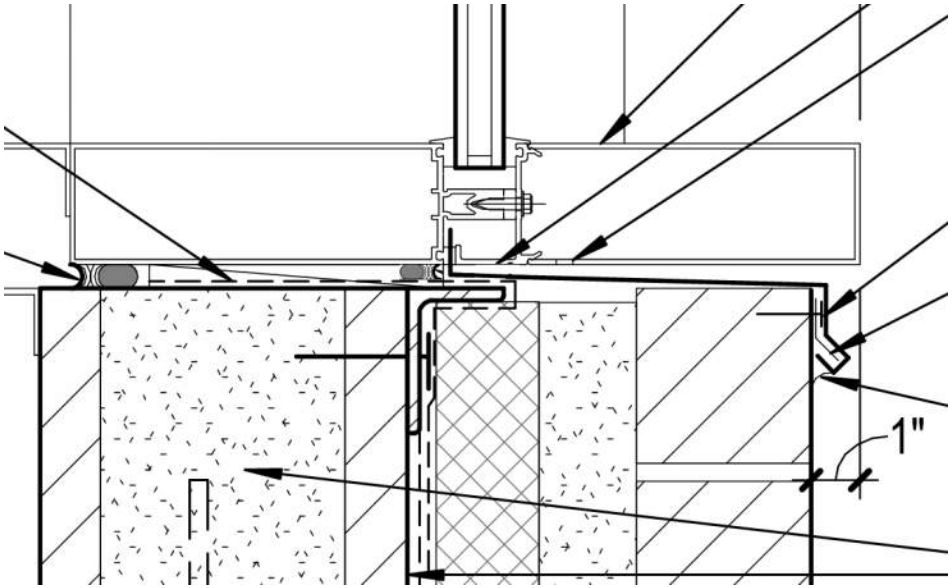
- Flashings
  - Generically uses term “flashing” on all sides (2012 IBC 1405.4 & 1405.13)
  - “Pan Flashing” that is sealed or sloped (2012 IRC R703.8.1)
- Follow Manufacturer’s Installation Instructions
- Drip/head flashing
- Tapes/sealants - types, compatibilities, weather conditions affecting installation, etc
- Wall drainage

Placement of Windows

- There are many opinions on the proper location of window placement.
  - Like these guys

Recommendations

- Most important aspect of window detailing: **The primary sealant joint of the window must be in direct contact with the water-resistive barrier and/or flashings.**



“Technical Assistance” from Manufacturers

Recommendations

- Specify that one of the required Shop Drawing Submittals is the current installation instructions from the manufacturer at the time of construction.
- Place that documents in your project file and save it for the life of your files. These change frequently and you may never see it again.
- Follow the installation directions step for step.
- These instructions were often stuck to the window, and were brief. Now we have seen some that are dozens of pages long. THINGS HAVE CHANGED!!!

What Can Go Right?

- The Good…..
  - Know the specific installation details of the window and weather barrier manufacturers.
  - Specify Mock-ups – get the installation right from the start.
  - Include the manufacturer of the window and water-resistive barrier.

Mock-up Example: Step-by-Step

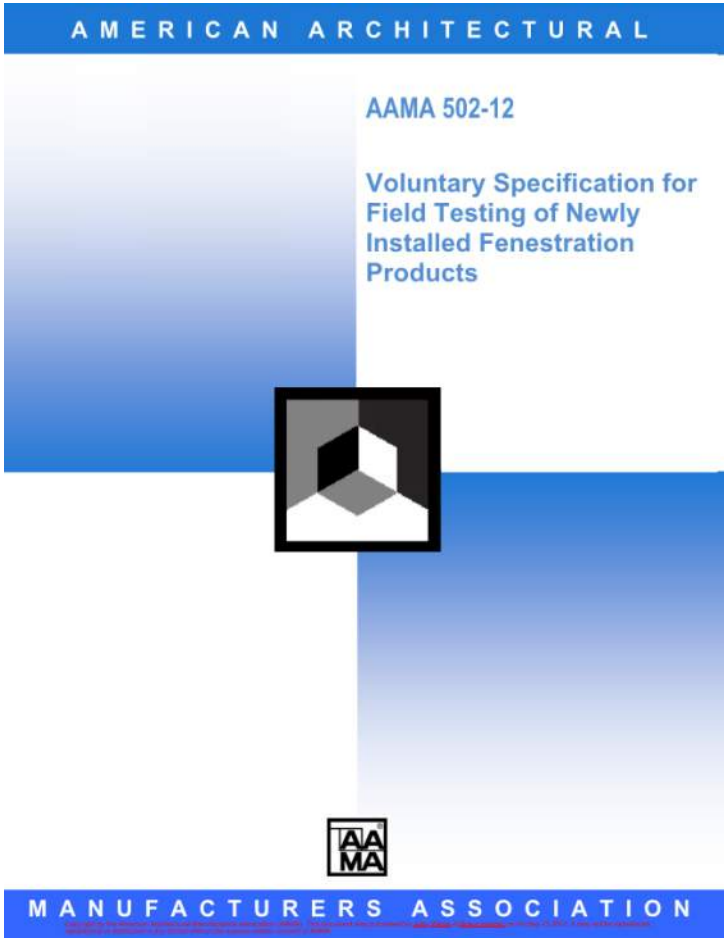
Mock-up Example: Step-by-Step

Mock-up Example: Step-by-Step

Mock-up Example: Step-by-Step

Mock-up Example: Step-by-Step

Quality Assurance: Field Window Testing



Field Window Test Types

- AAMA 501.2: *Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems*
  - A water spray quality check to reveal leaks in non-operable glazing systems that includes gaskets, sealants, perimeter caulking, splices and frame joinery intersections.

Field Window Test Types

- AAMA 501.2

Field Window Test Types

- AAMA 502: *Voluntary Specification for Field Testing of Newly Installed Fenestration Products*
  - Performance testing of the unit for air infiltration and water penetration utilizing a temporary pressure chamber.
  - Utilized on fixed and operable specimens

Field Window Test Types

- AAMA 503: *Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems*
  - Similar to AAMA 502, but specific to Storefronts, Curtain Walls and Sloped Glazing Systems (ie skylights).

Field Window Test Types

- AAMA 502 & AAMA 503 reference the following ASTM test methods:
  - E783: *Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors*
  - E1105: *Standard Test Method of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference*

AAMA 502 or 503

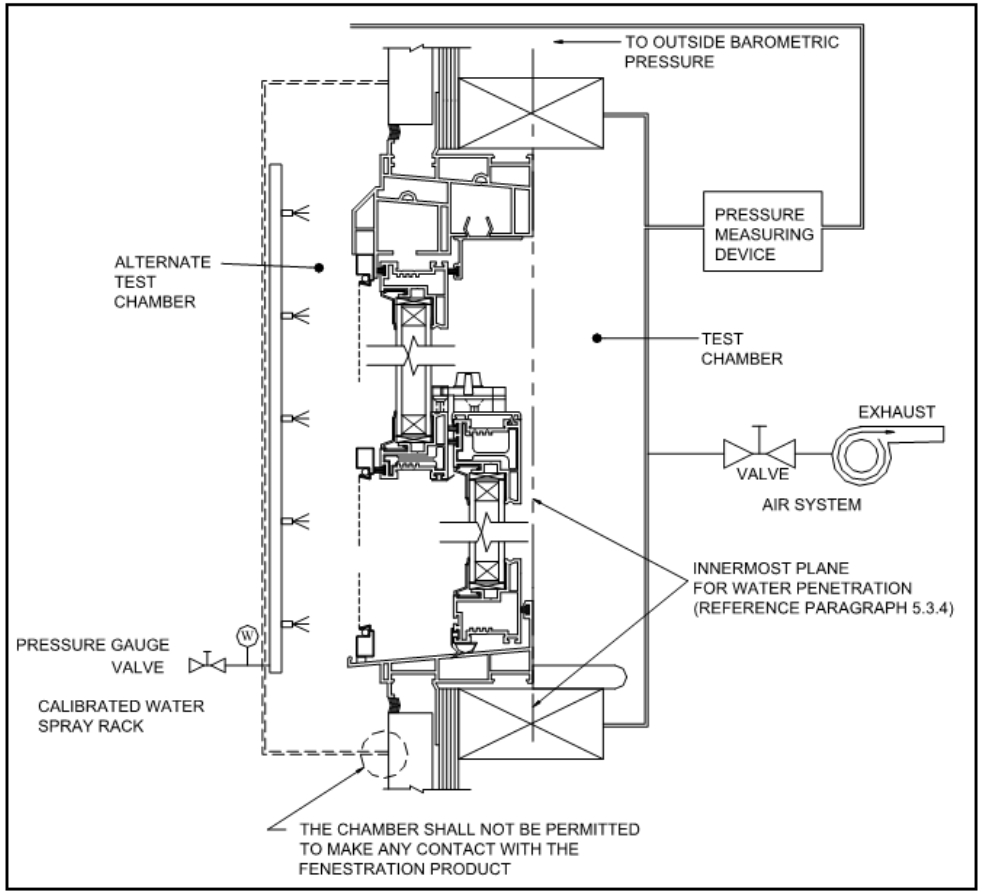


FIGURE 1: Test Chamber

AAMA 502 or 503

AAMA 502 or 503

- ASTM E783: Standard Test Method for Field Measurement of *Air Leakage* Through Installed Exterior Windows and Doors Field test allows an increase of 1.5 times that allowed in the NAFS.
  - For example, the R-PG30-H we looked at earlier is rated at 0.30 cfm/sf at 1.57 psf. The field test is allowed 0.45 cfm/sf at 1.57 psf.

AAMA 502 or 503

- ASTM E1105: Standard Test Method for Field Determination of *Water Penetration* of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference
  - Field test allows an reduction of pressure to 2/3 that allowed in the NAFS. For example, the R-PG30-H we looked at earlier is rated at 4.59 psf. The field test is allowed a pressure reduction to 3.06 psf.

Quality Assurance: Field Window Testing

- What constitutes “passing”?

- Test standards do not ask for results in “Pass” vs. “Fail”, rather in “Controlled” vs. “Uncontrolled” water penetration.

Quality Assurance: Field Window Testing

- ASTM E1105 Definition
  - Water penetration: Penetration of water beyond a plane parallel to the glazing (the vertical plane) intersecting the innermost projection of the test specimen, not including interior trim or hardware, under the specified conditions for air pressure difference across the specimen.

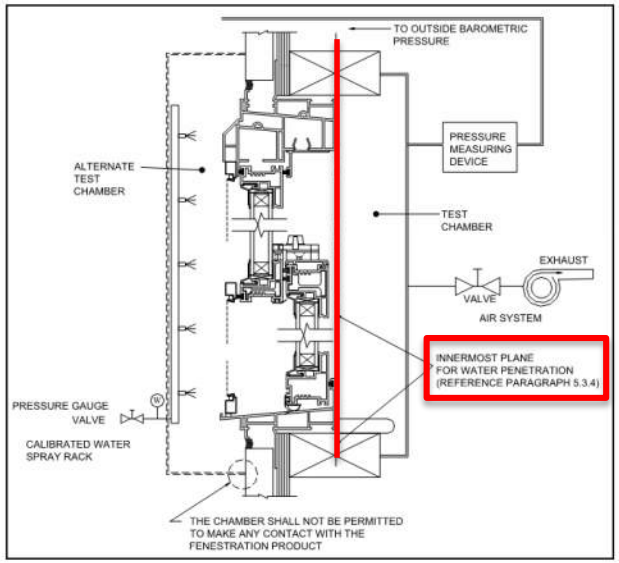


FIGURE 1: Test Chamber

Quality Assurance: Field Window Testing

- AAMA 502-12 requires any observed water penetration to be "controlled".
  - Water penetration ***attributable to the surrounding condition*** shall be defined as the presence of *uncontrolled water which did not originate from the fenestration product* or *the joint between the fenestration product specimen and the wall/roof.*
  - Water penetration ***attributable to the perimeter joint*** shall be defined as *uncontrolled water that indisputably originates at the joint*.
  - Water penetration ***attributable to the fenestration product specimen*** shall be defined as the *penetration of uncontrolled water beyond a plane parallel to the innermost edges of the product* and that indisputably originates from the fenestration product.

Quality Assurance: Field Window Testing

- AAMA 502-90 requires any observed water penetration to be "controlled". *Controlled* water is defined as:
  - Windows: Water contained or drained back to the exterior, or the collection of up to one-half ounce of water on top of an interior horizontal window surface that does not spill onto adjacent finishes or materials is acceptable.
  - Exterior Panning, Subframe, Flashing, and Perimeter Joints: The penetration of water through the exterior construction is acceptable providing the installed window system is designed to collect and drain this leakage to the exterior, i.e. subsill, drained flashing, etc, without damage to the adjacent construction.
  - A small amount of percolation (less than 10 drops) through meeting rails or over sills that is visible on adjacent finishes or materials.

Quality Assurance: Field Window Testing

- AAMA 503-14 requires any observed water penetration to be "controlled".
  - Water penetration ***attributable to the surrounding condition*** shall be defined as the presence of *uncontrolled water which did not originate from the product specimen* or *the joint between the fenestration product specimen and the wall/roof*.
  - Water penetration ***attributable to the perimeter joint*** shall be defined as *uncontrolled water that indisputably originates at the joint*.

Quality Assurance: Field Window Testing

- AAMA 503-14 requires any observed water penetration to be "controlled".
  - Water penetration attributable to the fenestration product specimen shall not be as defined in ASTM E1105.
  - Water leakage shall be defined as any water not contained in an area with provisions to drain to the exterior or the collection of more than 14 grams or 0.5 ounces of water on an interior horizontal framing member surface.
  - Any water present shall not extend beyond a plane parallel to the glazing (the vertical plane) intersecting the innermost projection of the test specimen, not including interior trim or hardware.

Examples of Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

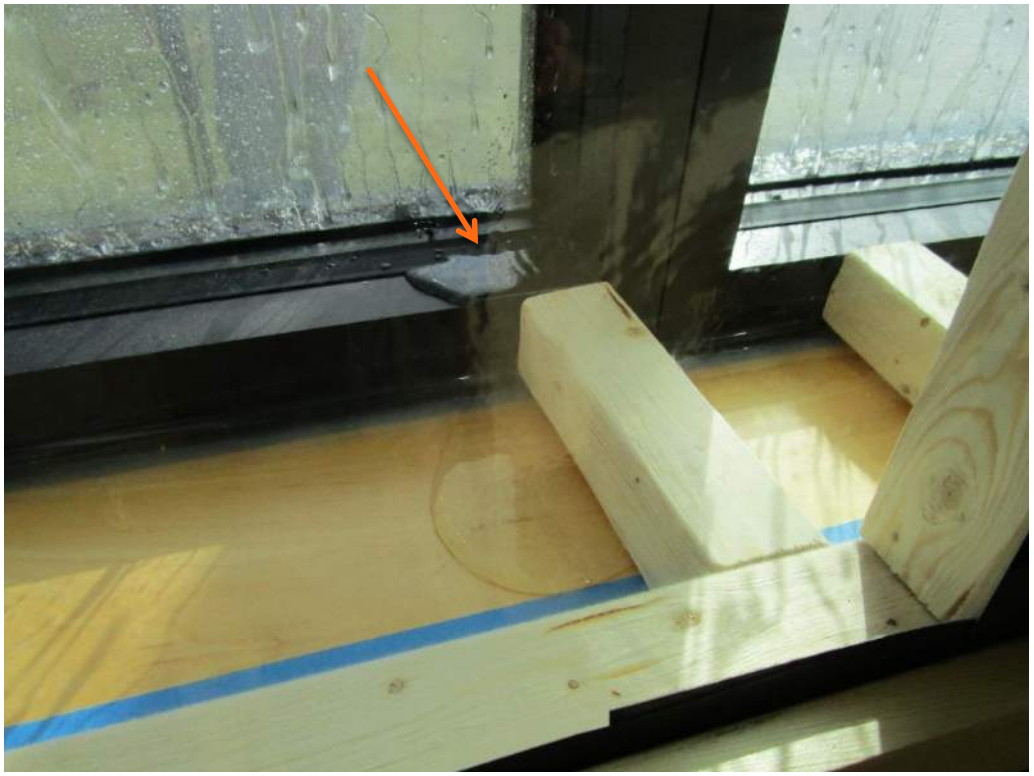
Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration



Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

Window Testing: Water Penetration

Specifying Quality Assurance Field Window Testing

- Identify which test, or combination of tests, is desired.
  - AAMA 501.2 – Field Check
  - AAMA 502 – Performance Test
  - AAMA 503 – Performance Test

Specifying Quality Assurance Field Window Testing

- Select number of tests desired for representative sampling
  - AAMA 501.2 – Field Check
    - 100 sq. ft. min. in size and shall include perimeter caulking, typical splices, frame intersections, and if applicable, at least two entire vision lites and two entire spandrel lites containing an intermediate vertical member and an intermediate horizontal member.
      - Recommended testing intervals at 5%, 25%, 50%, and 90% completion
      - Testing should be performed as soon as possible and prior to the installation of drywall or interior finish wall materials.
      - No operable sections are applicable to this test method.

Specifying Quality Assurance Field Window Testing

- Select number of tests desired for representative sampling
  - AAMA 502 – Field Performance Test
    - Three (3) tests are standard recommended test quantity
      - Recommended testing intervals at 5%, 50%, and 90% completion.
      - Testing should be performed as soon as possible and prior to the installation of drywall or interior finish wall materials.
      - Operable sections are applicable to this test method.
    - Some Architects specify based on a percentage of the total windows.
      - 1-3% of total windows installed
      - Understand the cost implications to the Owner of large number of tests

Specifying Quality Assurance Field Window Testing

- Select number of tests desired for representative sampling
  - AAMA 503 – Field Performance Test
    - Size and location shall be selected by Architect and clearly identified in the Construction Documents
    - If not selected, 100 sq. ft. min. in size and shall include perimeter caulking, typical splices, frame intersections, and if applicable, at least two entire vision lites and two entire spandrel lites containing an intermediate vertical member and an intermediate horizontal member.
      - Recommended testing intervals at 5%, 25%, 50%, and 90% completion
      - Testing should be performed as soon as possible and prior to the installation of drywall or interior finish wall materials.
      - Operable sections are applicable to this test method.
      - If section of storefront or curtain wall, air test may not be possible or practical due to continuous nature of test specimen.

Specifying Quality Assurance Field Window Testing

- Part 3 – Field Quality Control
  - Newly installed fenestration shall be field tested in accordance with [AAMA 501.2] [AAMA 502] [AAMA 503]
  - Test [three] [ ] of the fenestration product specimens after the products have been completely installed.
    - Indicate on drawings the location and/or size of desired specimens.
  - Test fenestration product specimen at intervals of 5%, [25%], 50%, and 90% of completion.
  - Air leakage and water penetration resistance shall be conducted at pressures and rates according to the specified Performance Grade.
    - Architect can exceed water penetration definition and require “no water penetration allowed” in the specifications. Otherwise, definitions in test method applies.

Specifying Quality Assurance Field Window Testing

- Part 3 – Field Quality Control
  - If test area or unit fails to meet specified air or water infiltration testing:
    - Contractor to submit proposed remedial work to Architect
    - Contractor to complete remedial work
    - Coordinate repeat testing.
    - When test results meet specified requirements, incorporate remedial work into other work on the Project.
    - Architect to select [one] additional area or unit for field testing to confirm effectiveness of remedial work on other specimens.
  - Field testing will be provided by:
    - AAMA Accredited Testing Laboratory retained by the [Owner] [General Contractor] [Window Installer].
      - If hired by Owner, initial tests to be paid for by Owner. If testing fails to meet the specified requirements, additional and retesting will be deducted from the contract by Change Order.

What Can Go Wrong?

- ….The Bad and the Ugly

- Water penetration that leads to:
  - Deterioration
  - Damage
  - Rotting of the wall system components.

Sill flashing not integrated

Reverse lap of WRB under window

Head/drip flashing too short

Sealant cohesive failure – field mull prone to leak

No head/drip flashing

No sill flashing

Sealant adhesion failure

Missing water-resistive barrier

Sheathing damage below windows

Sill flashing applied after window installed and window weeps into wall

Single-wythe wall – water penetrates around unsealed head flashing

BRAUN INTERTEC

The Science You Build On.

Q & A

Download Presentation @ https://braunintertec.com/news-and-events/

Steve Flaten, AIA
Principal, Senior Architect
952.995.2348
sflaten@braunintertec.com

Jack R. Rasmussen, AIA, NCARB
Associate Principal, Senior Architect
Enclosure Consulting & Forensics Manager
952.393.5217
jrasmussen@braunintertec.com