Water Penetration and Air Leakage Testing of Flanged Window Details

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BES/Terracon and JE Dunn Construction

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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

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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

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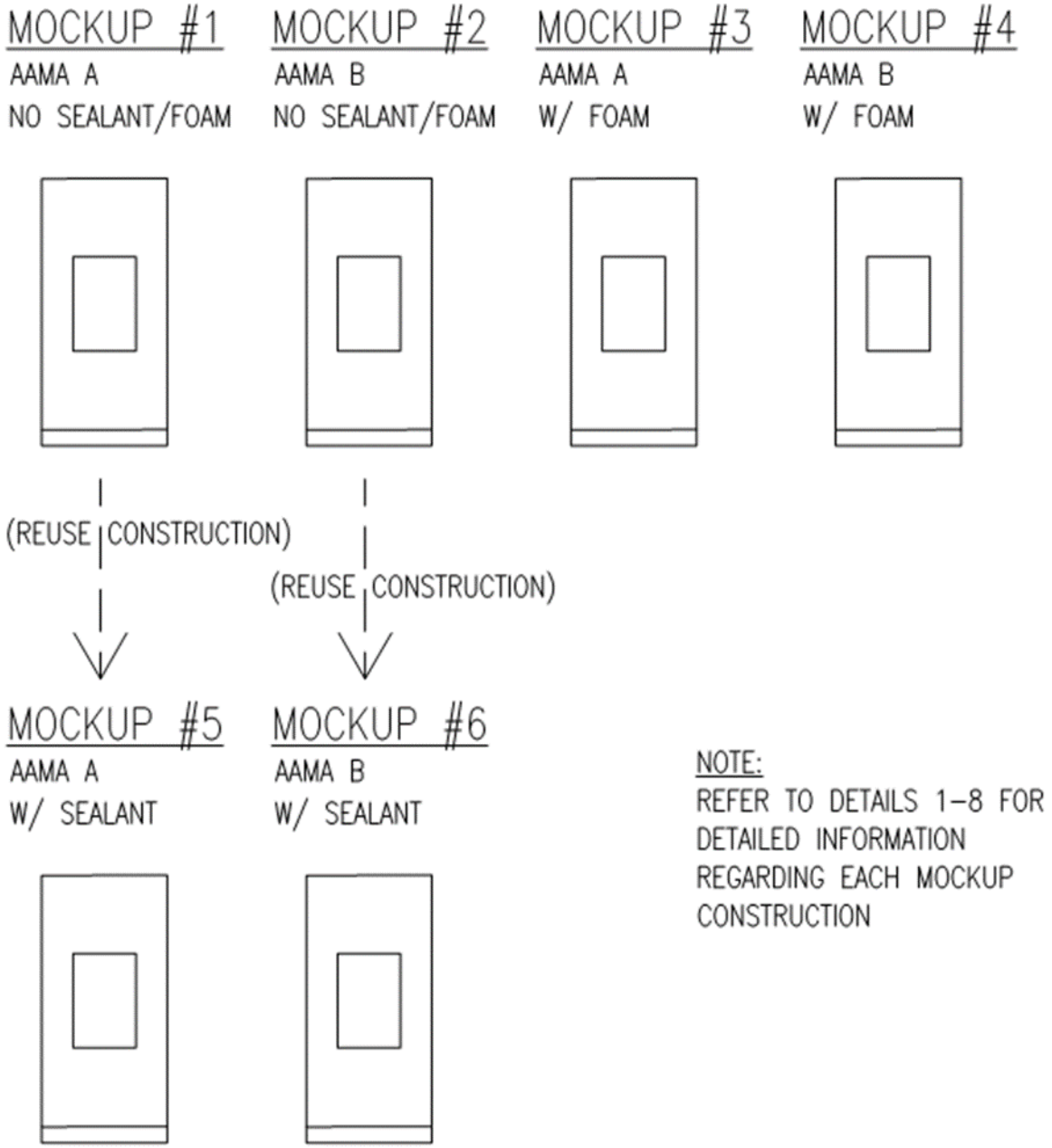
Details

Mockups Diagram



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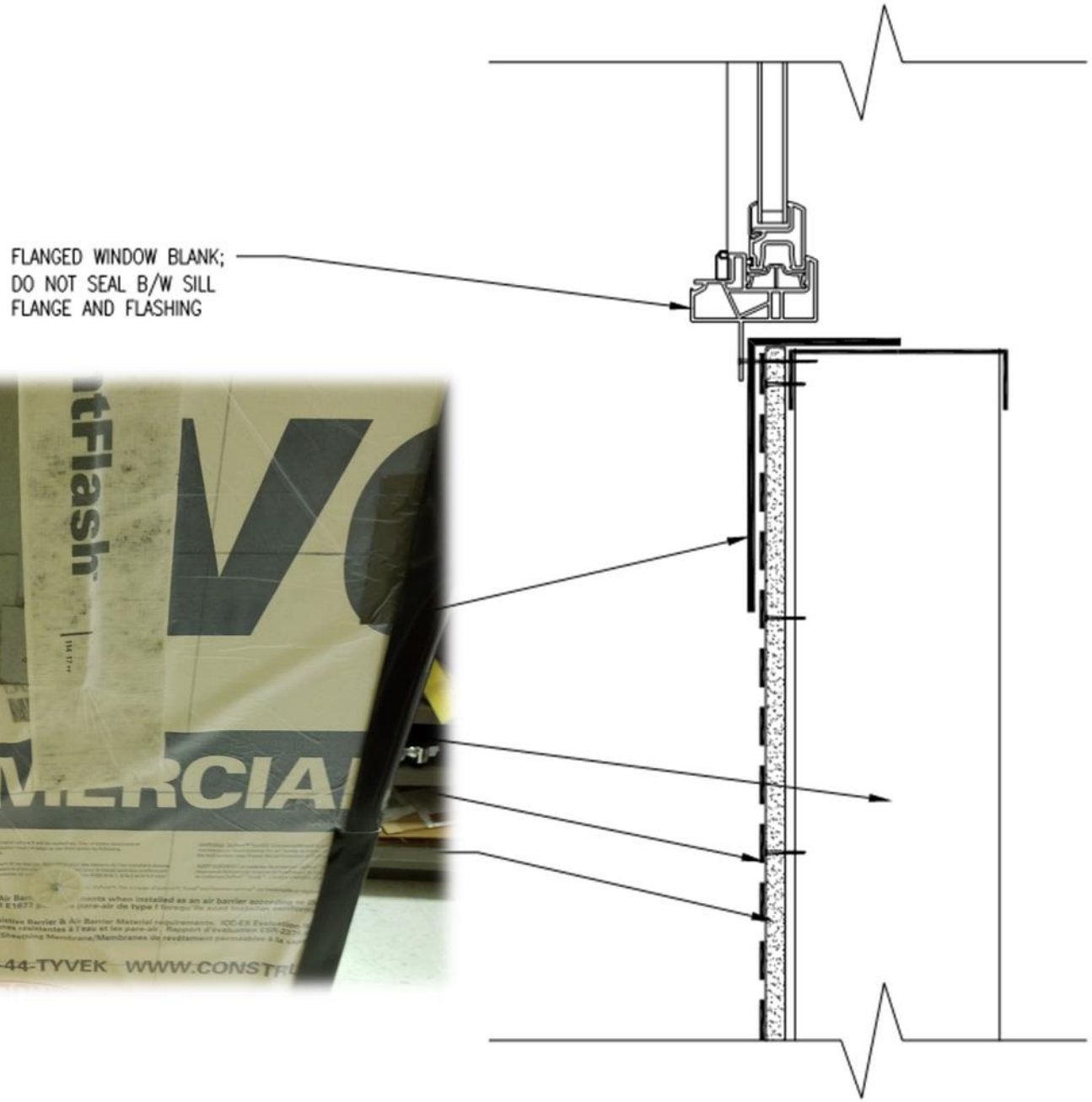
Mockup #1

E2112 Method “A1”

No foam/sealant



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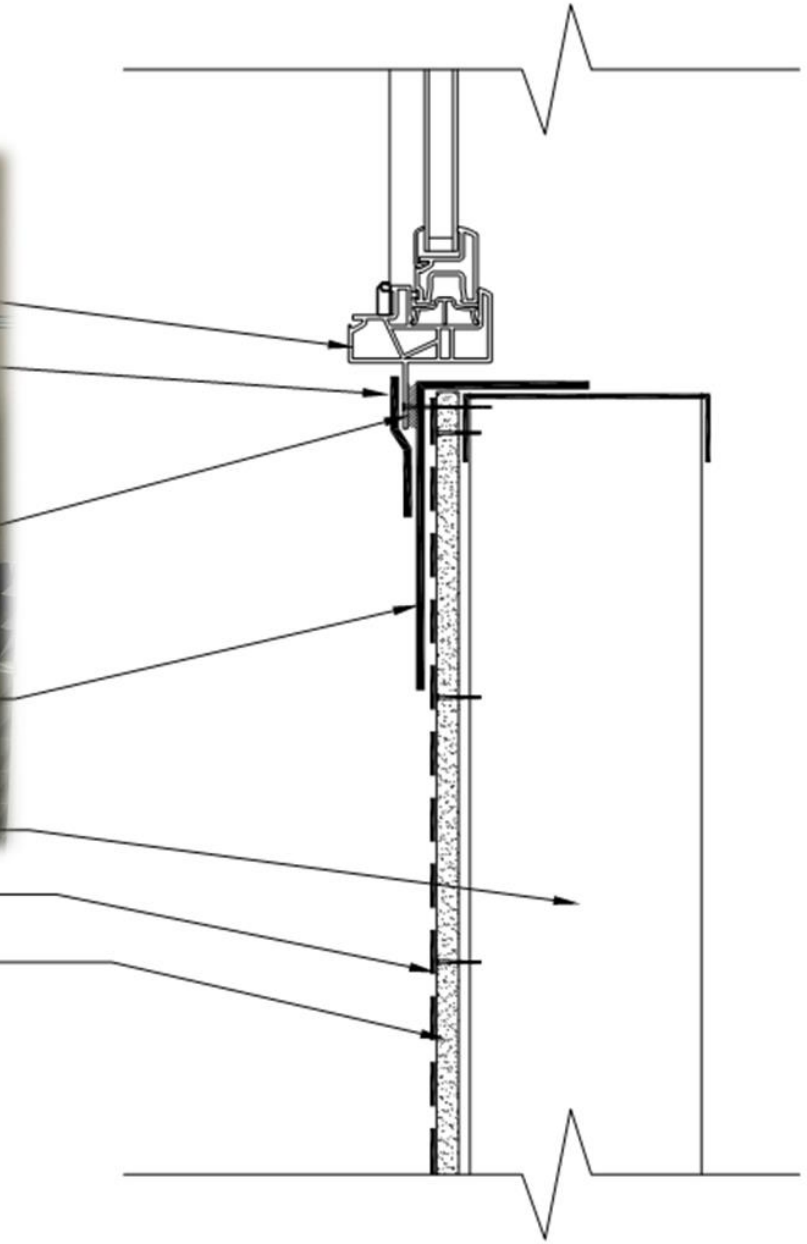
Mockup #2

E2112 Method “B1”

No foam/sealant



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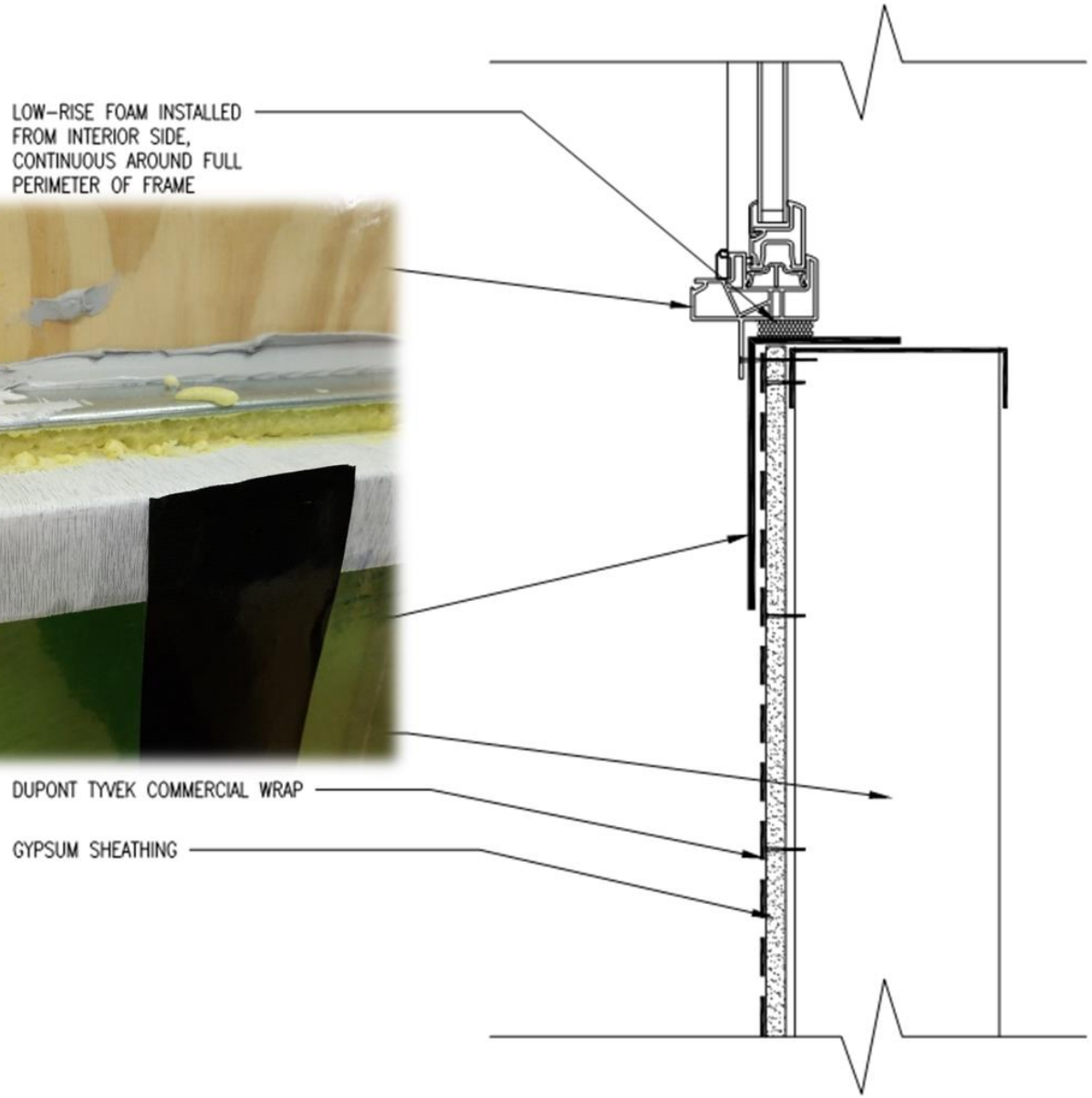
Mockup #3

E2112 Method “A1”
With foam



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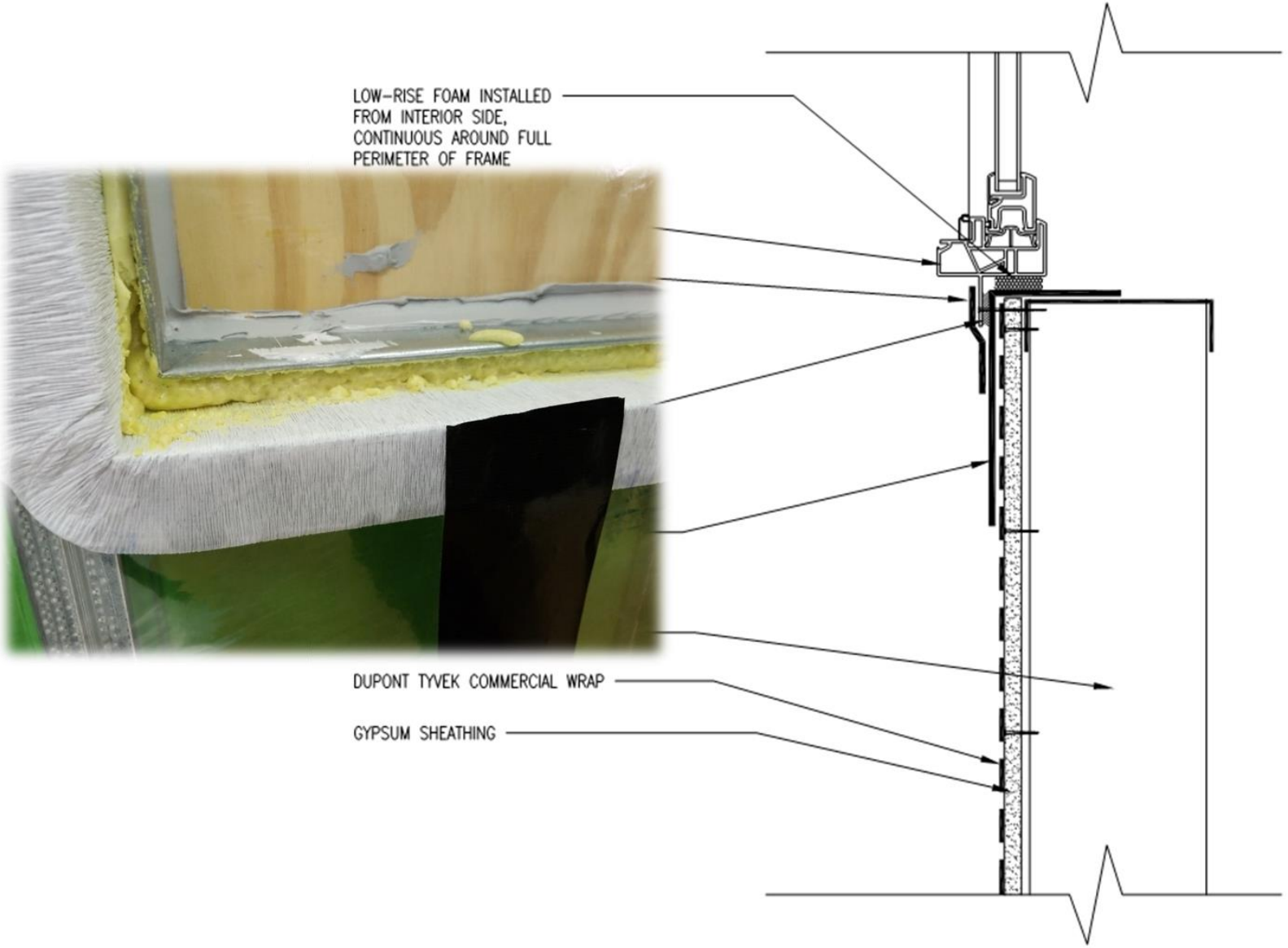
Mockup #4

E2112 Method “B1”
With foam



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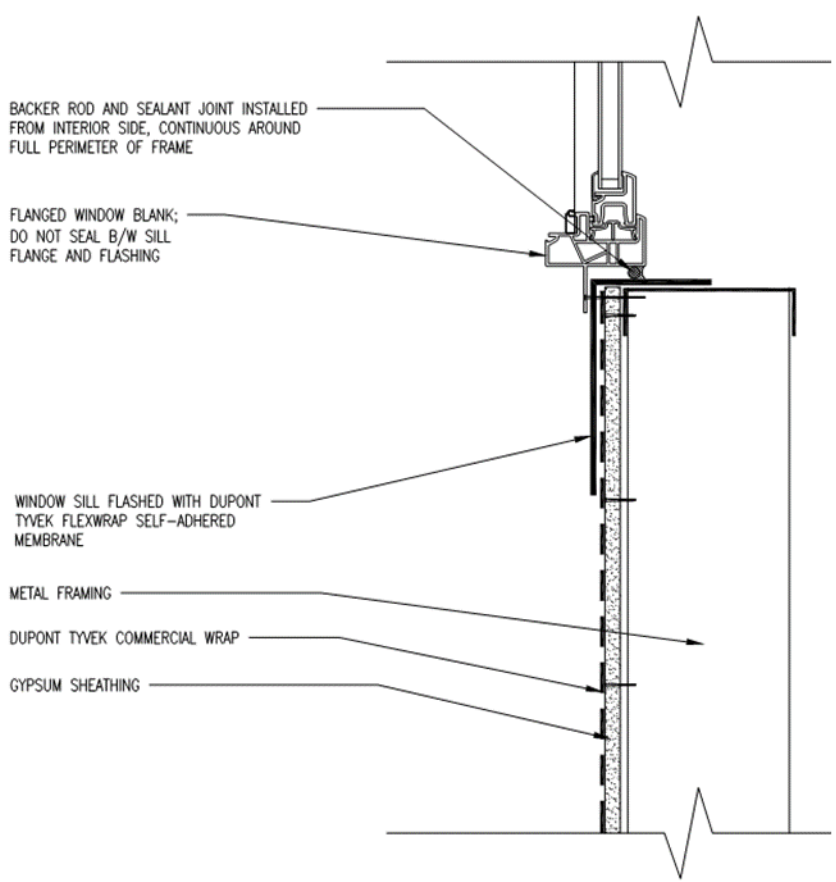
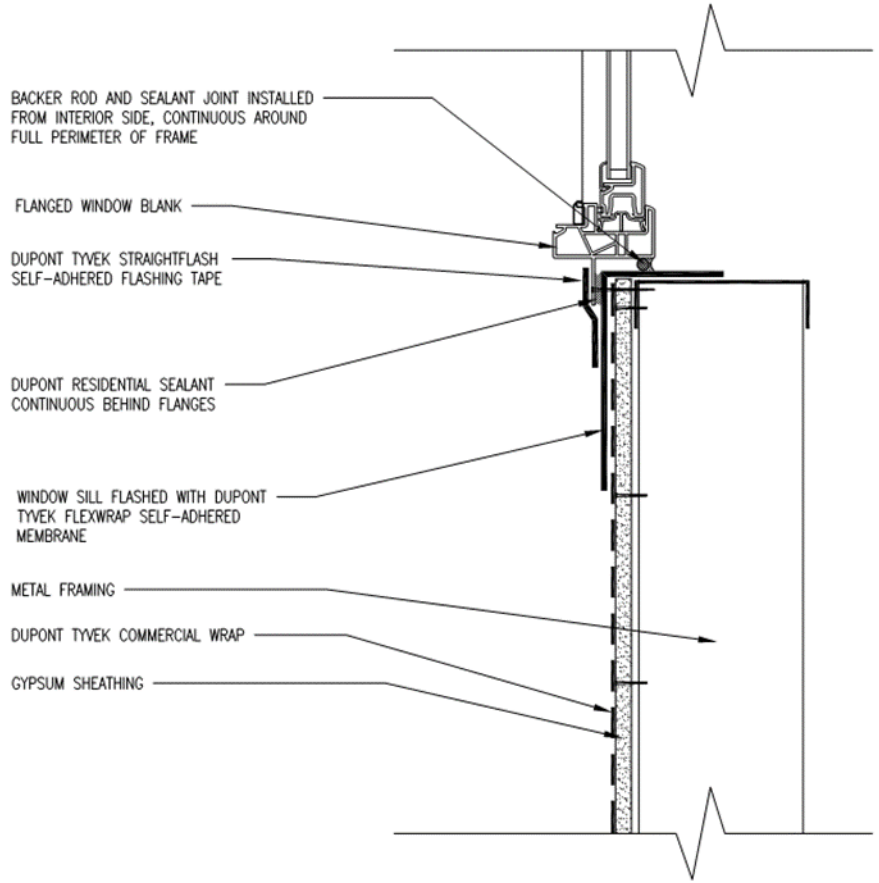
Mockups #5, #6

E2112 Method “A1” and “B1”
With Backer Rod & Sealant
(not yet built)





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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

Mockup Construction

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Window “Blanks”

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I-Cut

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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

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Controversy at the head…

Controversy at the sill…

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Pressure Chambers

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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

Manometer (inches of water)

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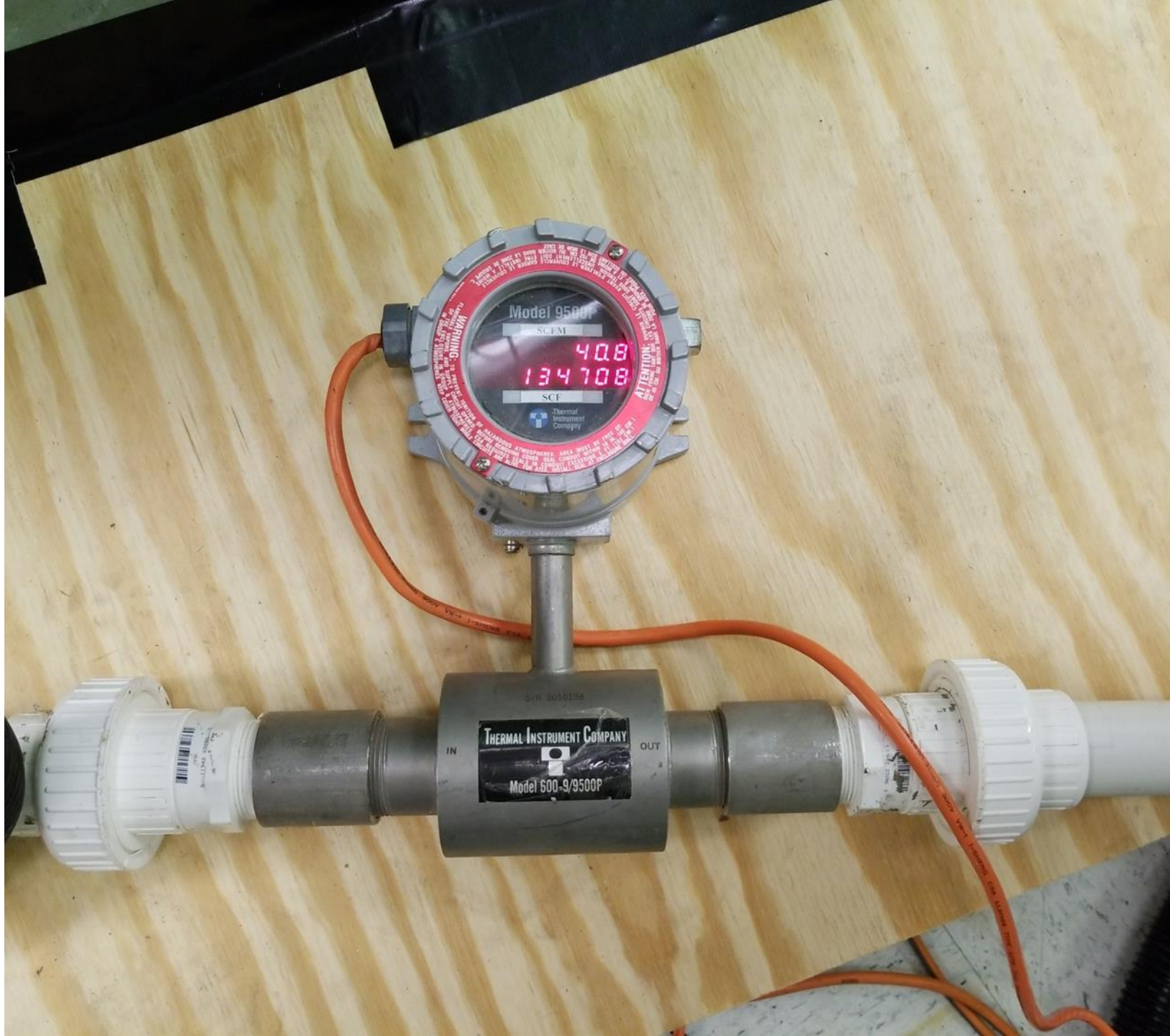
Airflow Meter (cfm/sf)



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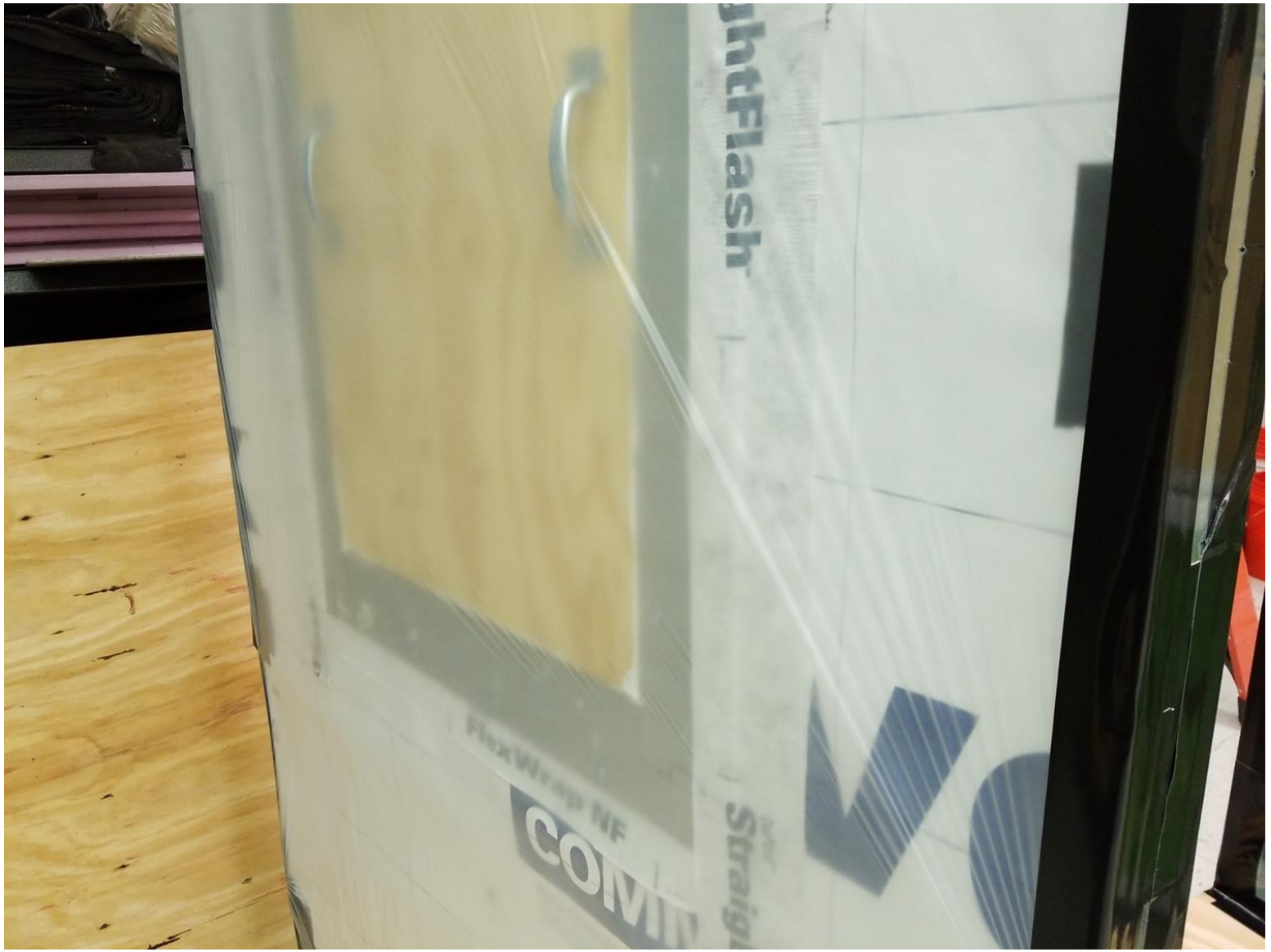
Full Isolation



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“Blank” Isolation

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No Isolation

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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

Water Testing

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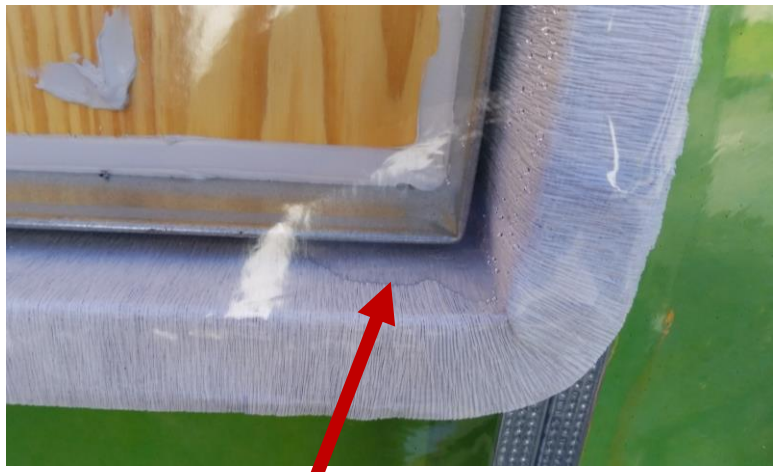
Water Testing



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Water Testing

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Water Testing woes…

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Results

Air Leakage Testing Results

tests performed on Feb. 21, 2018	tests performed on Feb. 23, 2018

Description	Mockup	Air Test 1 E283 at 300 pa fully covered w/ plastic		Air Test 3 E283 at 300 pa blank covered		Air Test 4 E283 at 300 pa fully open		Air Leakage Thru Blank (#4 - #3)		Air Leakage Thru Specimen (#4 - #1)	
E2112 Method "A1" no foam	1	9.9	32	14.9	40.8	15.0	41	0.1	0.2	5.1	9
E2112 Method "B1" no foam	2	14.2	34	15.8	36.8	15.9	36.8	0.1	0.0	1.7	2.8
E2112 Method "A1" with foam	3	14.7	30.1	16.0	30.4	16.1	30.5	0.1	0.1	1.4	0.4
E2112 Method "B1" with foam	4	17	28.5	17.0	28.4	17.1	28.4	0.1	0.0	0.1	-0.1
		cfm	cfm	cfm	cfm	cfm	cfm	cfm	cfm	cfm	cfm

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Water Testing Results

tests performed on March 1, 2018	tests performed on March 7, 2018

Description	Mockup	Water Penetration Test E1105 (cyclical) at 10 psf	
E2112 Method "A1" no foam	1	Water observed at approx. 10 seconds, right sill corner	
E2112 Method "B1" no foam	2	Water observed at approx. 9 minutes, right sill corner	
E2112 Method "A1" with foam	3	Water only observed permeating thru plywood at approx. 9 minutes (INCONCLUSIVE)	Attempted two more tests, but immediate leakage thru plywood. Second test painted plywood exterior, but did not stop water (INCONCLUSIVE)
E2112 Method "B1" with foam	4	Test #1 - water observed between blank sealant at approx. 9 minutes (INCONCLUSIVE) Test #2 - water observed at both sill corners only after testing complete and chamber was removed	

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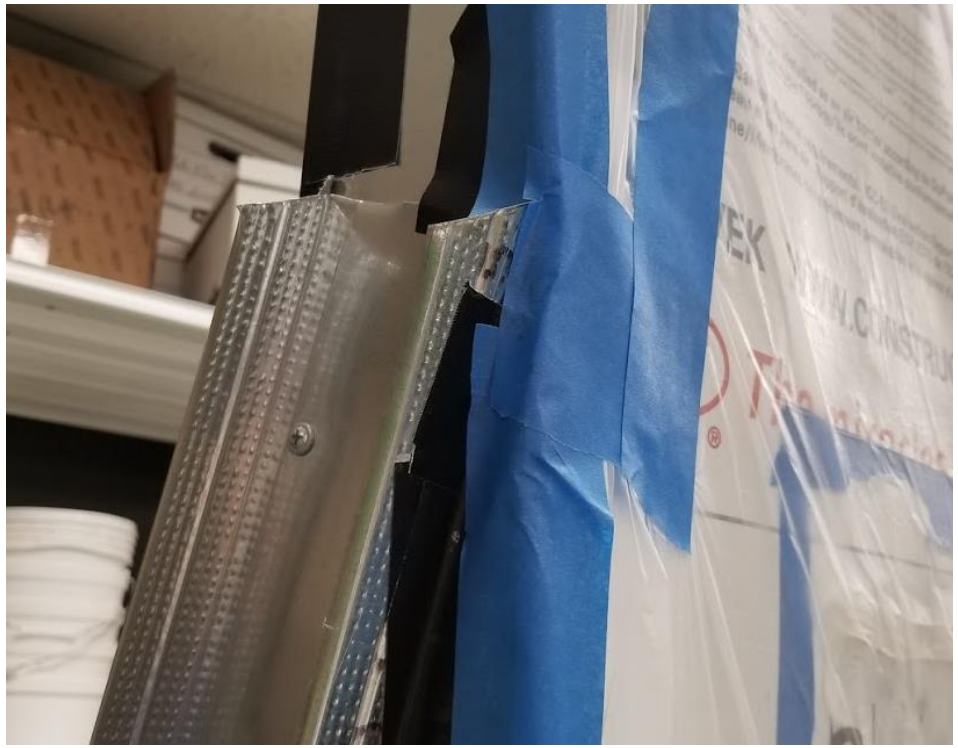
Next Steps

Lessons Learned



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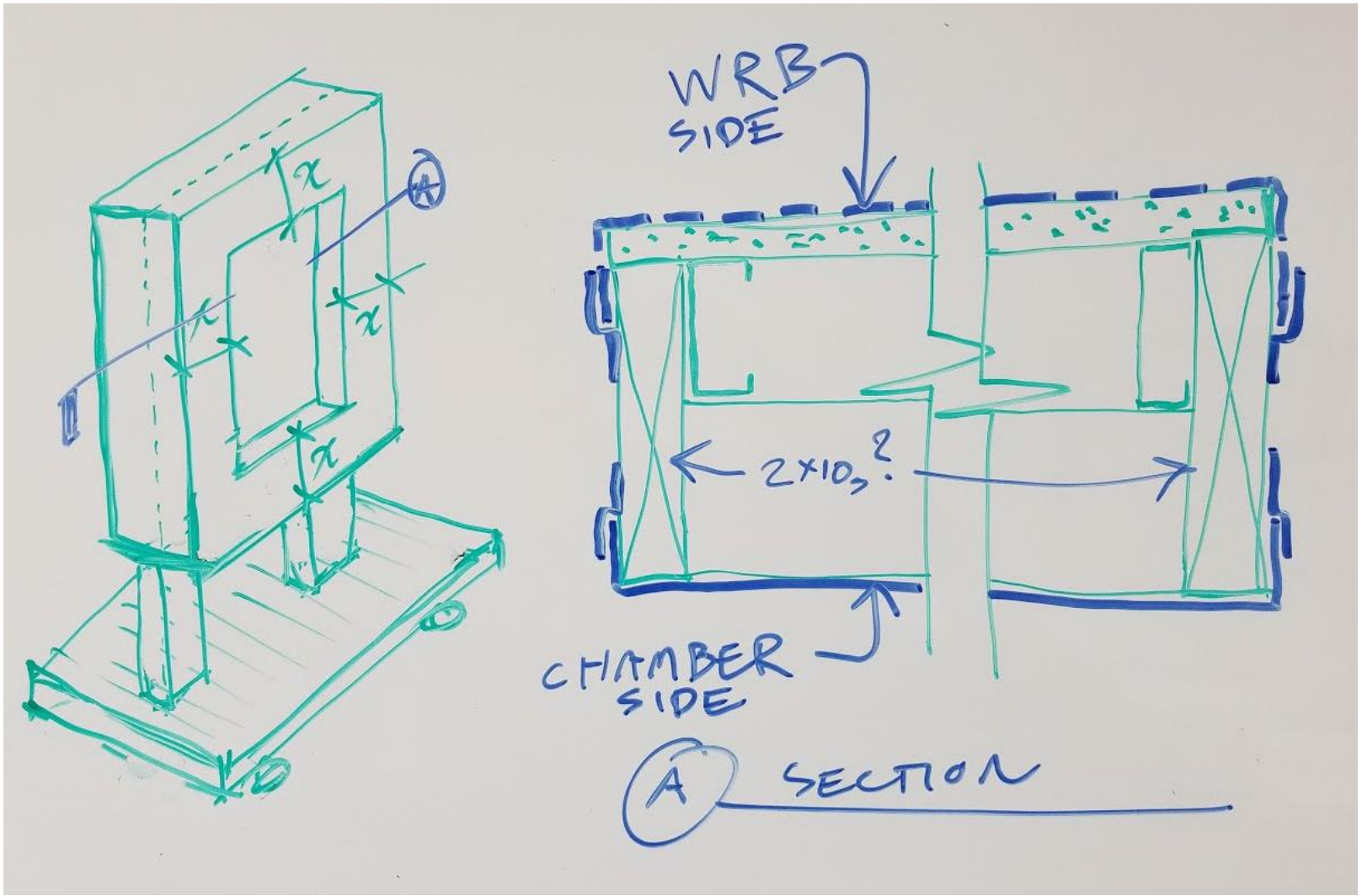
Next Steps



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What are we not testing/accounting for?

Does it make a difference?

Code air leakage: 0.4 cfm/sf at 75 pa (…we tested at 300 pa…)
PHIUS+ 2018 Standard: 0.05 cfm/sf at 75 pa

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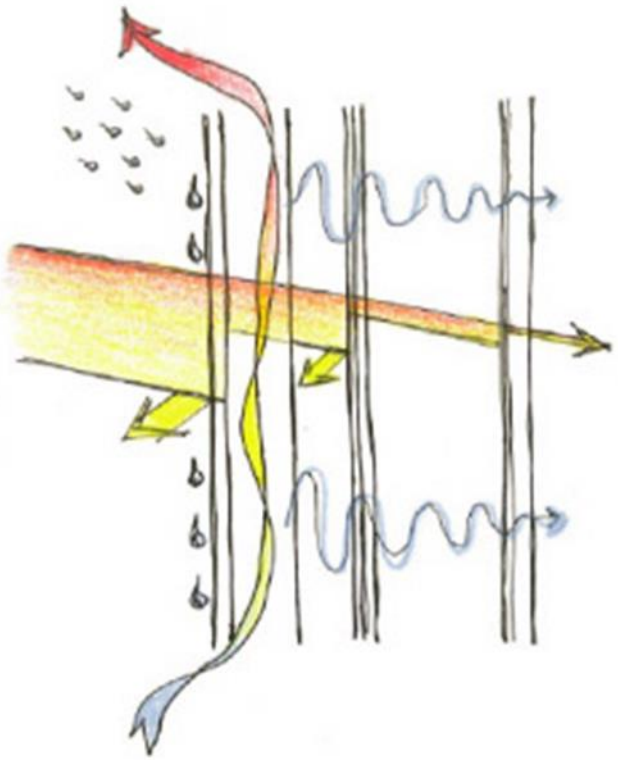

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