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Course Description

Field performance testing is an integral part of the Building Enclosure Commissioning process. Testing helps to verify that the enclosure meets the desired performance requirements for the project. Testing generally is performed to verify air tightness, water tightness, adhesion, energy efficiency, among others. This session discusses typical industry established test methods in detail to demonstrate to the level of effort required for the testing as well as why the tests are performed.

Learning Objectives

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

1. Understand several available enclosure test methods and what their purpose is or what information is obtained from the tests.
2. Understand why testing is important to validating the performance of the building enclosure but also that it is only one component to Building Enclosure Commissioning.
3. Understand the basics of how the selected tests are performed.
4. Understand the advantages and limitations of the tests discussed.

SOLUTIONS FOR THE BUILTWORLD

Building Enclosure Performance Testing

CxEnergy 2017 Conference and Expo

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www.wje.com

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Outline

- Background on Building Enclosure Field Performance Testing
- Case Study 1- wall air and water
  - ASTM E783
  - ASTM E1105
  - AAMA 501.1
  - AAMA 501.2
- Case Study 2- roof integrity & moisture
  - ASTM D7954
  - ASTM D7877
- Case Study 3- whole building air tightness
  - ASTM E1827
  - ASTM E1186

Background on Enclosure Field Testing

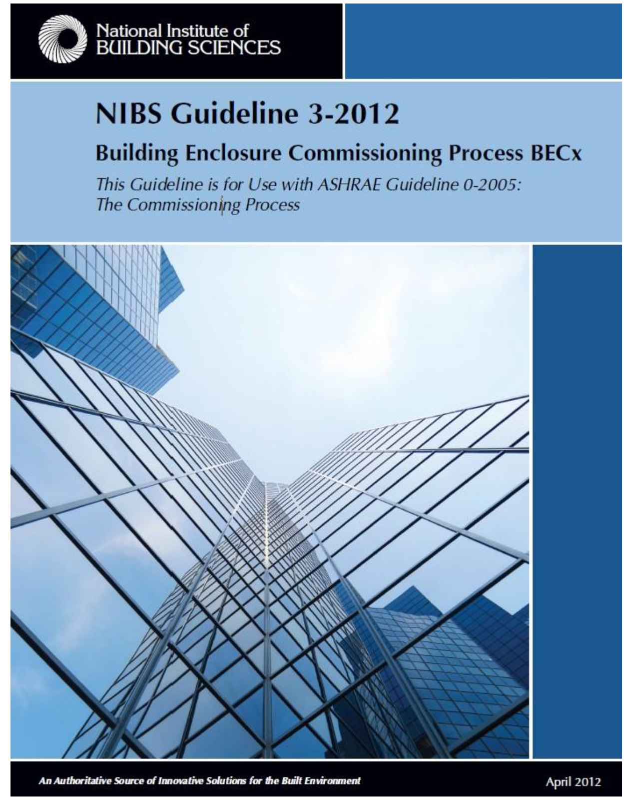
- What constitutes the building enclosure?

"the over-all function of an exterior wall, in conjunction with floors and roofs, is to provide a barrier between indoor and outdoor environments, so that the indoor environment can be adjusted and maintained within acceptable limits"

Hutcheon, N. CBD 48, 1963

Background on Enclosure Field Testing

- BECx Process
  - NIBS GL3 (2006) 2012 Building Enclosure Cx Process
  - ASTM E2813-12e1 (2012) Standard Practice for Building Enclosure Commissioning … *pending modifications*
  - ASTM E2947-2016a Standard Guide for BECx
  - ISO 21105NP - "Building envelope thermal performance verification and commissioning – Program"



Background on Enclosure Field Testing

- LEED v4
  - Fundamental *(by qualified Member of Design or Construction Team, not associated with project)*
    - OPR and BOD
    - Design Review
  - Enhanced *(by experienced CxA with min. 2 jobs with a similar scope & independent or disinterested party)*
    - All Fundamental tasks, plus references ASHRAE Guidelines 0, 1.1 and Guideline 3, 2012
    - CxA prepares a CFR & O&M Plan (including training in CDs)
    - CxA develops on-going Cx Plan
    - CxA documents Operator and Occupant training delivery & effectiveness

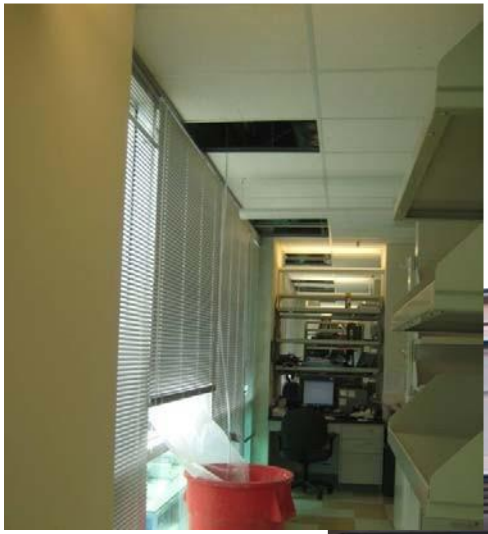
Background on Enclosure Field Testing

- How does enclosure field testing fit within BECx process?
  - Kick Off Meetings
  - OPR/BOD
  - BECx Spec and Plan
  - Design Reviews
  - Mockup Review and Testing
  - Submittal Reviews
  - Shop Visits
  - Pre-installation Meetings
  - Construction Observations

- Field Testing
- Issues Log
- Final BECx Report
- Warranty Review
- CFR plan

Background on Enclosure Field Testing

- Why are the tests important?
  - To reduce risk
  - To avoid unintended consequences that could be expensive to fix
  - To verify performance meets OPR & specifications
  - How much testing is enough?
  - KEEP IT REAL!



Background on Enclosure Field Testing

- What kind of tests are performed and how are they performed?
  - Established test methods (ASTM, AAMA, etc.)
  - Architect or BECx Provider writes test methods into spec

- Are the tests appropriate for the systems being tested?

Background on Enclosure Field Testing

- Who performs?
  - Independent testing agency (AAMA certified?)
  - BECx provider
  - Contractor
  - Other? Manufacturer

Background on Enclosure Field Testing

- When is testing performed?
  - Mock-ups
  - Throughout construction
  - Before WRB or air barrier is covered and before finishes are installed
  - End of construction
  - Typically well-before MEP commissioning
  - Schedule

Background on Enclosure Field Testing

- Where is testing performed?
  - Complex or risky details
  - Meeting of numerous trades
  - Typical systems to establish base for future extent of testing
  - Representative sampling
  - Failure / re-testing / additional locations

Background on Enclosure Field Testing

- Testing Considerations
  - Sources of power, water
  - Access
  - Weather
  - Inter-relationship of systems
  - Damage to systems
  - Over testing
  - Isolation of the test specimen
  - Out of sequence work

Case Study 1

ASTM E783

ASTM E1105

AAMA 501.1

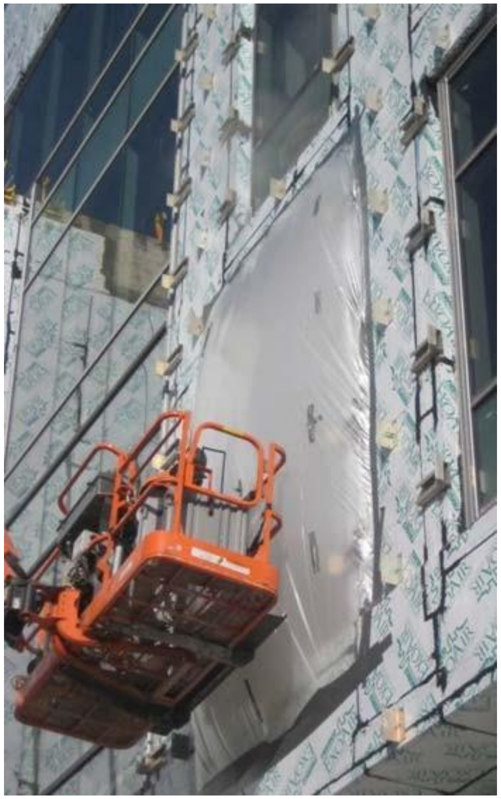
AAMA 501.2

Case Study

- Wisconsin Institute for Discovery, Univ. of Wisconsin in Madison
- 327,000 GSF
- 4 stories plus penthouse and below grade level
- Below grade Vivarium connected to building
- $200,000,000 total project cost
- Construction started 9/2008
- Substantial completion 12/2010
- LEED Gold
- Interdisciplinary collaborative research facility

ASTM E783

- *Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors*



ASTM E1105

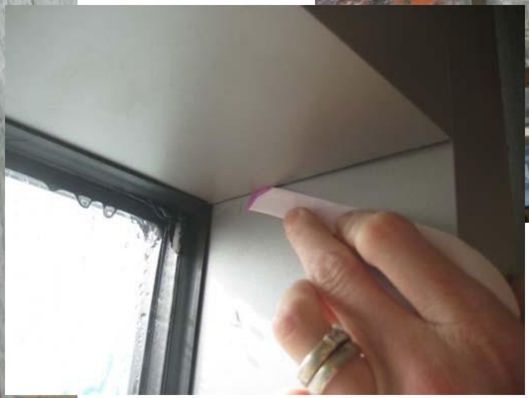
- *Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Differential*

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 Differential*

AAMA 501.1

- *Standard Test Method for Water Penetration of Windows, Curtain Walls, and Doors Using Dynamic Pressure*



AAMA 501.2

- *Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems*

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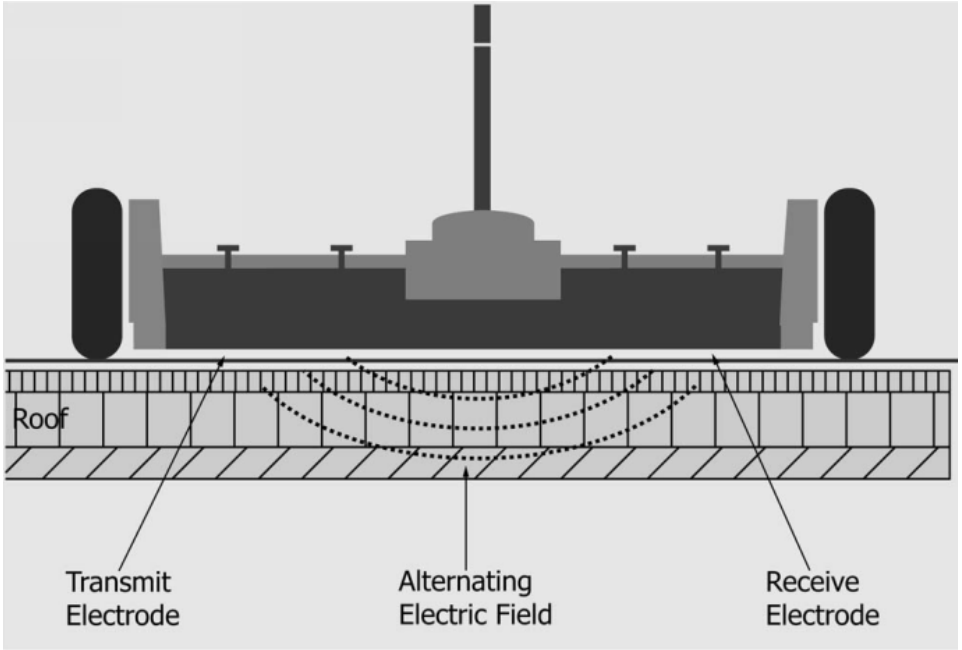
Case Study 2

ASTM D7954

ASTM D7877

ASTM D7954

- Standard Practice for Moisture Surveying of Roofing and Waterproofing Systems Using Non-Destructive Electrical Impedance Scanners



ASTM D7877

- Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes

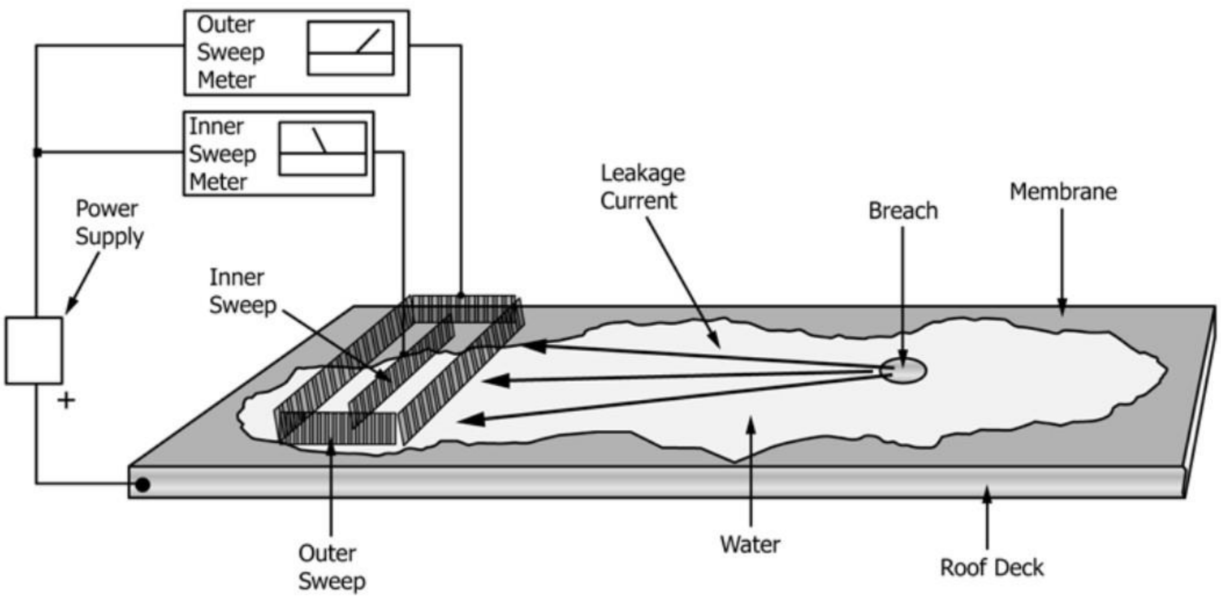


FIG. 1 Basic Circuit and Application of the Membrane Scanning Platform

ASTM D7877

- Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes

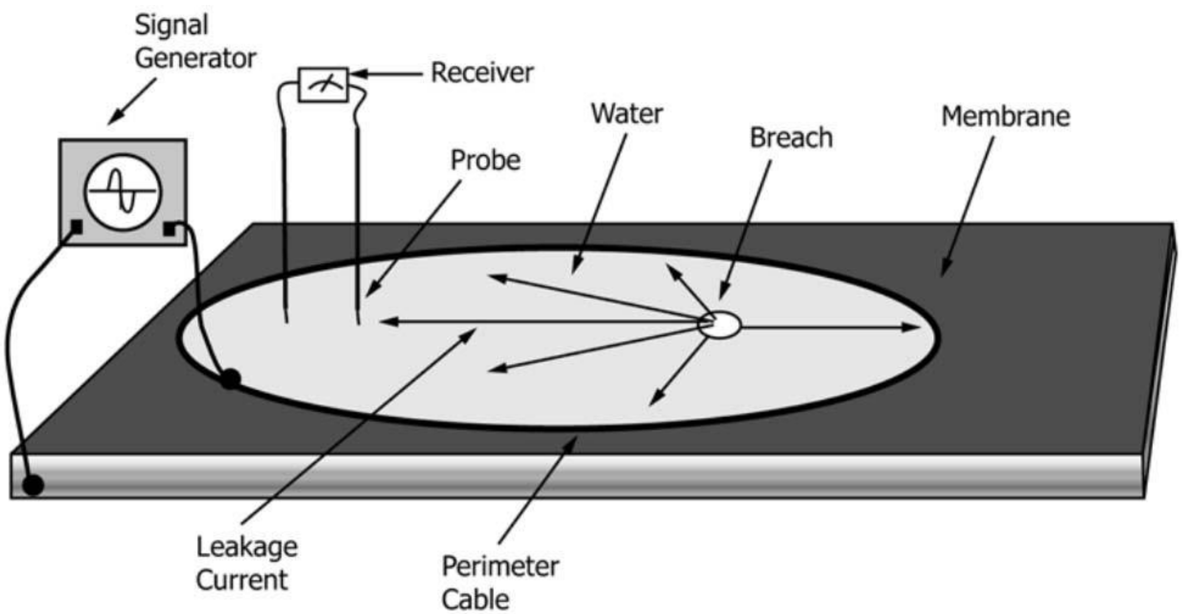
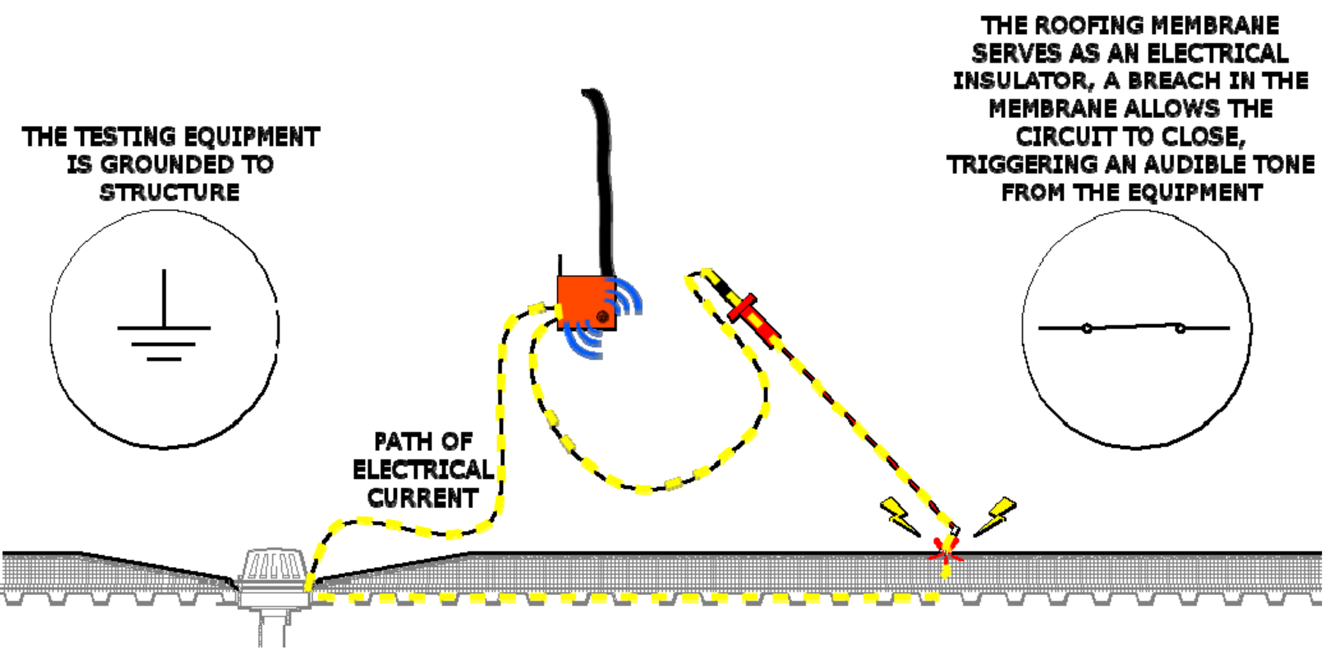


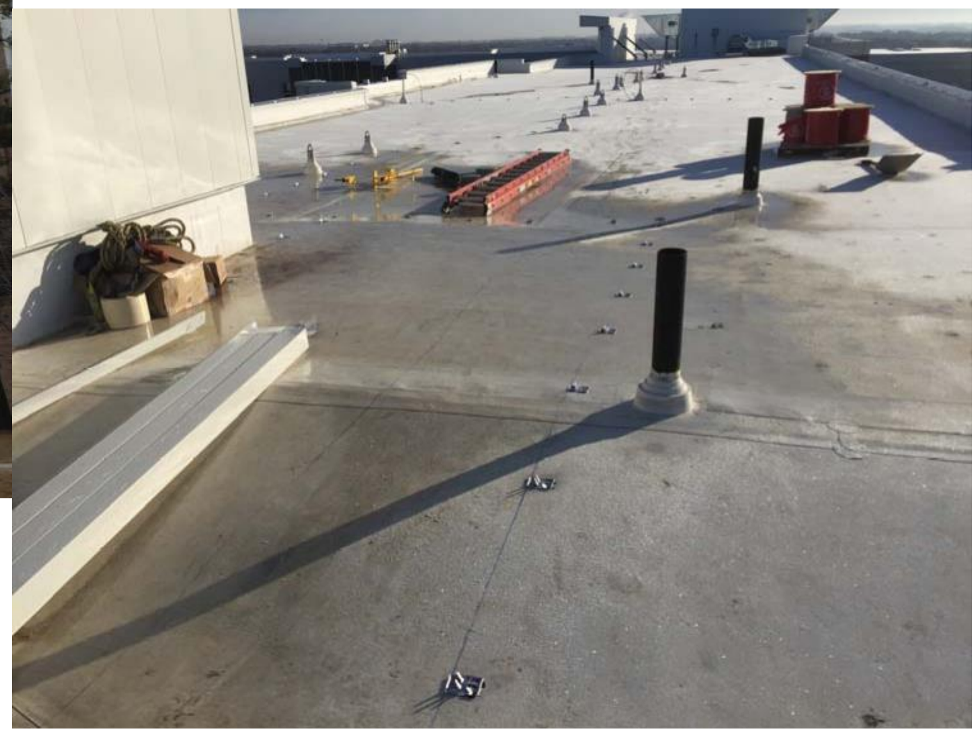
FIG. 3 Basic Circuit of Electric Field Vector Mapping Leak Locator

ASTM D7877

- Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes



Case Study



Case Study

Case Study

Case Study

Case Study

Case Study

Case Study

LEGEND
INSPECTION OPENINGS
POTENTIAL MOISTURE FOUND W/ TRAMEX
#1
#2
#3
#4
#5
#7
#8
#9

Case Study

LEGEND
INSPECTION OPENINGS
BREACHES FOUND W/ IR
POTENTIAL MOISTURE FOUND W/ TRAMEX
NOT SCANNED DUE TO EQUIPMENT OBSTRUCTION
#1
#2
#3
#4
#5
#6
#7
#8

Case Study

Case Study

WJE

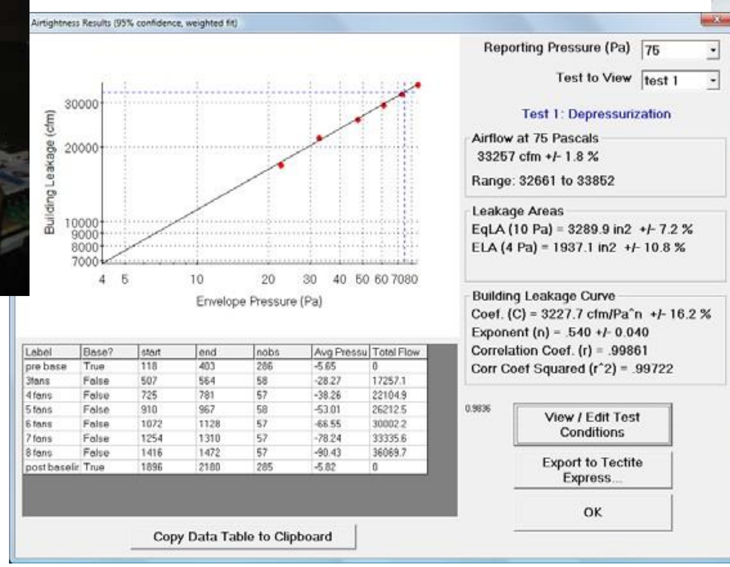
Case Study 3

ASTM E1827

ASTM E1186

ASTM E1827

- Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
  - “x” cfm/sqft @ 50 Pa



ASTM E1827

- Why test?
  - Test compliance with an air tightness specification or regulation- get quantitative value for leakage at whole building enclosure
  - Validate the effort in air tightness
  - Motivate contractors
  - To evaluate retrofit effectiveness
  - To determine leakage rates for energy modeling

ASTM E1827

- Air tightness requirements
  - IECC- three paths, one of which is whole building air tightness < 0.4 cfm/sf at 75Pa
  - USACE - < 0.25 cfm/sf at 75PA (all 6 sides)
  - GSA - < 0.4 cfm/sf at 75PA
  - DOE Building America - < 0.25 cfm/sf at 50PA
- ASHRAE air tightness definitions
  - 0.1 cfm/sf at 75PA = “tight”
  - 0.25 cfm/sf at 75PA = “average
  - 0.6 cfm/sf at 75PA = “leaky”

Case Study

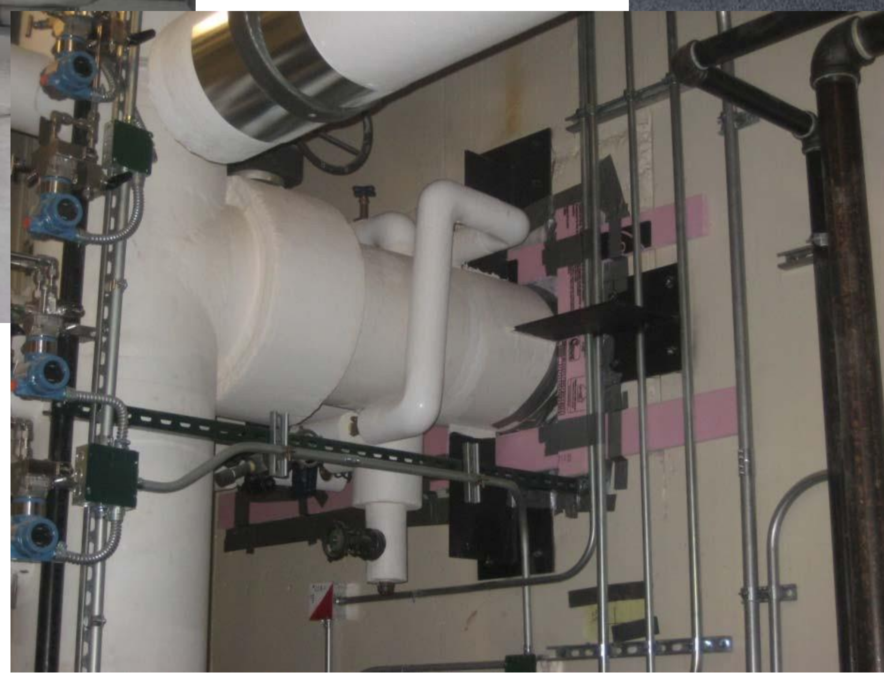
Case Study

Case Study


Exterior Zones Requiring Open Doors
Required Open To Access Exterior Zones
Doorways Required To Be Open
Doorways/Dampers Required To Be Closed
Area Open to Floors Below
Pressure Boundary
Interior Zones With Vents/Open Piping
Interior Zones - Optional Open

Case Study

- Building Set Up



Case Study

Case Study

- Digital Pressure & Flow Gauge
  - Gauge measures differential pressures and air flow simultaneously
  - One gauge per fan

Channel B Input tap is connected to fan (fan flow)- currently at 296.4 cfm

Channel A Reference tap is connected to outside (house pressure)- currently at 54.3Pa

Case Study

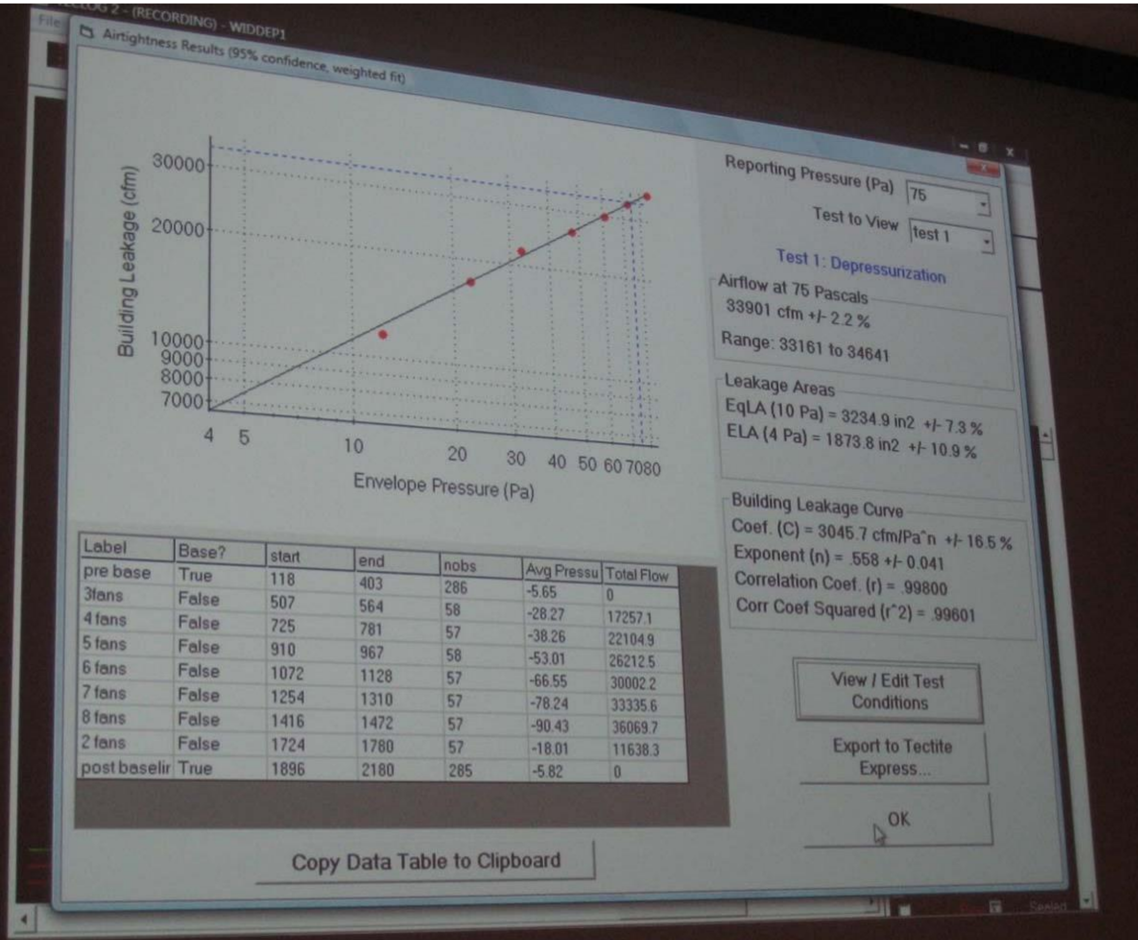
- Pressure Taps
  - 4 on roof on 4 facades
  - 4 at grade on 4 facades

Case Study

- Weather conditions
  - Measure wind speed- less than 4.5 mph recommended
  - Measure indoor and outdoor temperatures- exterior temperature of 41 to 95 degrees recommended

Case Study

Case Study



33,901 cfm / 173,104 sf =

0.196cfm/sf at 75Pa (above grade)

33,901 cfm / 260,797 sf =

0.13cfm/sf at 75Pa (above grade + below grade)

3,235 sq.in. of leakage area at 10Pa

ASTM E1186

- *Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems*

ASTM E1186

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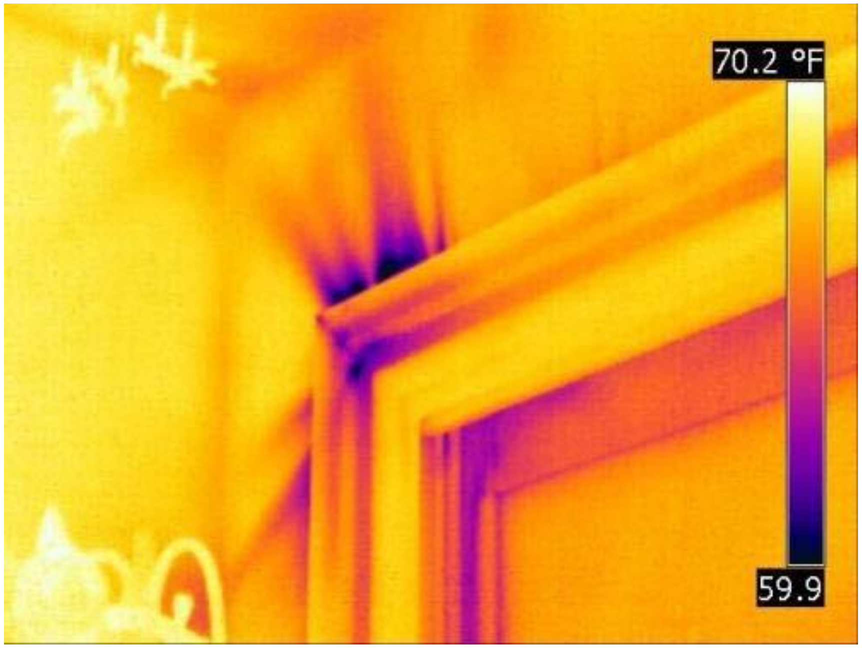

Thank you!

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