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CSI Technical Committee Presentation

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Today's Topic: Quality Assurance Field Testing Pitfalls
Designing and Installing Fenestration products to Meet Design Performance Criteria

Why do we perform quality control and quality assurance Field Testing?
Quality Assurance (QA), refers to the implementation of proactive processes that aim to identify and prevent construction defects. ... Quality Control (QC) simply refers to the process of inspecting the product to identify and correct defects.

"*Specifiers are advised to require verification of the actual installed performance of fenestration products by specifying field testing during or immediately after construction and before occupancy*"

Significance of fenestration glazing systems on buildings:
Commercial glass & glazing systems, i.e. storefront, window and aluminum & glass curtain wall systems generally represent as much as *50% to 100% of the exterior cladding of large commercial buildings* and are determining elements in the performance of the exterior building envelope.

In most projects of any significance, the *performance of the window and curtain wall* systems which are to form part of the building envelope are evaluated in an accredited testing laboratory prior to construction. This is true of Mfg. standard off-the-shelf, pre-engineered, systems, as well as; special one-off modified or custom glazing system designs.

All team members should have a mutual understanding of the project's field testing quality requirements?

- What is the appropriate field test method that should be specified?
- What is the appropriate performance criteria?
- How many specimens should be tested and how often?
- What is definition of water leak?
- What happens after a failed test?
- Who should attend quality assurance performance testing?
- Where is the water source and electric, can we maintain pressure and service?

What does "resistance to water penetration" mean?
Resistance to water penetration performance requirements will vary ultimately depending on the building's requirements based on specific height/width, geographic location and exposure classification which determines wind load design pressure.

In the United States, the resistance to water penetration rating is typically established as a function of the building design wind pressure. The minimum performance levels for resistance to water penetration are established as a function of the design wind pressure, with values generally between 15 and 20 percent of specified design pressure based on applicable building code requirements. This information is always available on sheet S1 of the construction document set and should be coordinated on the subcontractors shop drawing submittals.

What are manufacturers' product water penetration resistance design criteria?
Today's standard *commercial* product manufactures, i.e. Arcadia, CRL/US Aluminum, Kawneer or YKKap, etc. have presented their standard system design options for water penetration resistance beginning at 6.24psf up to 15psf. Generally, this is the difference between storefront products to curtain wall systems. Most applications can be categorized by specifying one of the following product performance levels:

- 6.24 psf
- 8.0 psf
- 10.0 psf
- 12.0 psf
- 15.0 psf
- 20.0 psf

This is similar to the *window fenestration rating system* where entry-level ("gateway") Performance Grade lables are based on:

- 15 psf for R class (commonly used in one- and two-family dwellings)
- 25 psf for LC class (commonly used for low- and mid-rise multifamily dwellings and other buildings where larger sizes and higher loading requirements are expected)
- 30 psf for the new CW class (commonly used in low- and mid-rise buildings where larger sizes, higher loading requirements, limits on deflection and heavier use are expected)
- 40 psf for the AW class (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 products is expected)

Note: The selection of the *water penetration resistance* DP (design pressure) should be based on **15%** of the specific building DP for LC, CW, and HC performance classes or **20%** of the building DP for AW performance classes and *all commercial* glazing systems.

Design Pressure Conversion to Water Test Pressure

Conversion as per NAFS-08

- 15% for R, LC, CW
- 20% for AW
- Water Resistance Test Pressure is capped at 12.00 psf for the U.S. and 15.00 psf for Canada

Gateway Requirements			
Performance Class	Minimum Design Pressure, Pa (psf)	Minimum Structural test pressure, Pa (psf)	Minimum Water Resistance Test Pressure, Pa (psf)
R	15.0	22.5	2.90
LC	25.0	37.5	3.75
CW	30.0	45.0	4.50
AW	40.0	60.0	8.00

Building wind load calculations are based on the recommendations found in ASCE 7 using two typical factors:

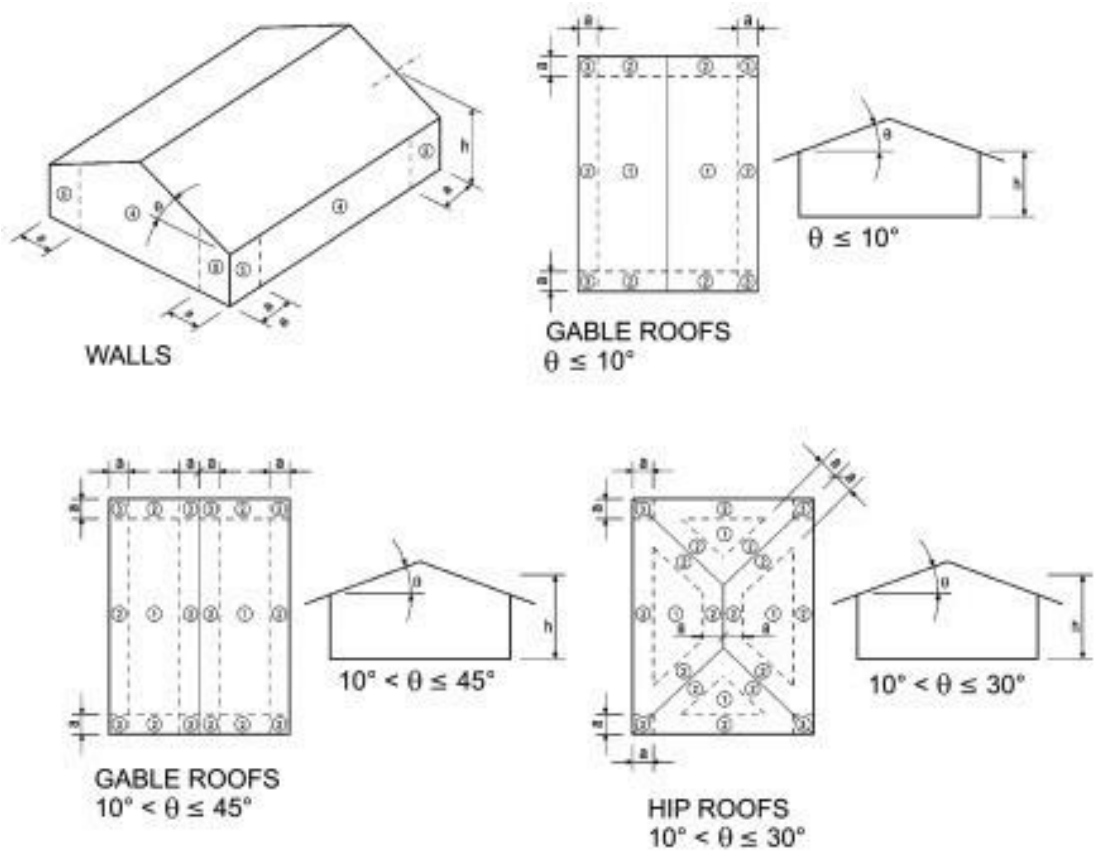
- Basic Wind Speed
- Exposure Category (specific to the location of the structure).

Additionally, wind loading calculations are determined based on maximum building height dimension and least building width. Verify this criteria requirement with the E.O.R. or check sheet S1 of the structural drawings for project specific information.

Increased WL Pressure Requirements at Building Corner Zones:

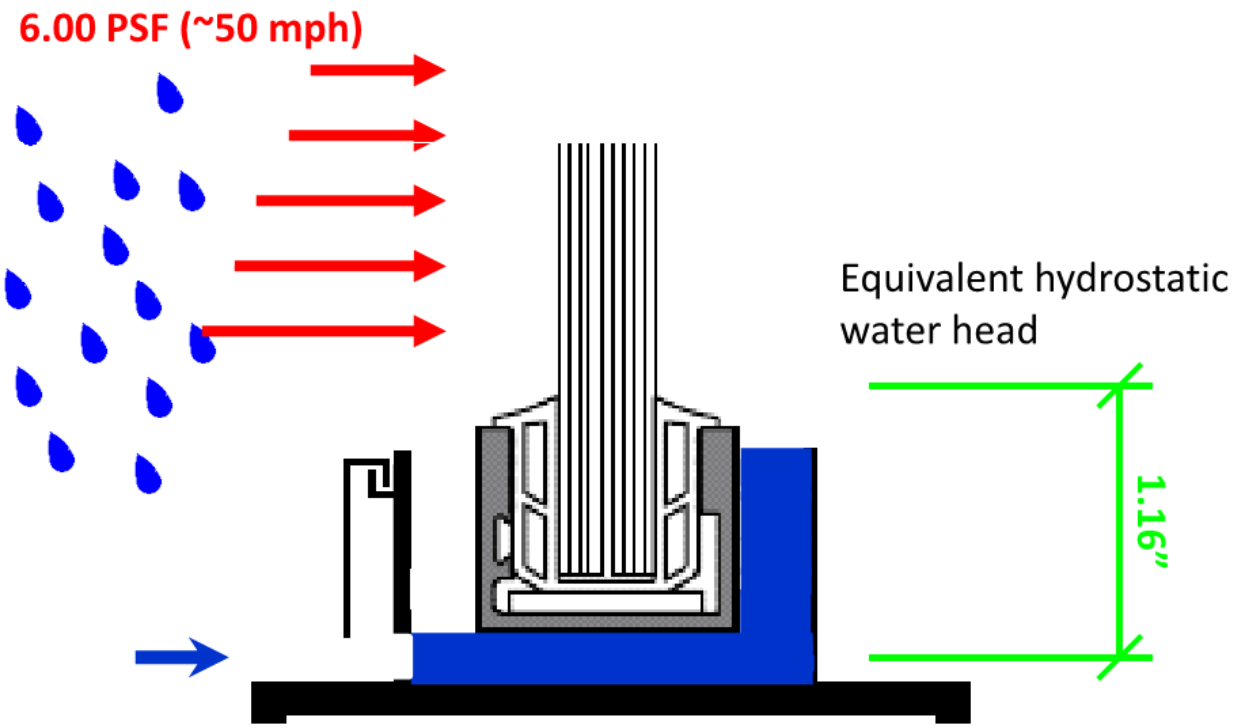
The greatest wind load pressures acting on a building are negative pressures (suction) and the locations of the greatest pressures occur at wall and roof corner zones as illustrated in Figure below. Corner zones at walls, roof ridge and roof perimeter represent locations of potentially high forces relative to the central portions of the wall or roof.

The extent of increase in wind loading forces for roofs depends on roof geometry but increases equal to, two or more times the negative pressures associated with central wall area are possible.



Pa	kph	psf	in.H_2O	mph
75 Pa	40 kph	1.57 psf	0.30''H_20	25 mph
137 Pa	54 kph	2.86 psf	0.55''H_20	34 mph
144 Pa	56 kph	3.00 psf	0.58''H_20	35 mph
150 Pa	57 kph	3.13 psf	0.60''H_20	35 mph
180 Pa	62 kph	3.75 psf	0.72''H_20	39 mph
200 Pa	66 kph	4.17 psf	0.80''H_20	41 mph
216 Pa	68 kph	4.50 psf	0.87''H_20	42 mph
252 Pa	74 kph	5.25 psf	1.01''H_20	46 mph
288 Pa	79 kph	6.00 psf	1.15''H_20	49 mph
299 Pa	80 kph	6.24 psf	1.20''H_20	50 mph
300 Pa	80 kph	6.26 psf	1.20''H_20	50 mph
324 Pa	83 kph	6.75 psf	1.30''H_20	52 mph
360 Pa	88 kph	7.50 psf	1.44''H_20	55 mph
383 Pa	90 kph	8.00 psf	1.53''H_20	56 mph
384 Pa	91 kph	8.00 psf	1.54''H_20	56 mph
396 Pa	92 kph	8.25 psf	1.59''H_20	57 mph
400 Pa	93 kph	8.34 psf	1.61''H_20	58 mph
431 Pa	96 kph	9.00 psf	1.73''H_20	60 mph
467 Pa	100 kph	9.75 psf	1.88''H_20	62 mph
500 Pa	104 kph	10.43 psf	2.01''H_20	64 mph
503 Pa	104 kph	10.50 psf	2.02''H_20	65 mph
539 Pa	108 kph	11.25 psf	2.17''H_20	67 mph
575 Pa	111 kph	12.00 psf	2.31''H_20	69 mph
600 Pa	114 kph	12.51 psf	2.41''H_20	71 mph
700 Pa	123 kph	14.60 psf	2.81''H_20	76 mph
750 Pa	127 kph	15.64 psf	3.01''H_20	79 mph

Figure 24: Table of wind speed equivalences.



What is the definition of a water leak and failure? (As specified by AAMA)

Water Leakage: (AAMA 503-08) and (AAMA 503-14)

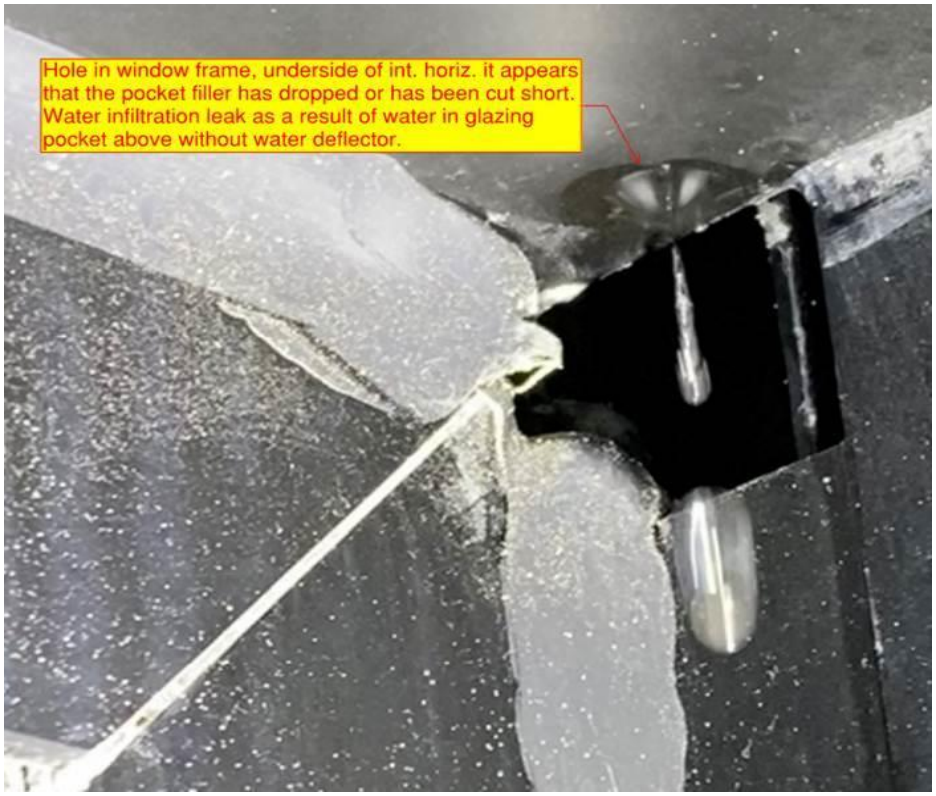
> Water penetration shall be defined as any water that is not contained in an area with provisions to drain to the exterior or the collection of more than 14g (0.5 oz) of water in the 15 minute test period on top of an interior horizontal framing member surface. Any water present shall not extend beyond a plane parallel to the glazing (the vertical plane) intersecting the innermost projection of the test specimen, not including interior trim and hardware, under the specified conditions of air pressure difference across the specimen.

Water Leakage: (AAMA 503-03)

No uncontrolled water shall pass the innermost surface of the specimen as defined by the face of the vertical or sloped surface of the innermost framing member, or shall enter the wall cavity during the water penetration resistance tests.

For purposes of this testing, acceptable, controlled water leakage is defined as:

> Any water that is contained in an area with provisions to drain back to the exterior, or the collection of up to one half ounce (1/2 oz) of water in the 15 – minute test period on top of an interior horizontal frame surface that does not spill onto adjacent finishes or materials.



Water Leakage: (AAMA 502-11 and 12)

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 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.

Water penetration attributable to the perimeter joint shall be defined as uncontrolled water that indisputably originates at the joint.

Water Leakage: (AAMA 502-08)

Water penetration 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 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. Water penetration attributable to the perimeter joint shall be defined as uncontrolled water that indisputably originates at the joint.

Water Leakage: (AAMA 502-02)

Water penetration shall be defined as 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 and hardware under the specified conditions of air pressure difference across the specimen. Any such water penetration shall constitute failure of the water penetration resistance test. It shall also constitute failure if water penetrates through the perimeter frame of the test specimen. Water contained within drained flashing, gutters, and sills shall not be considered failure.

Water Leakage: (AAMA 502-90)

No uncontrolled water shall pass the innermost plane of the window system as defined by the face of the vertical surface of the innermost sash or frame member, or enter the wall cavity during the water penetration tests.

For purposes of this testing, acceptable, controlled water leakage is defined as follows:

Water contained and drained back to the exterior, or the collection of up to one-half ounce of water in the 15 minute test period on the top of an interior horizontal window surface that does not spill onto adjacent finishes or materials is acceptable.

The penetration of water in the 15 minute test period through the exterior construction is acceptable providing the installed window system is designed to collect and drain this leakage to the exterior, i.e., sub-sill, drained flashing, etc., without damage to adjacent construction.

A small amount of percolation (less than 10 drops) through meeting rails or over sills that are visible on adjacent finishes or materials is acceptable.

Water Leakage: (AAMA 501.2-03) and (AAMA 501.2-15)

No uncontrolled water shall appear on any normally exposed interior surfaces, that is not contained or drained back to the exterior, or that can cause damage to adjacent materials or finishes. Water contained within drained flashings, gutters, and sills is not considered water leakage. The collection of up to 15 ml (1/2 ounce) of water in a five minute test period on top of an interior stop or stool integral with the wall system shall not be considered water leakage.

Water Leakage: (ASTM E 1105-15) and all previous publication dates

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 and hardware under the specified conditions of air pressure difference across the specimen. For products with non-planer surfaces (domes, vaults, pyramids, etc.) the plane defining water penetration is the plane defined by the innermost edges of the unit frame. Failure also occurs whenever water penetrates through the perimeter frame of the specimen.

Water Leakage: (AAMA 501.1-05)

No uncontrolled water shall appear on any normally exposed interior surfaces, that is not contained or drained back to the exterior, or that can cause damage to adjacent materials or finishes. Water contained within drained flashings, gutters, and sills is not considered water leakage. The collection of up to 15 ml (1/2 ounce) of water in a five minute test period on top of an interior stop or stool integral with the wall system shall not be considered water leakage.

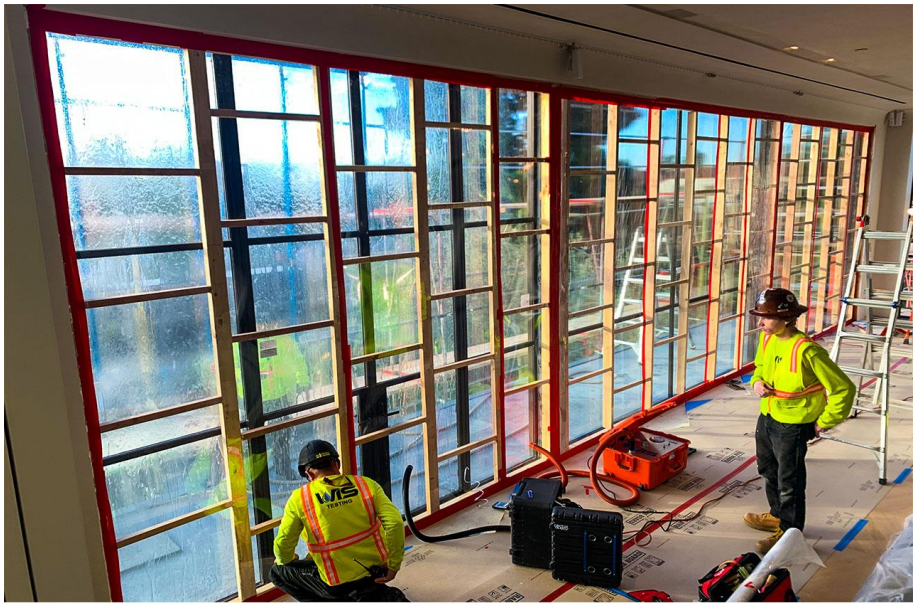
Identify industry testing standards, which are commonly used to establish field performance verification for windows and curtain walls.

AAMA 502/503: (testing standard for) *Voluntary Specification for Field Testing of Newly Installed Fenestration Products*; Storefronts, Windows, Curtain Walls and Sloped Glazing Systems, primarily outlines field performance requirements and test methods for resistance to water penetration and air leakage resistance for Storefronts, Curtain Walls and Sloped Glazing Systems.

Unlike simply specifying ASTM 1105 test method, the AAMA 502/503 specification allows water penetration testing in the field to be conducted at a static test pressure equal to 2/3 of the specified project water penetration test pressure. AAMA equates the water-resistance design pressure and/or test pressure to be 15-20% of the buildings actual design pressure. As such, this value may be based on 20% of greatest net positive wind loading on the building.

AAMA 502
Standard: AAMA 502 – *Voluntary Specification for Field Testing of Newly Installed Fenestration Products*
Scope: This test method establishes the requirements for field test specimens, apparatus, and sampling. Test procedures and test reports to be used in verifying the air infiltration resistance performance and water penetration resistance performance of newly installed fenestration products.

AAMA 503
Standard: AAMA 503 – *Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls, and Sloped Glazing Systems*
Scope: This test method establishes the requirements for field test specimens, apparatus, sampling, test procedures and test reports to be used in verifying the air infiltration resistance performance and water penetration resistance performance of newly installed fenestration products.



AAMA 501.2

Standard: AAMA 501.2-15 – Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems

Scope: This test is utilized to provide quality assurance and diagnostic field water penetration check method for installed storefronts, curtain walls and sloped glazing systems.

Applicable Products: Applicable to curtain walls, storefronts, window walls, sloped glazing systems, skylights, atriums, WRB/AVB, coping, fascia and soffit & fixed joint.

Test Procedure: Water is applied using a hand-held spray assembly employing a type B25 #6.030 nozzle, pressure gauge, control valve and a 3/4" hose. The water flow is adjusted to produce 30 psi at the nozzle. Note, no less than 25 or greater than 35psf. Water is directed at the joint under test, perpendicular to the face of the specimen. The nozzle is moved slowly back and forth above the joint, at a distance of one foot, for a period of five minutes for each five feet of joint. An observer on the inside checks for water leakage and documents the results.

End Result: The product tested meets the performance criteria for water penetration resistance or does not meet criteria and further remediation may be required to pass.