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National Institute of Building Sciences

Provider Number: G168

Water Penetration and Air Leakage Testing of Flanged Window Details

1-TU-3A

John Posenecker, P.E.

Kayla Maines, AIA, LEED AP

January 7-10, 2019



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Course Description

Multifamily building has been one of the fastest growing market sectors over the last five years and market outlooks predict that trend will continue. At the same time, AHJs (Authority's Having Jurisdiction) across the nation have been adopting the 2015 IECC (International Energy Conservation Code), which *eliminates* the air barrier exception for climate zones 1, 2, and 3. This significant code change effects multifamily construction across much of the southern part of the United States from Florida to California. However, many architects do not yet know how to design with air barrier details and most contractors do not yet know how to build air barrier details. The focus of this research aims to provide the multifamily construction sector with air and water penetration knowledge for one critical building component: *window detailing*.





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Learning Objectives

At the end of the this course, participants will be able to:

- Review of air and water testing of six distinct flanged window sill details
- Why we are curious
- Review of industry standards: installation, air and water testing
- Testing Methodology
- Results
- Lessons Learned
- Next Steps





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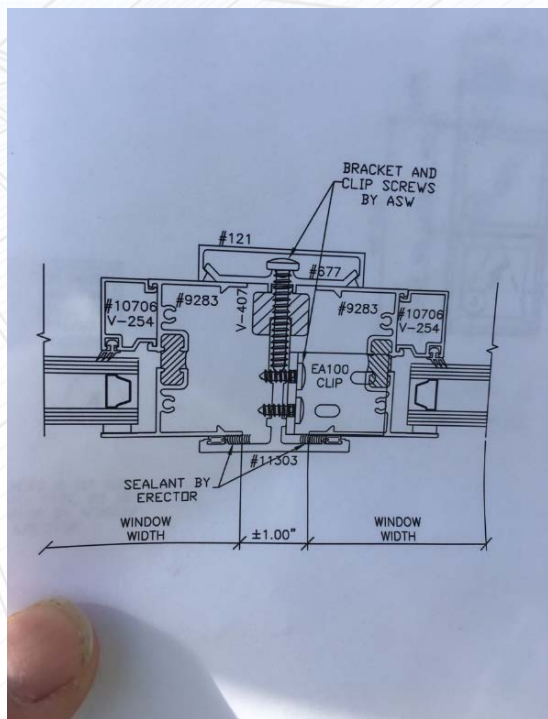
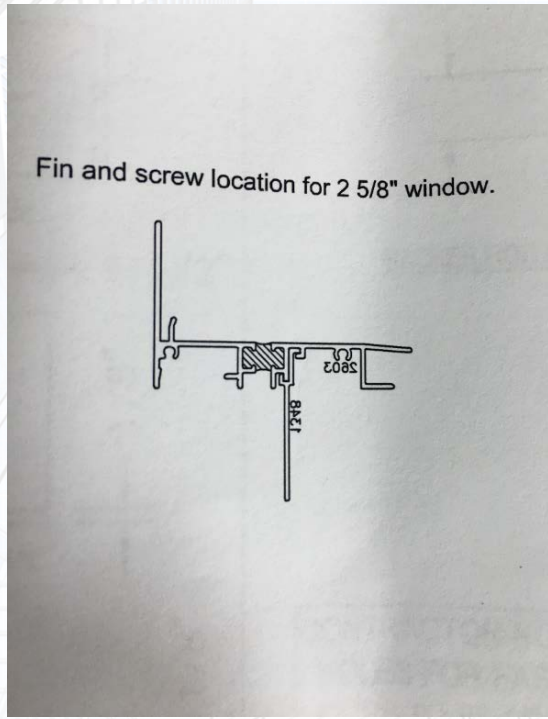
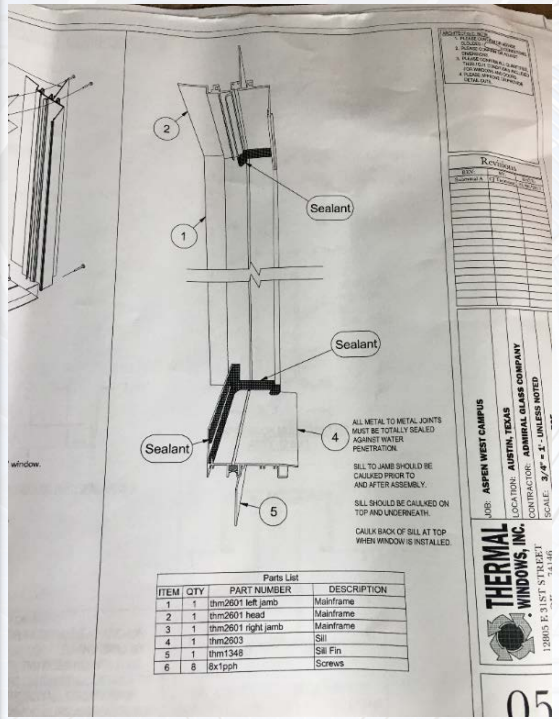
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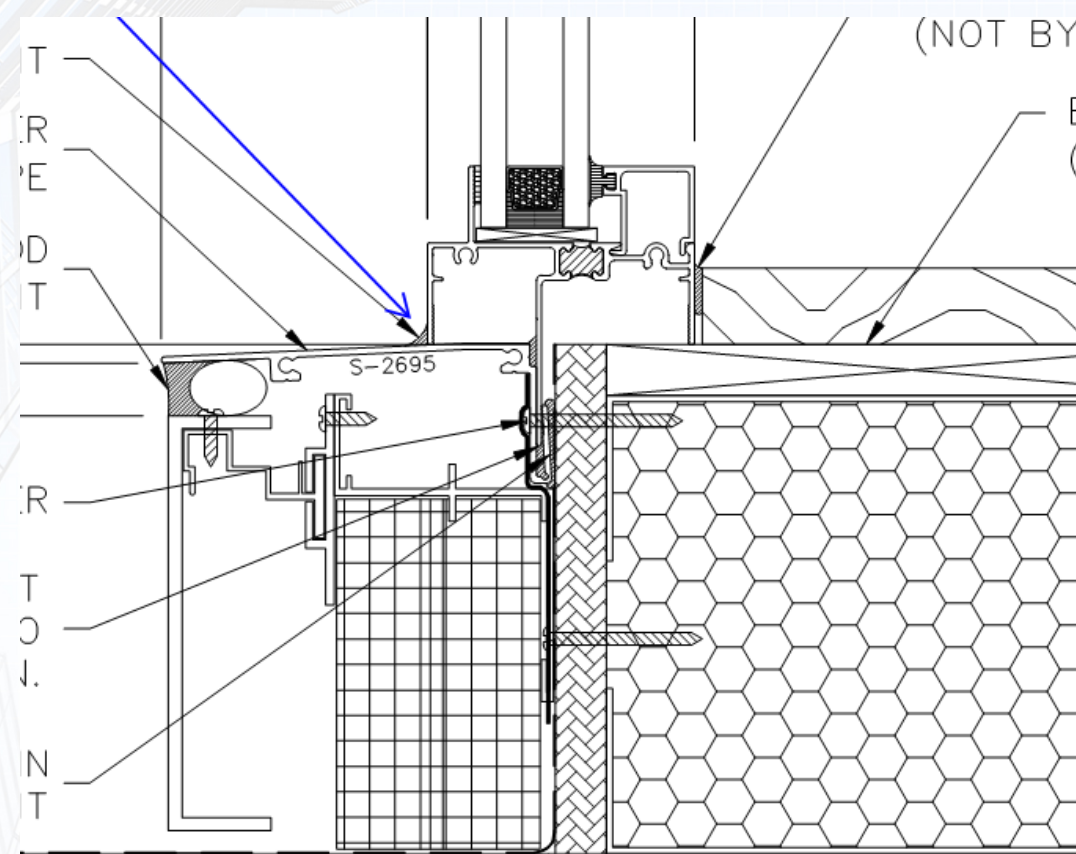
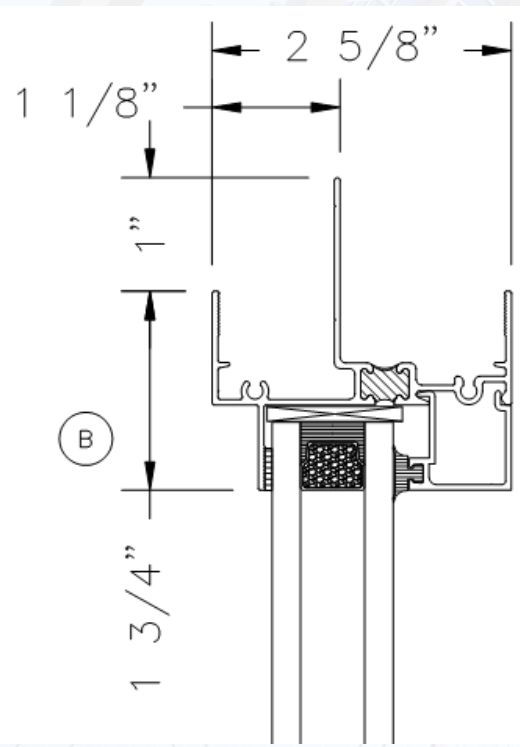
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Relevant Standards and Guidelines:

Installation

- **AAMA 100-07** Standard Practice for the Installation of Windows with Flanges or Mounting Fins in Wood Frame Construction
 - Section 1.1 *"This standard practice covers...**no more than 3 stories in height.**"*
- **AAMA 2400-10** Standard Practice for Installation of Windows with a Mounting Flange in Open Stud Frame Construction for Low Wind/Water Exposure
 - Section 1.1 *"This practice covers...**residential buildings of no more than four (4) stories in height.**"*
- **ASTM E2112-07** Standard Practice for Installation of Exterior Windows, Doors, and Skylights
 - Section 1. *"This practice covers...**as used primarily in residential and light commercial buildings.**"*
- **DuPont Flashing Systems Commercial Installation Guidelines, 04/09**

Relevant Standards and Guidelines:

Air Leakage Testing

- **AAMA/WDMA/CSA 101/I.S.2/A440-08** NAFS Specification for windows, doors, and skylights
 - Table 1: **AW** Performance Class, Minimum PG 40
- **ANSI/NFRC 400-2014** Determining Fenestration **Product** Air Leakage
 - Section 4. “**ASTM E283** shall be the only method used to measure product air leakage rates...A differential static pressure of **300 pascals** (6.24 psf) shall be acceptable if the NAFS is used for products obtaining an HC or AW rating.”
- **ASTM E 283-04(2012)** Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- **ASTM E 783-02(2010)** Standard Test Method for **Field** Measurement of Air Leakage Through Installed Exterior Windows and Doors
- **ASTM E2357-17** Standard Test Method for Determining Air Leakage of Air Barrier **Assemblies**
 - Section 9.1.1 “...in accordance with ASTM E283”



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Relevant Standards and Guidelines:

Water Penetration Testing

- **ASTM E 331-00** Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by **Uniform** Static Air Pressure Difference
- **ASTM E 547** Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by **Cyclic** Static Air Pressure Difference
- **ASTM E1105-15** 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



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From Cascadia Windows and Doors Presentation page 18

R PG 15	LC PG 25	CW PG 30	AW PG 40
			



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Mockup Construction

A little of this:

ASTM E2112-07 Standard Practice for Installation of
Exterior Windows, Doors, and Skylights

And a little of this:

**DuPont Flashing Systems Commercial Installation
Guidelines, 04/09**



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Mockup Construction





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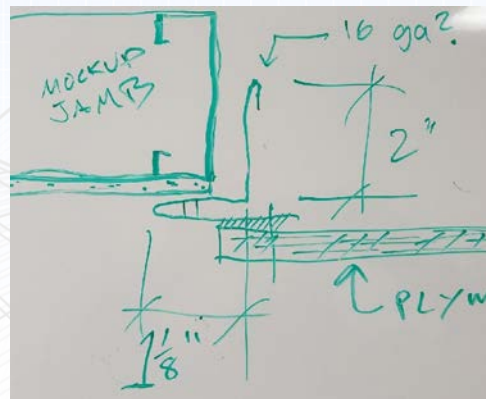
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Window “Blanks”





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Sill Flashing





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Flange Sealant





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Window “Blank” Installation





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Sealant “Bleed-Out” Visible





Controversy at the head.

Controversy at the sill.





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Pressure Chambers





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Details



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Mockup Information

Mockup No.	Installation Method	Interior Air Seal
1	A1	Nothing
2	B1	Nothing
3	A1	Foam
4	B1	Foam
5	A1	Backer Rod & Sealant
6	B1	Backer Rod & Sealant



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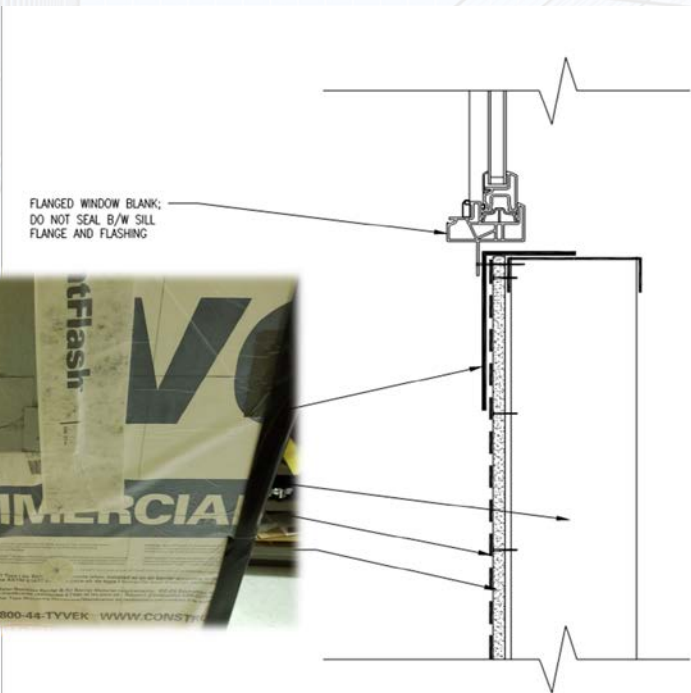


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Mockup #1 E2112 Method “A1” No Foam/Sealant





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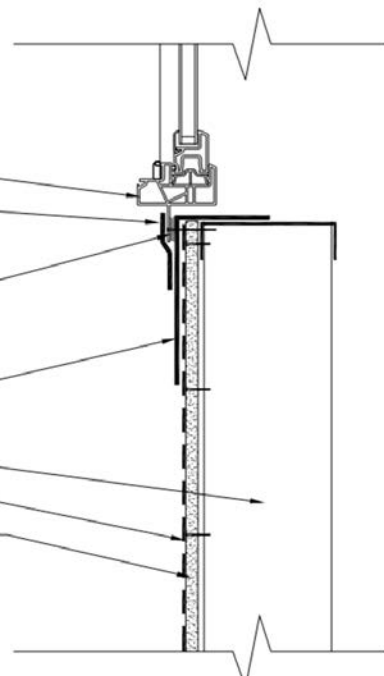


Mockup #2 E2112 Method “B1 No Foam/Sealant



DUPONT TYVEK COMMERCIAL WRAP

GYPSUM SHEATHING





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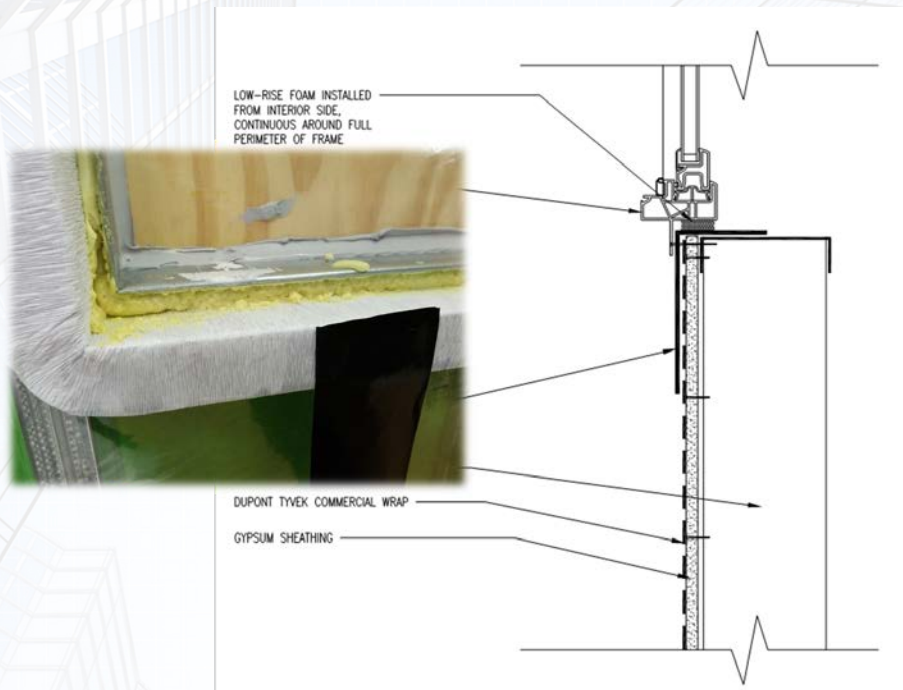
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Mockup #3 E2112 Method “A1” With Foam





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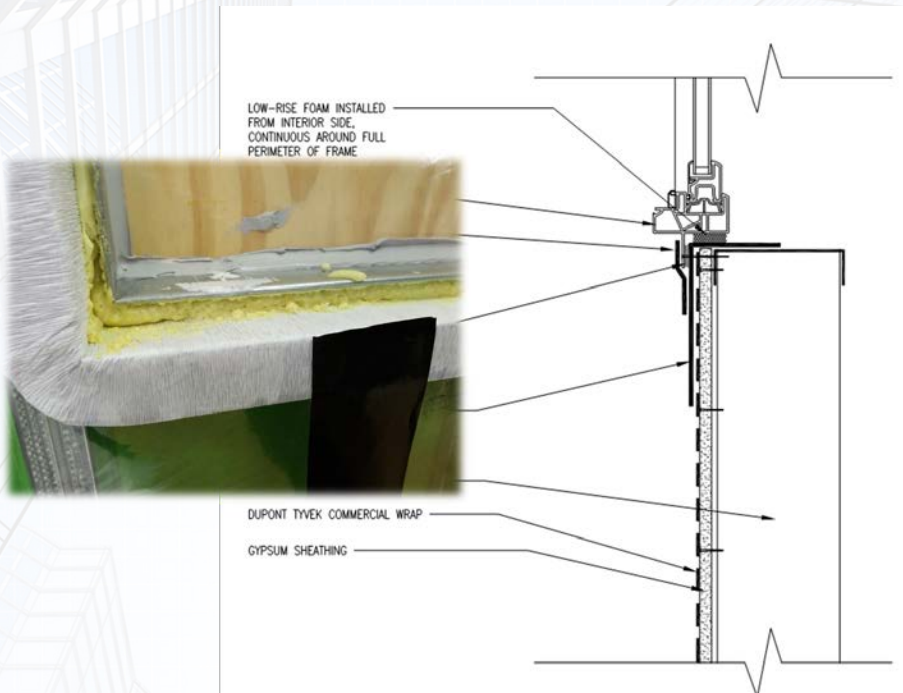
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Mockup #4 E2112 Method “B1” With Foam





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Mockups #5 E2112 Method “A1” With Backer Rod & Sealant



BACKER ROD AND SEALANT JOINT INSTALLED
FROM INTERIOR SIDE, CONTINUOUS AROUND
FULL PERIMETER OF FRAME

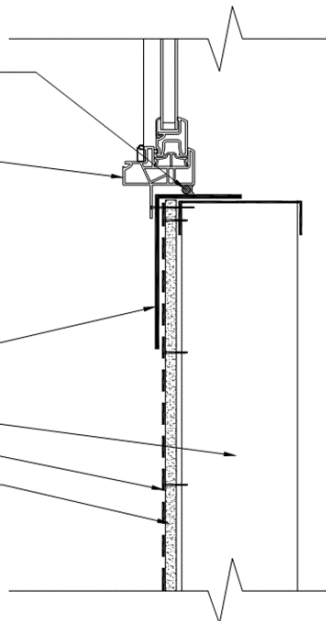
FLANGED WINDOW BLANK;
DO NOT SEAL B/W SILL
FLANGE AND FLASHING

WINDOW SILL FLASHED WITH DUPONT
TYVEK FLEXWRAP SELF-ADHERED
MEMBRANE

METAL FRAMING

DUPONT TYVEK COMMERCIAL WRAP

GYP SUM SHEATHING





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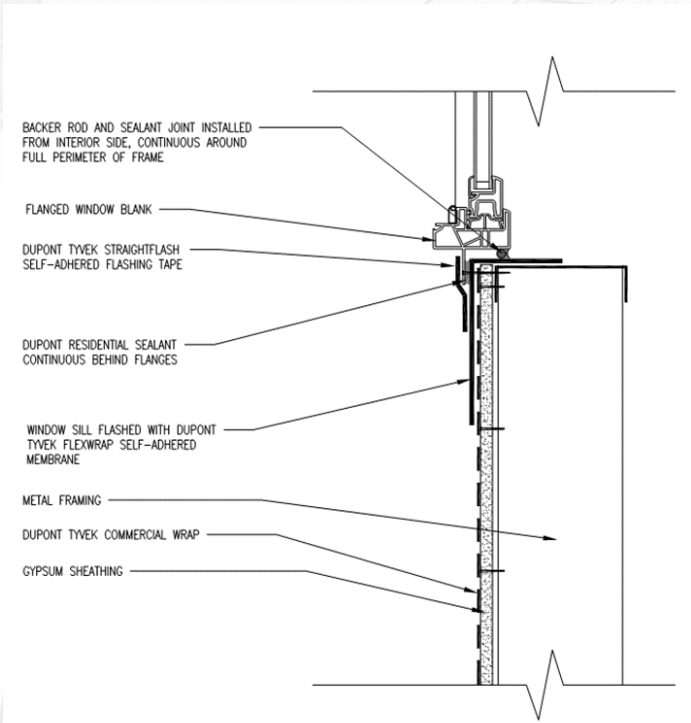
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Mockups #6 E2112 Method “B1” With Backer Rod & Sealant





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Air Leakage Testing

ASTM E 783-02(2010) Standard Test
Method for **Field** Measurement of Air Leakage
Through Installed Exterior Windows and Doors



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Manometer (inches of water)





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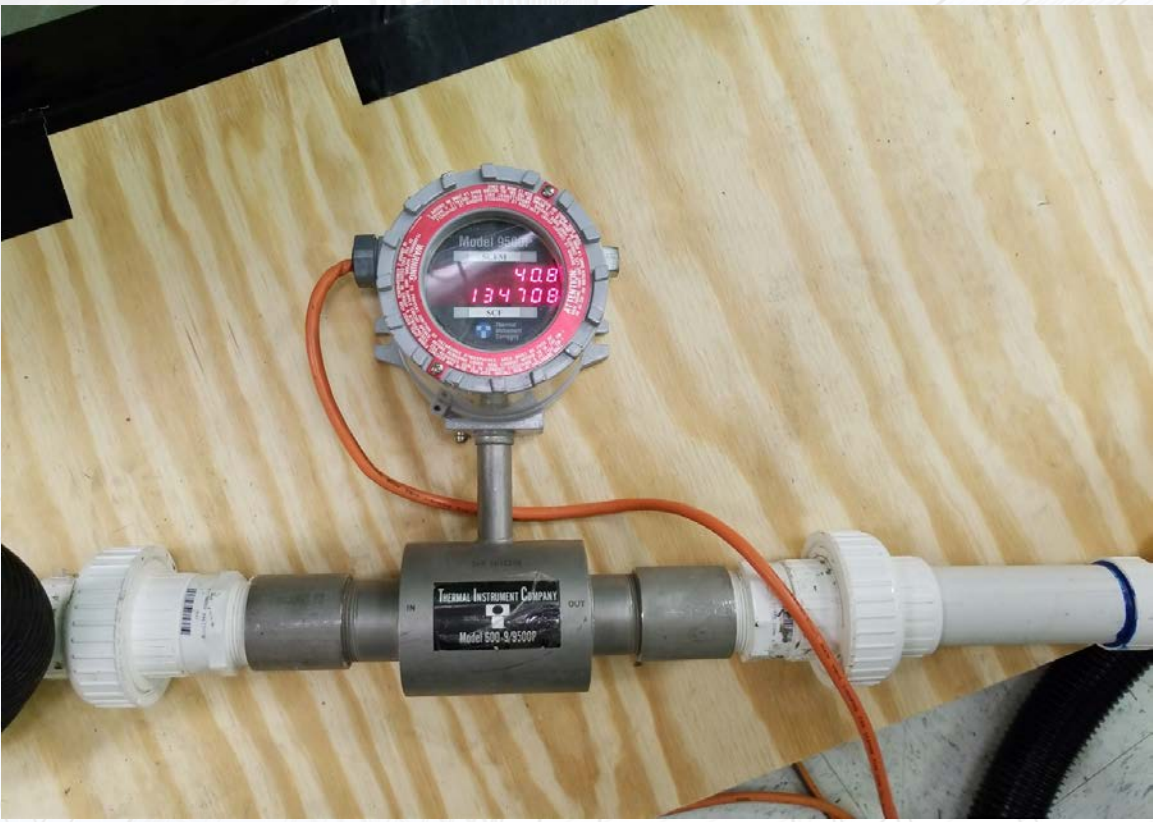
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Airflow Meter (cfm/sf)





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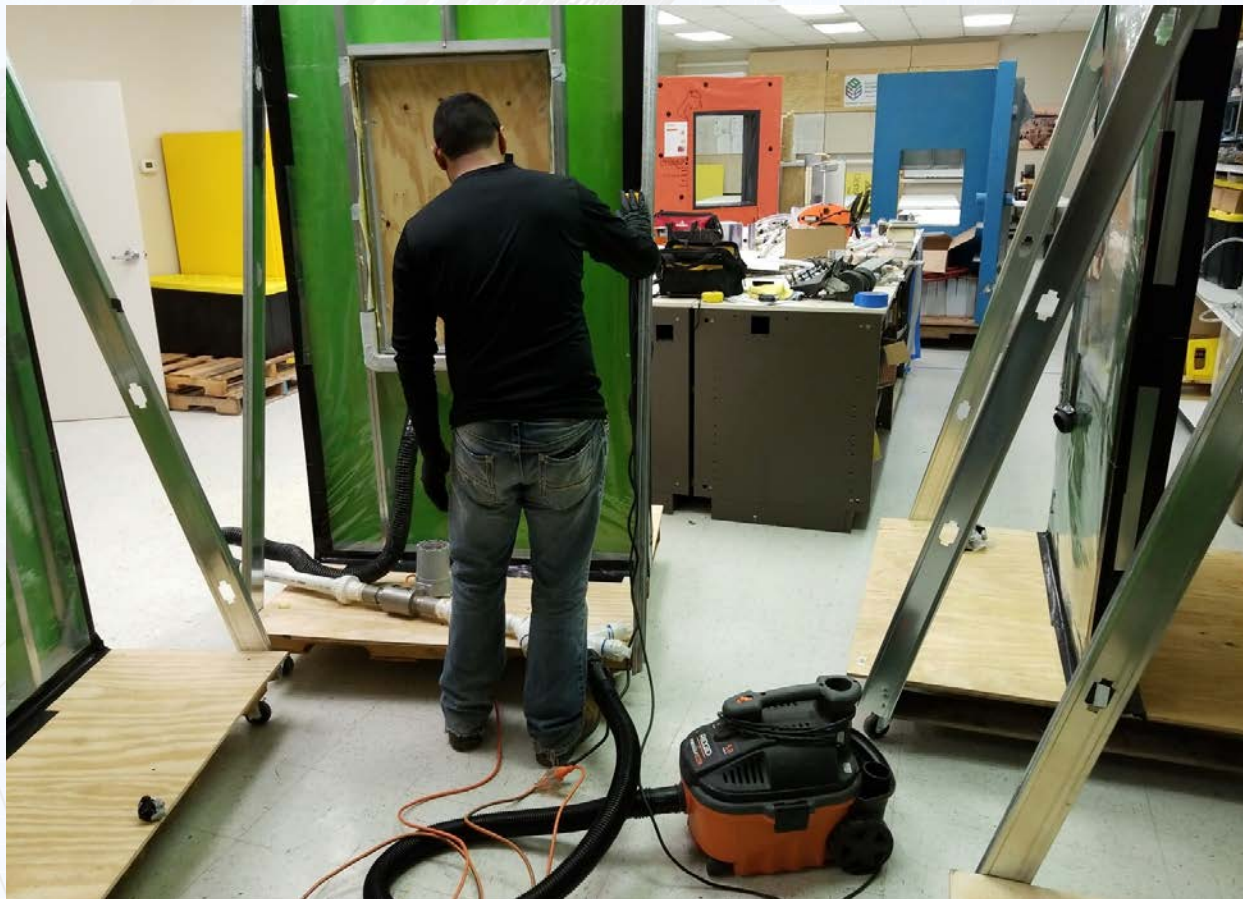
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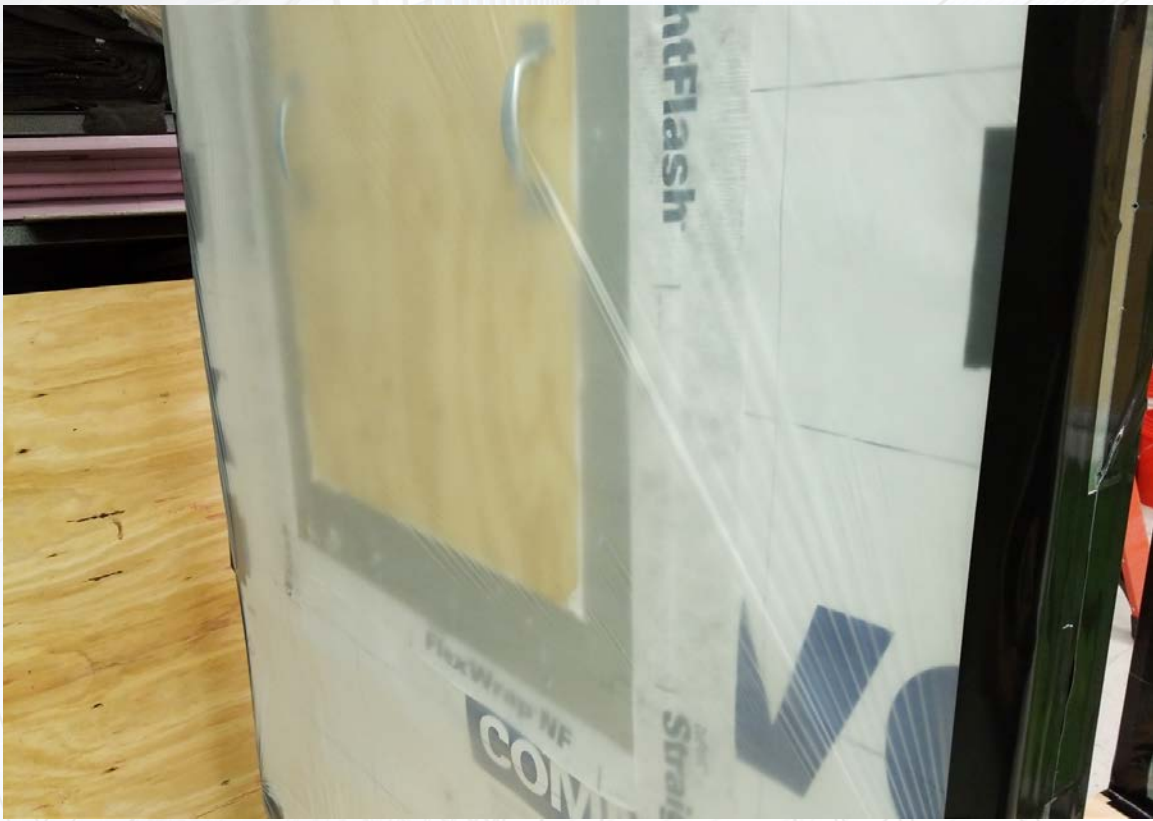


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Full Isolation





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“Blank” Isolation





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No Isolation





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Isolation v.2.0





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Water Testing

ASTM E1105-15 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



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Water Testing







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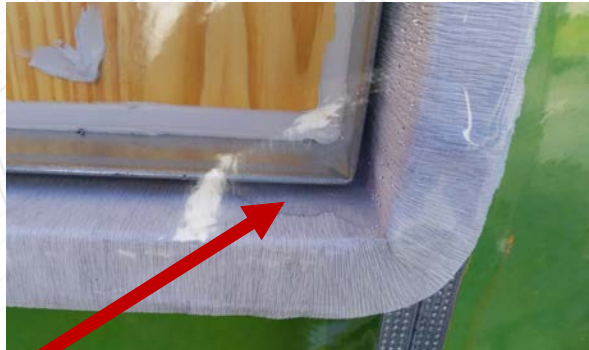


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Water Testing





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Water Testing





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Results



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Mockup Information			Air Leakage Thru Specimen in cfm ASTM E783	
Mockup No.	Installation Method	Interior Air Seal	Average Results at 300 pa	Simplified Results at 75 pa
1	A1	Nothing	8.2	2
2	B1	Nothing	2.1	1.4
3	A1	Foam	0.9	0
4	B1	Foam	0	0
5	A1	Backer Rod & Sealant	0.7	0
6	B1	Backer Rod & Sealant	0	0



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Mockup Information			Water Penetration Tests E1105 (cyclical) at 10 psf - 23 min.	
Mockup No.	Installation Method	Interior Air Seal	Water Penetration Tests E1105 (cyclical) at 10 psf - 23 min.	Summary Description
1	A1	Nothing	Water observed at approx. 10 seconds, right sill corner "FAIL"	Worst by Far
2	B1	Nothing	Water observed at approx. 9 minutes, right sill corner "FAIL". Water observed at approx. 19 minutes, left sill corner "FAIL".	
3	A1	Foam	No water observed. "PASS"	BEST
4	B1	Foam	Water observed at both sill corners only after testing was complete and chamber was removed.	
5	A1	Backer Rod & Sealant	No water observed. "PASS"	BEST
6	B1	Backer Rod & Sealant	Water observed approx. 13 minutes, primarily at right sill corner, but all along sill "FAIL".	



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Conclusions



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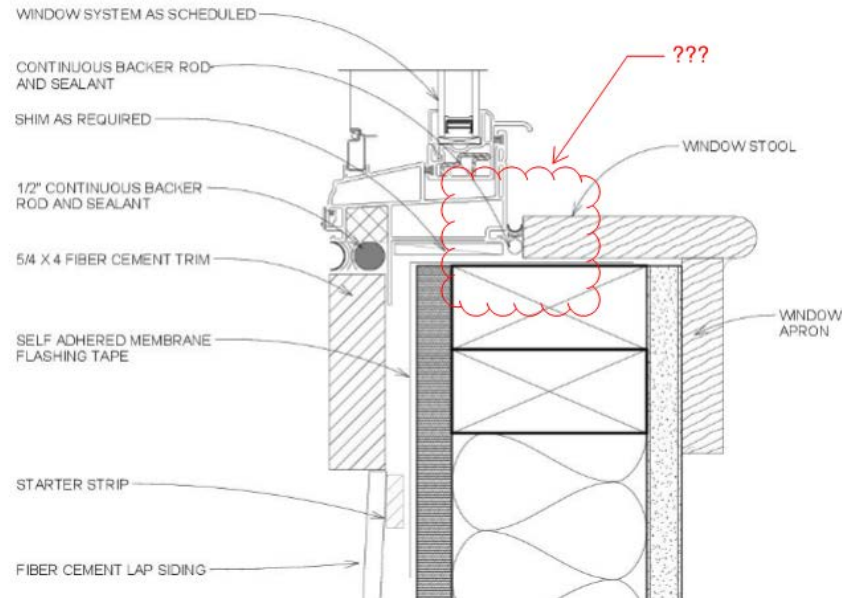
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1. The backer rod and sealant or foam installed from interior...is very important!

Lessons Learned



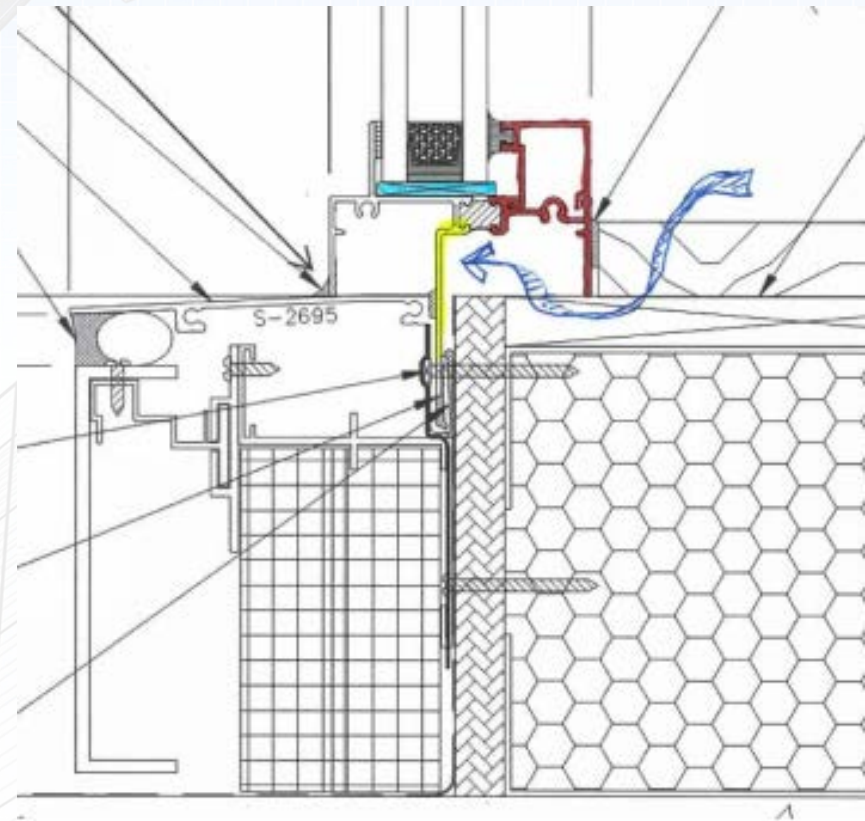
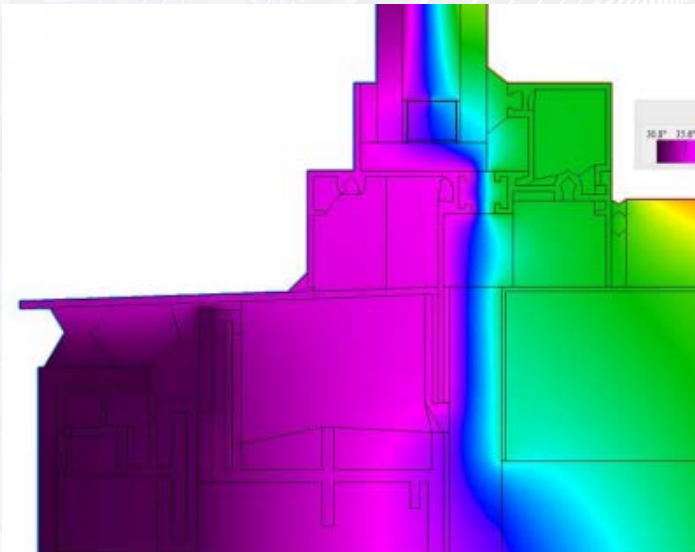


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Lessons Learned

2. E2112 Method “A1” appears to be better than “B1” at managing water, but more testing needed to verify high rise construction, hurricane zones.
3. E2112 Method “B1” is the best for air tightness. But “A1” can be good too.
4. Doesn’t matter if it is A1 or B1 w/backer rod and sealant or foam at 75 pa (Code, Passive House). Could make a difference at 300 pa, high rise construction, hurricane zones.



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Next Steps



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Future Testing

1. Additional water testing. Rebuild mockups and test again.
2. Full battery of tests comparing head installation details.
3. Determine ultimate installation detail for mechanically fastened WRB.
4. Then do it all again with a fluid-applied WRB, a self-adhered WRB, and a pre-applied board stock WRB (i.e. ZIP, ExoAir 430, etc.). Determine the ultimate installation detail for each of these generic system types.



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What are we
not accounting
for?

- Future Window Failures
- *Schlocky* Construction
- Future Building Movement



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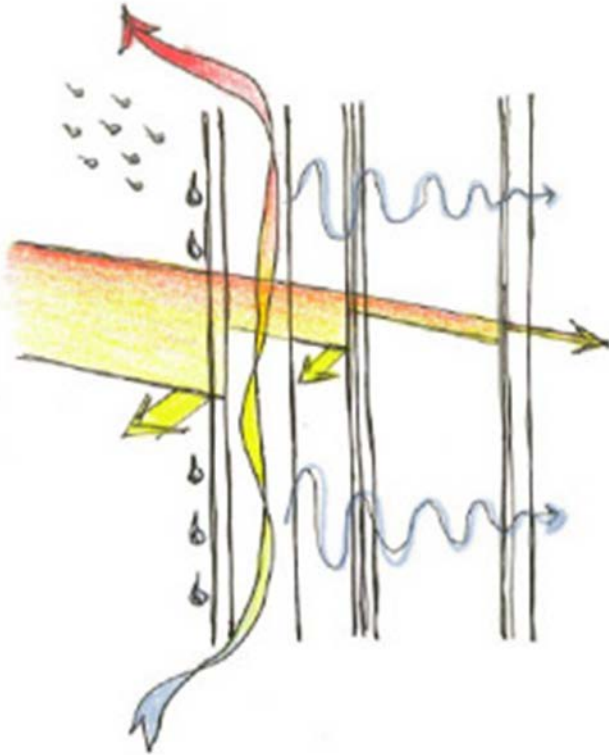
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- Chamberlin Roofing & Waterproofing
- DuPont Tyvek and Weatherization Partners (WPL)



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John Posenecker, P.E.

jposenecker@besgrp.com

Kayla Maines, AIA, LEED AP

kayla.maines@terracon.com



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