BECx
Common Enclosure Tests

Presented at:
Better Buildings 2014

BY:

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Disclaimer & Credits

This is the best and most current general information of which we are aware. It is not intended to be used as legal advice. Individual projects require individual attention.

Comments and feedback are always welcome

Credits: to our clients.

Learning Objectives

- Understand the goals of the commonly specified field tests for enclosure assemblies.
- Understand the basic requirements of some commonly specified tests.
- Understand current building air leakage goals.
- Recognize the value of assembly vs. component testing of enclosures.

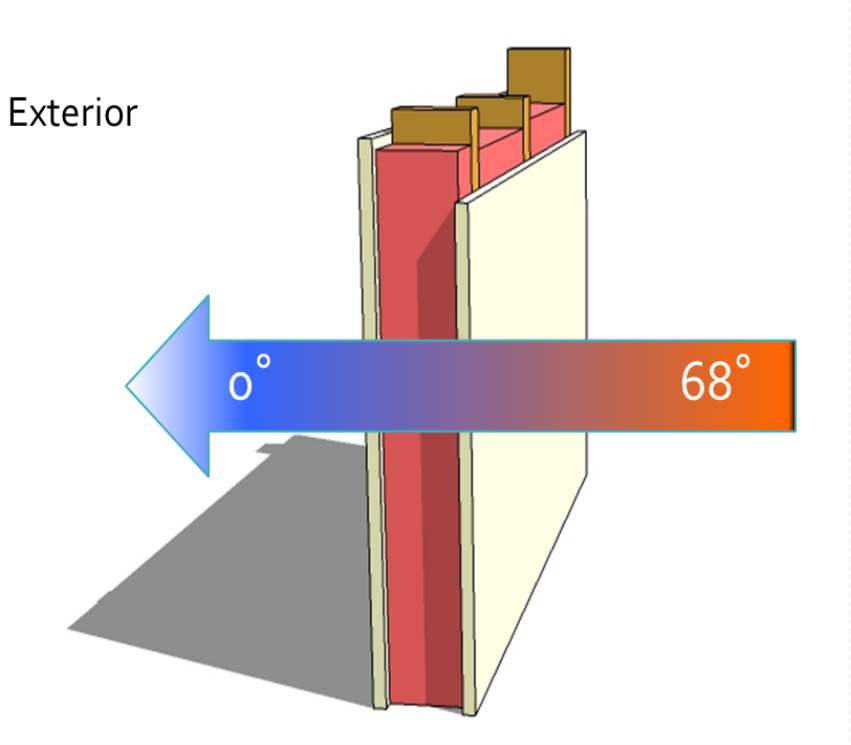
Definitions:

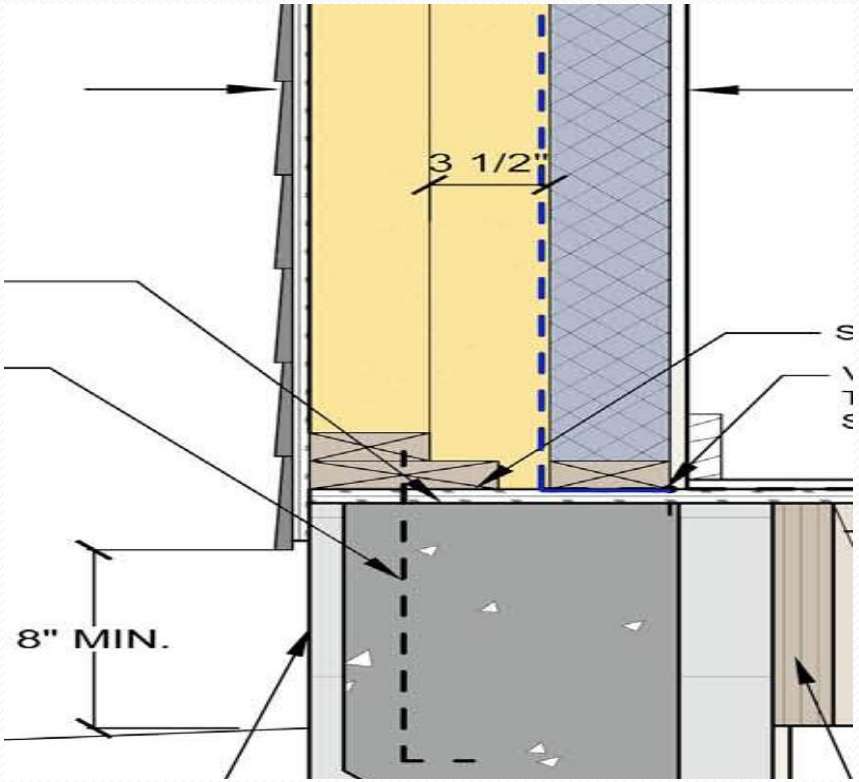
- **Enclosure:** Physical Barrier separating the indoor environment from the ambient outdoor environment
- **Components**: Individual assemblies that comprise the composite wall, roof or floor.
- **Assemblies**: Include materials that are typically used to complete an component such as air barriers that include barrier materials, transition materials and mastics

“Water Managed Assemblies” are Designed to:

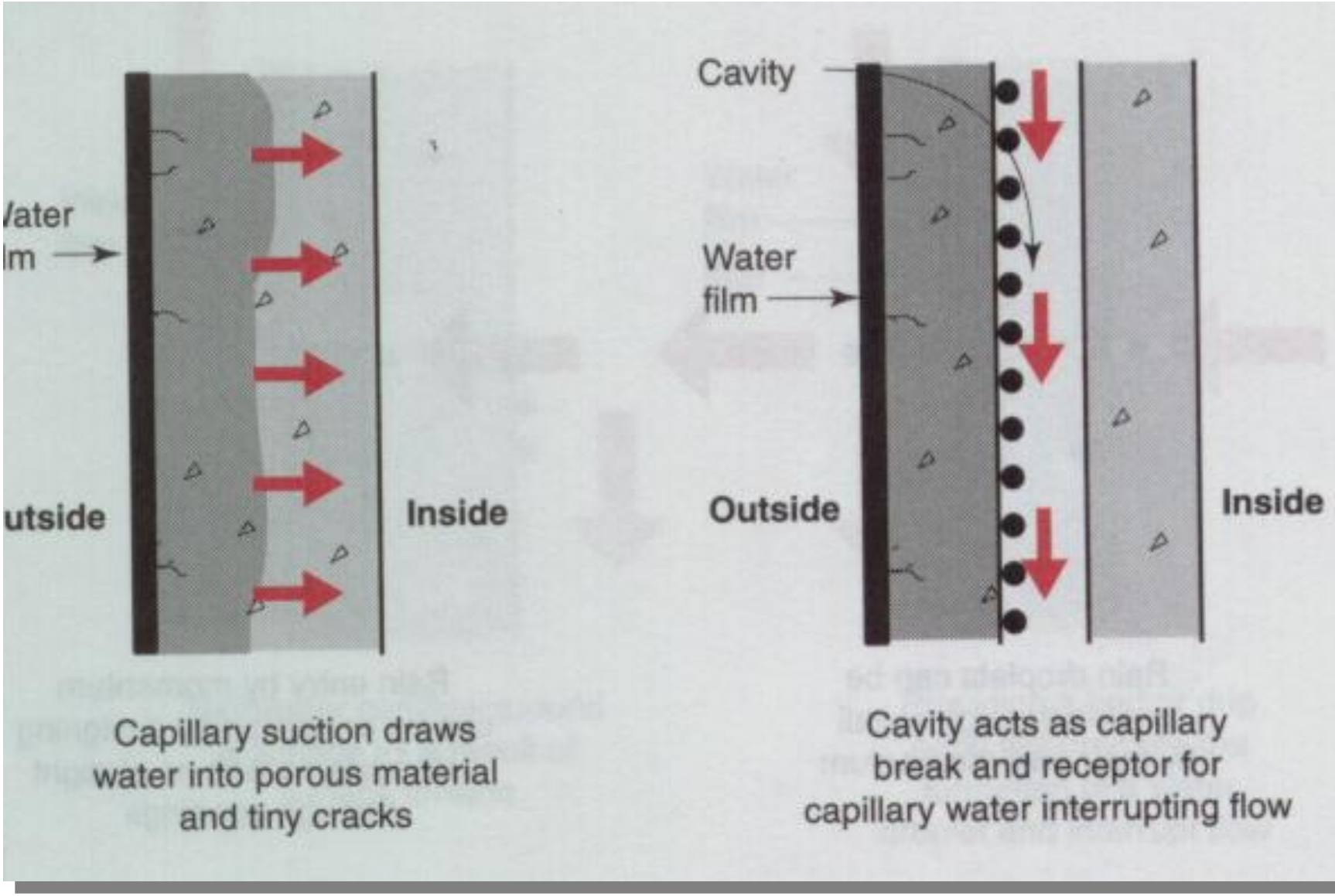
- **Keep Wind Driven Rain Out**
- **Manage Vapor Drive for the Climate**
- **Allow Some Moisture to Leave**
- **Use Very Durable Materials & Often Redundancy To Keep Water Out**

Sample Wall Graphic:





Courtesy David Johnston & Company & rcmzeroenergy.com.com



Courtesy
Building Science
Corporation

Definition:

- **"Whole building air tightness testing":**

A specific test to measure the air tightness of an enclosure or to measure the leakiness of the enclosure and *in some special cases* as a means to quantify building energy use that my be attributed to the enclosure.

Basic & Enhanced Building Enclosure Commissioning

- Field testing for enhanced Commissioning may require additional testing.
- Whole building air tightness testing is usually required as well as site leakage detection.
- Increased observations & testing of joint seals & air barrier assemblies.

Categories of Enclosure Testing

- Enclosure tests fall into about

  <u>10 categories</u>

  half of which you're likely to see on almost any building & the others will be used mostly on specialized structures.

Most Common Tests Preformed

- Most likely to see tests for:
  - Air Infiltration
  - Water Intrusions
  - Thermal Performance
  - Moisture Content

Not So Common:
May Appear in Enhanced BECx

- Utilized on special building types & include:
  - Security
  - Solar optical performance (mostly lab tests)
  - Rain screen (mostly lab tests)
  - Structural Performance
  - Appearance & Durability (mostly lab tests)
  - Acoustical Performance

Today's Topics

- This presentation will focus on common field tests to verify:
  - **Air Leakiness Rate (& leakage site)**
  - **Water Intrusion (& leakage site)**
  - **Moisture Content**
  - **Thermal Performance**

Agencies, Associations, & Councils

- Agencies that have test standards for field testing of enclosure assemblies & components include:
  - ABAA (Air Barrier Association of America)
  - ASTM (American Society for Testing and Materials)
  - ANSI (American National Standards Institute)
  - CAN/CGSB (Canadian General Standards Board)ref.
  - ASHRAE
  - NFRC (National Fenestration Rating Council) ,
  - CSA (Canadian Standards)
  - AAMA (American Architectural Manufactures Association)
  - Others?

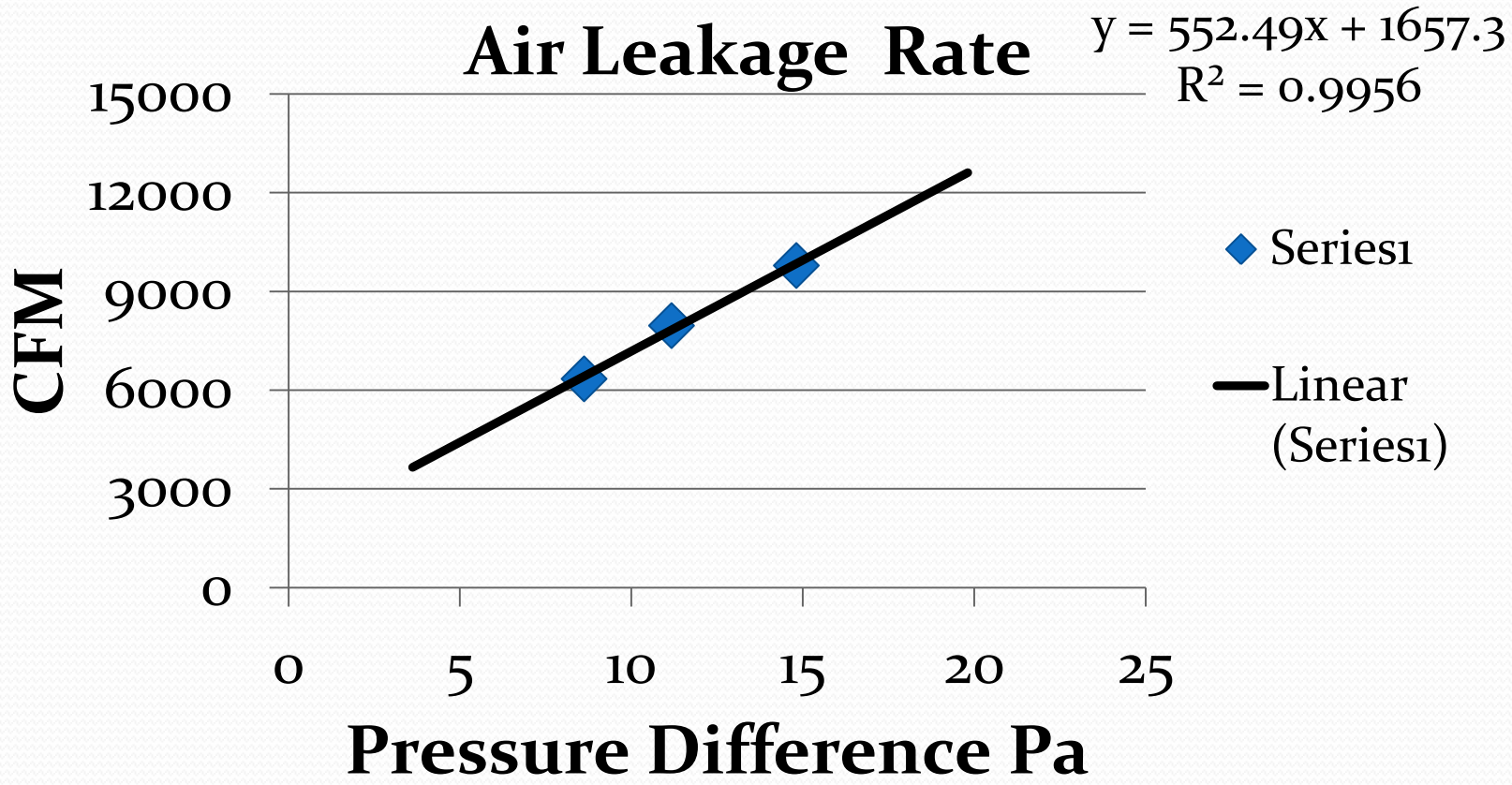
Common "Field" Performed Air Infiltration Tests

- ASTM E779 (Std. Blower Door Tests)
- ASTM E1827 (Orifice Blower Door)
- ASTM E1186 (Locating Leakage Sites)

ASTM E779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

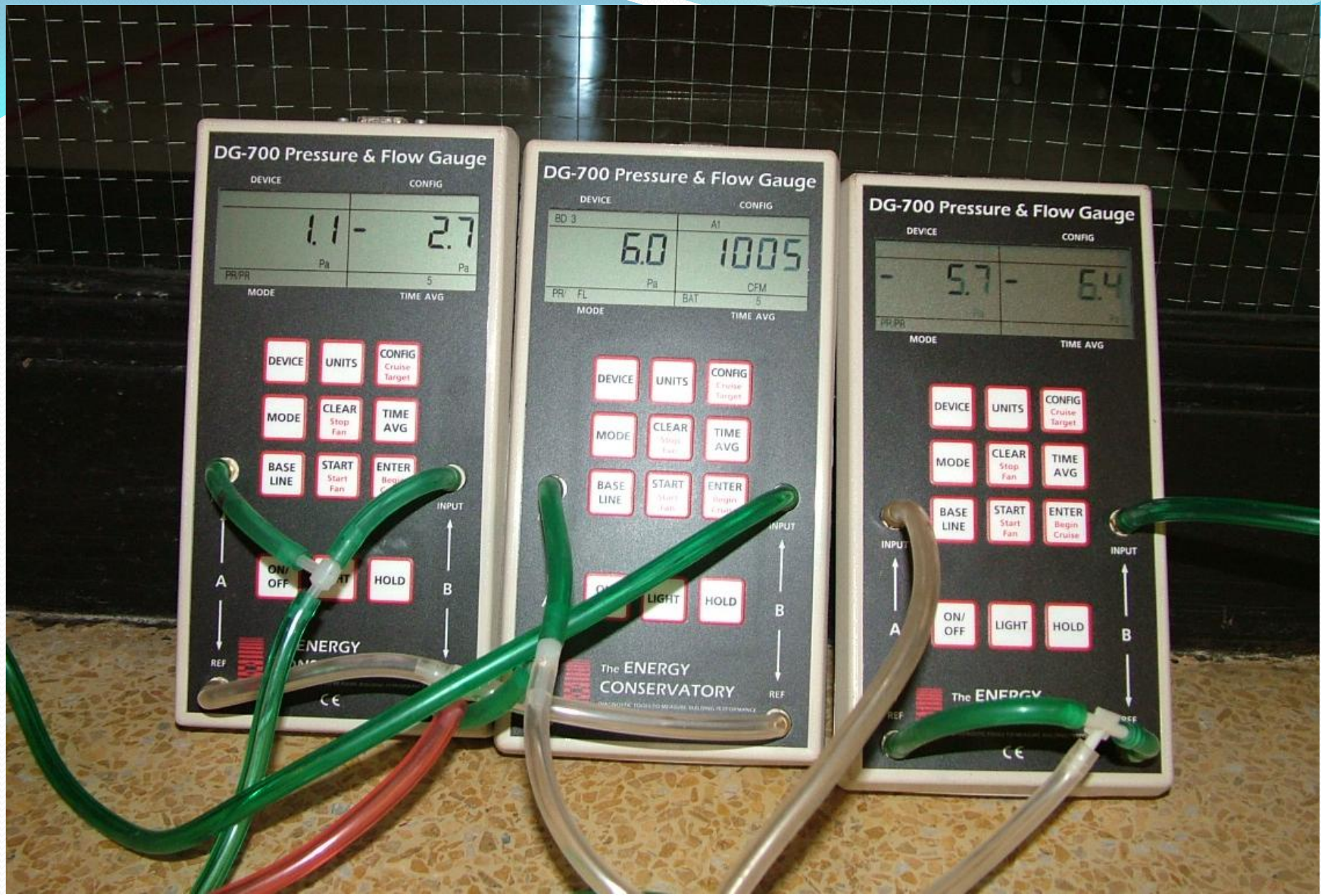
- 1. Measures building enclosure air leakage rate at a high building pressure difference to minimize errors induced by wind pressure.
- 2. Multi point test utilizing linear regression analysis techniques
- 3. Single zone test
- 4. Pressurization, Depressurization, & Combined

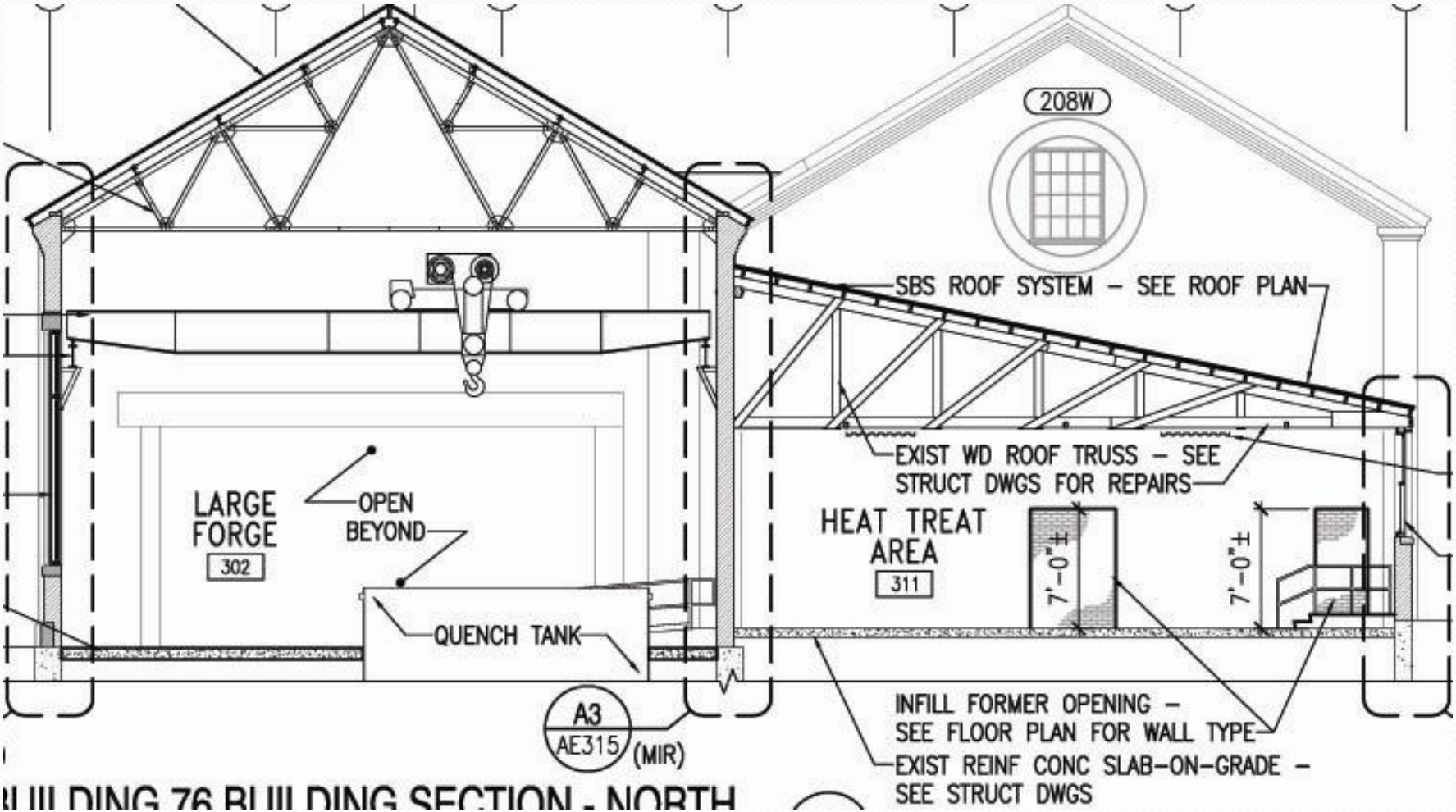
Typical Linear Regression Chart



E779 Restrictions & Limitations:

- Building must be configured as a single zone (with less than 10% variation within the zone) at the highest test pressure.
- Limited to temperature and building height restrictions (Dt*height<200m°C).
- Test methods does not simulate air leakage under normal operating conditions. (Suggest multiple ASTM E 741 Tracer Gas runs at varying conditions over time)



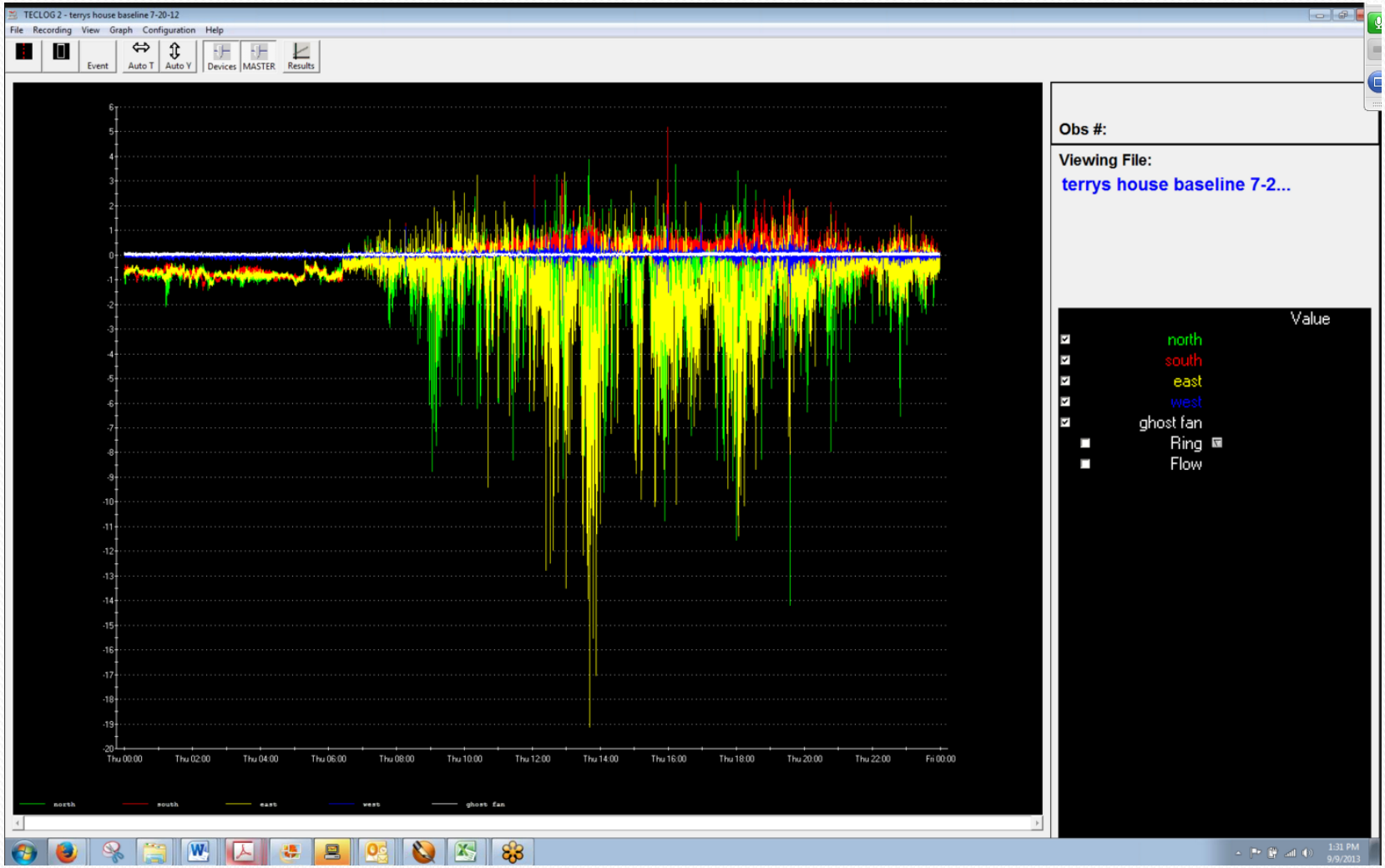


BUILDING 76 BUILDING SECTION - NORTH

E779 Restrictions & Limitations:(Cont)

- Test needs to be completed:
  - When wind speeds are low, no more than 4 MPH
  - Temperature difference between inside and outside are not greater than 65 degrees
  - Based on Indoor Air Temperature of approximately 70 degrees.

Affect of Wind Speed on Building Pressure



E779 Test Results

- Presented in:
  - Effective Leakage Area at 4 Pa (ELA)
  - EqLA (10Pa)
  - Estimated Infiltration (50 Pa) ACH50
  - Air Flow in (cfm)at Reporting Pressure
    - 75 Pa, 50 Pa, 25 Pa, 10 Pa, 4Pa

Summary of E779 test:

- Use blower doors to pressurize (or depressurize) building to a specified range of pressures.
- Multiple test points allow the construction of a Building leakage /Building pressure curve that can indicate potential expected air leakage rate at any given pressure difference.

ASTM E1827 Standard Test Method for Determining Air Tightness of a Building Using an Orifice Blower Door

- Two techniques to measure air leakage rates through a single zone.
- Single point test or two point test can be preformed under this test method.
- Test can be pressurization or depressurization or combination.
- Both use a blower door to pressurize or de-pressurize the enclosure.

ASTM E1827 Features

- Provides a table of recommended test envelope conditions for various equipment that may affect the leakage rate such as clothes dryers, ventilation units, furnaces etc.

E1827 Restrictions & Limitations

- Same wind speed and temperature restriction apply.
- Test do not simulate actual building air leakage.
- Single point test:
  - Test pressure is 50 Pa and the building flow exponent η is assumed to be 0.65.
- Two point methods:
  - Test pressures are 12.5 Pa and 50 Pa.

ASTM E1186 Standard Practice for Air Leakage Site Detection in Building Envelopes & Air Barrier Systems

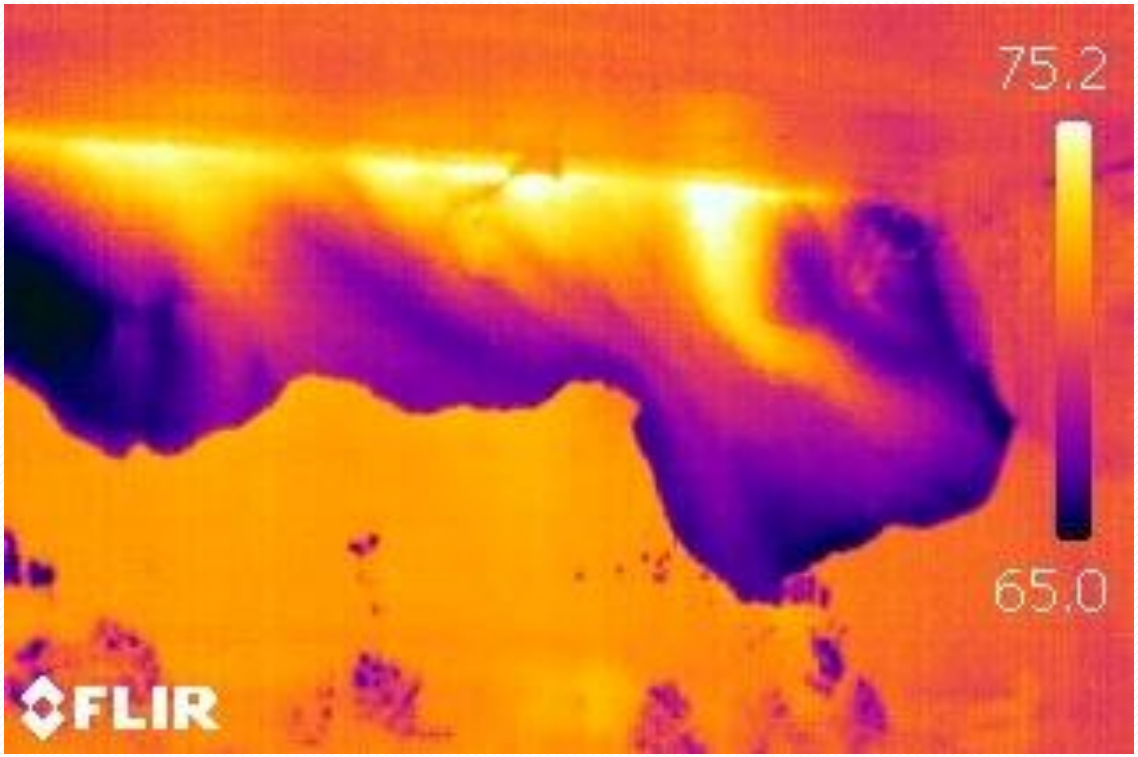
- **Include:**
  - Infrared Thermography
  - Sound Detection
  - Visible Chemical Smoke
  - Tracer Gas Testing
  - Air Pressure Differences Measured with Anemometers

Observational Tests to Find Leakage Sites in an Enclosure Test Area

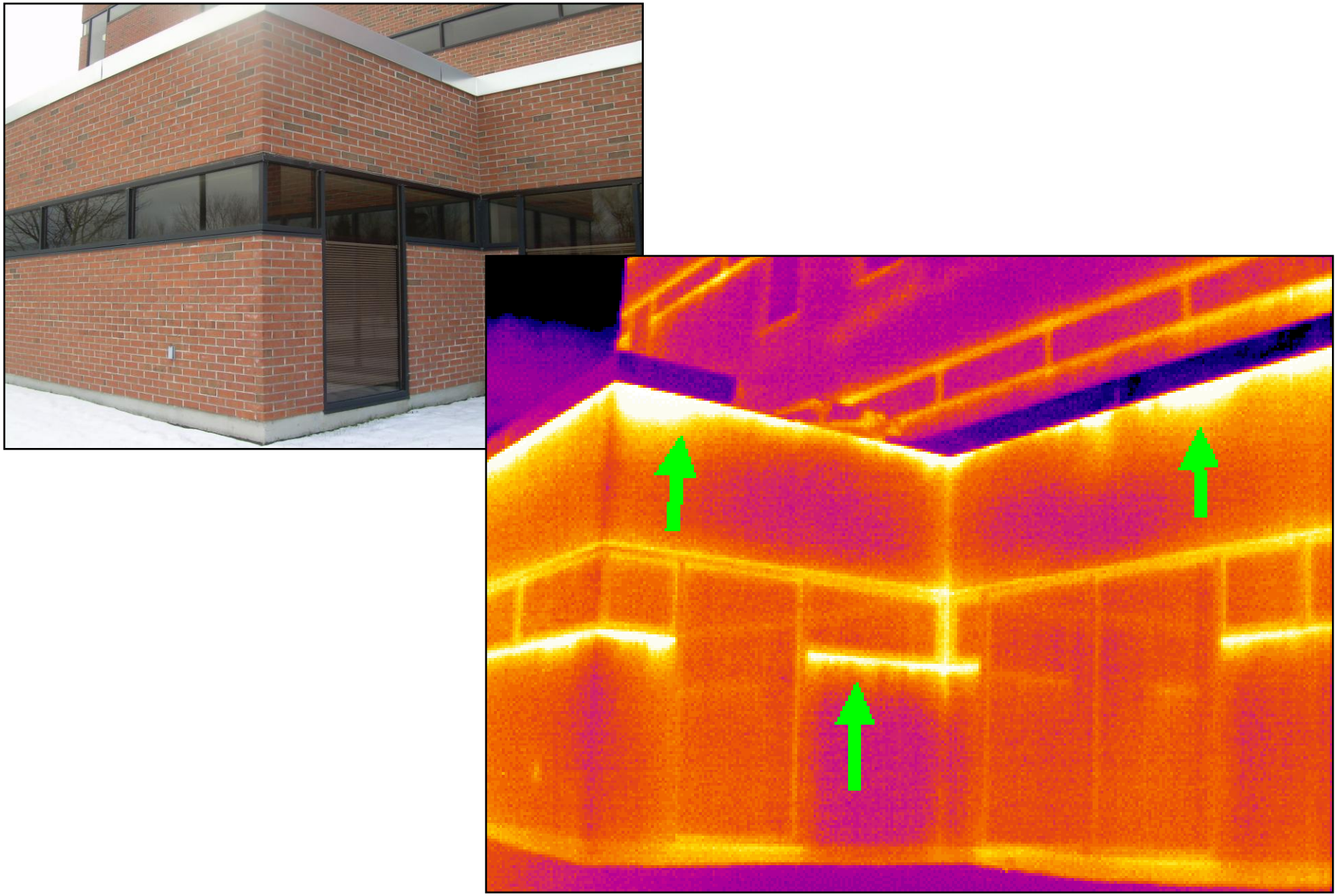
- These procedures are designed to locate air leakage sites within a building enclosure. Infrared, Visible Chemical Smoke & Pressure Difference require a significant pressure difference be generated across the test assembly utilizing the building HVAC system, blower doors, or other air moving devices.

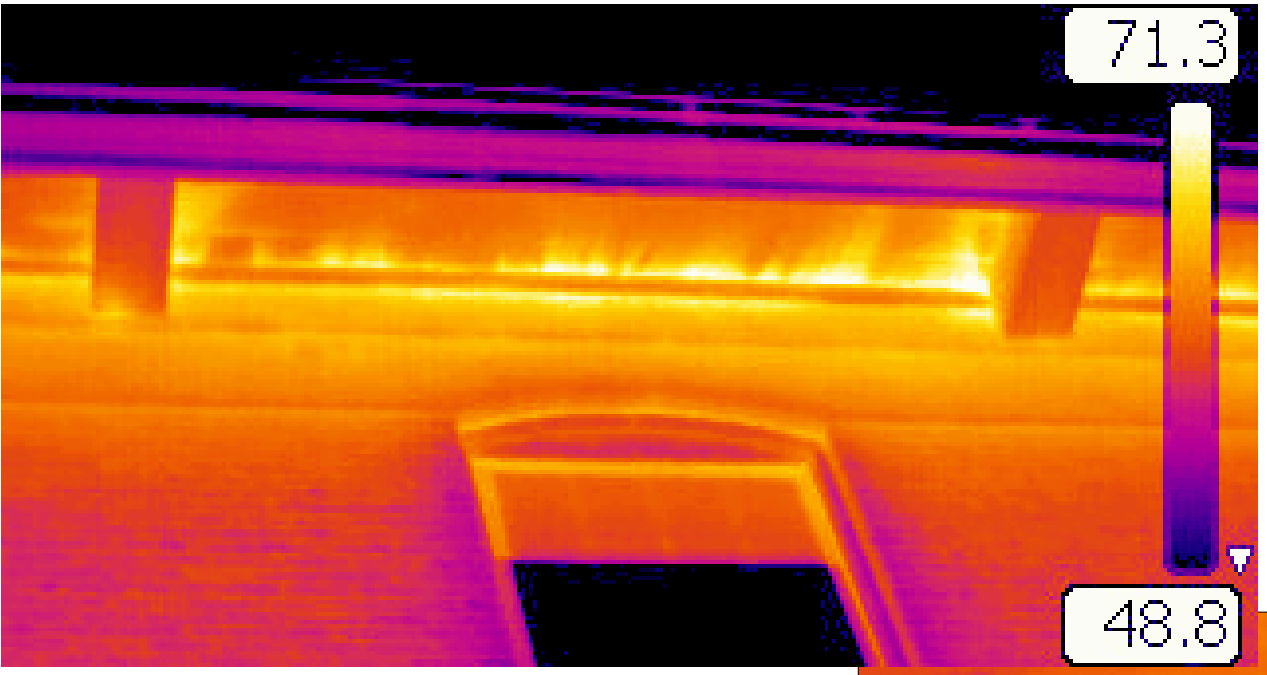
Locating all Leakage Areas

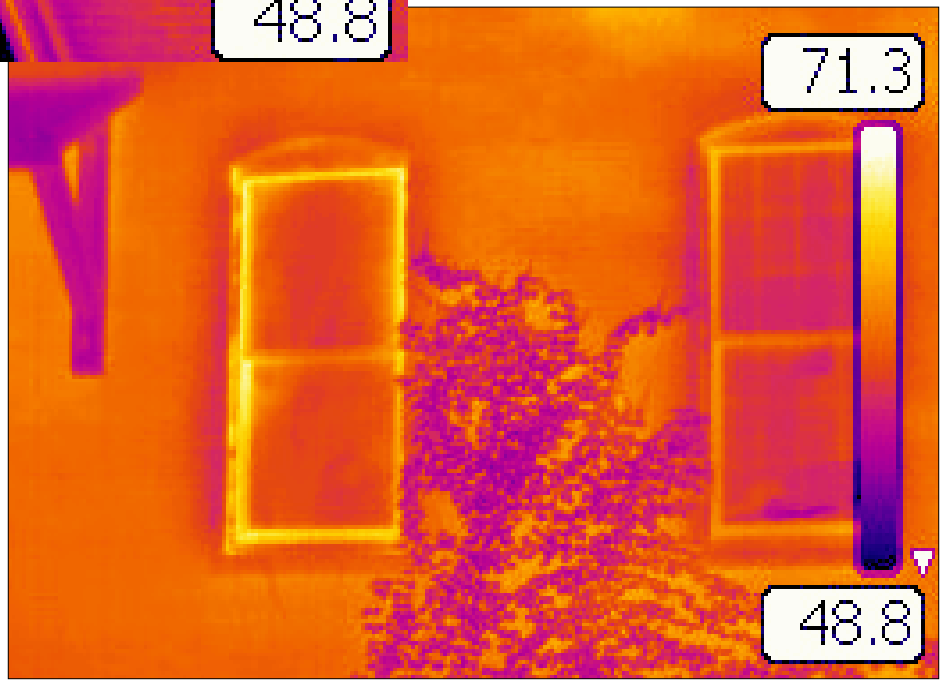
- All tests locate surface areas where leakge is occurring, in some cases the air leak inlet & outlet are not aligned.

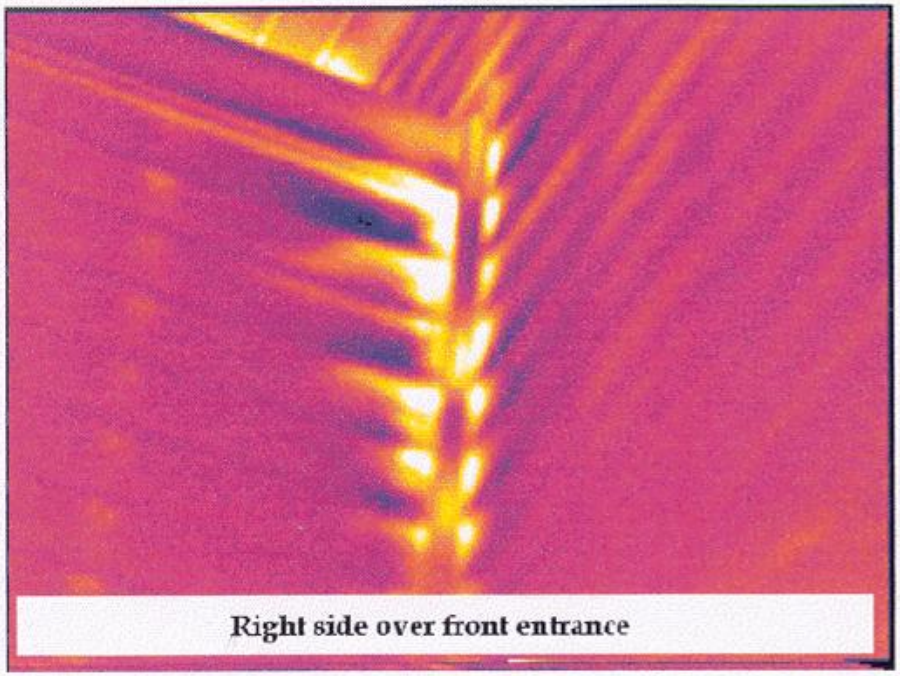


Testing of both inside & the outside surfaces of the test enclosure may be required.









Right side over front entrance

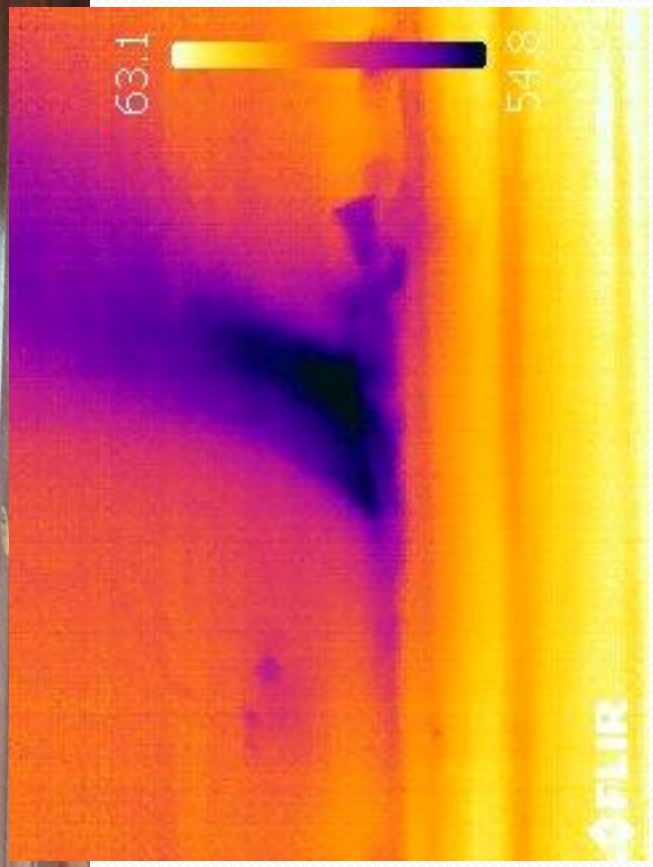
Infrared & Visible Smoke

- Infrared & Visible Smoke are most common (easiest). Infrared is very effective at finding suspected & unsuspected leakage areas.

- However, infrared requires a minimum temperature difference between leakage air & enclosure surface temperatures of 10 degrees (20 degrees works much better).

Visible Chemical Smoke

- Smoke is not particularly good for finding very small leaks or leaks over a very large area.
- Need to be close to the leak to observe. However; is a very visual process & it is easy for a contractor to understand & see the location.
- Tracer gas (in sniffing mode, sound detection, & pressure difference induced air flow are not good for large area detection but works well for small areas such as the interface between doors and walls.



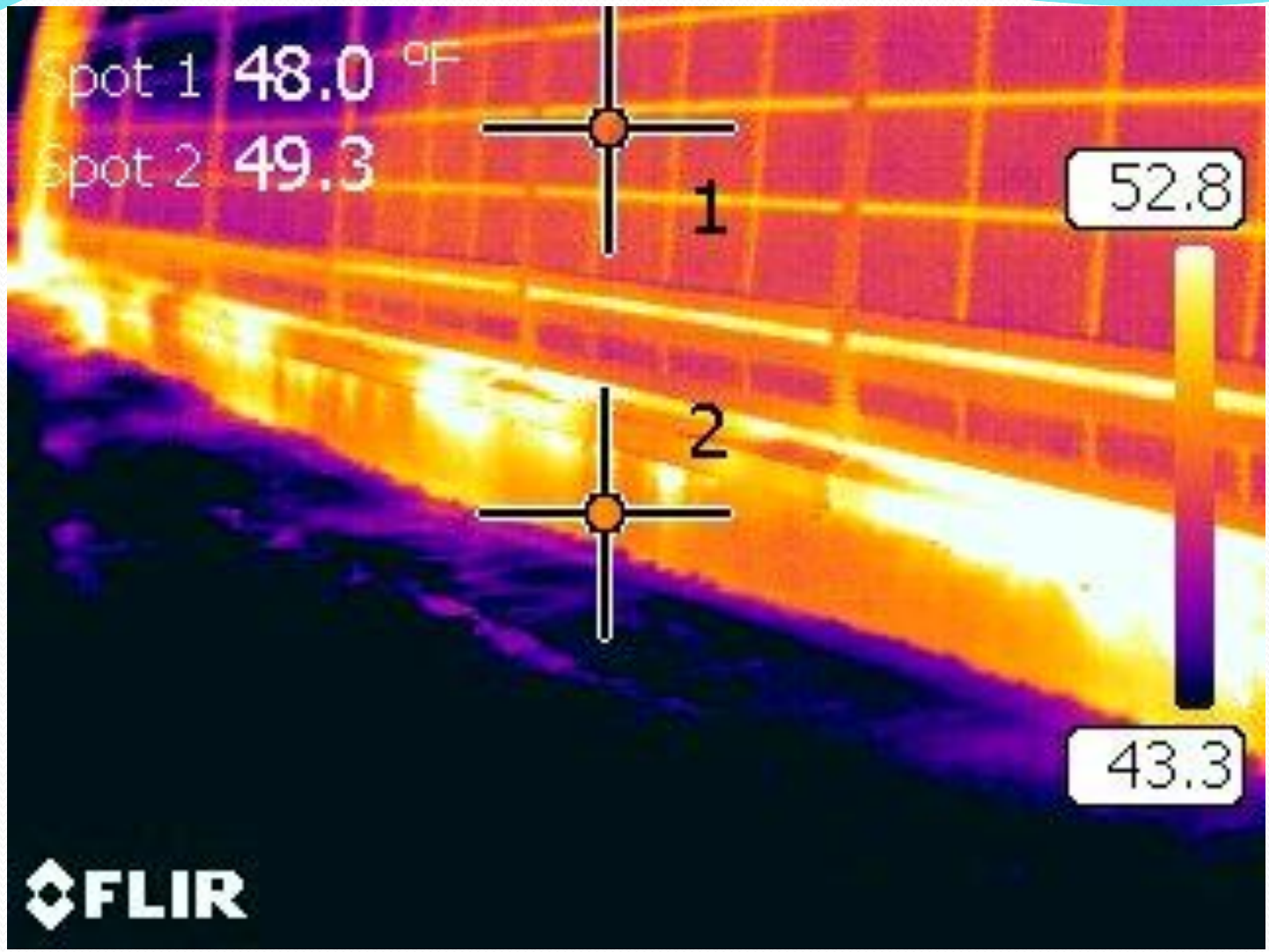
Note: Air Leakage Does Not Indicate Water Leakage

Sound, Air Pressure, & Tracer Gas

- Tracer gas (in sniffing mode, sound detection, & pressure difference induced air flow are not good for large area detection but work well for small areas such as the interface between doors & walls.

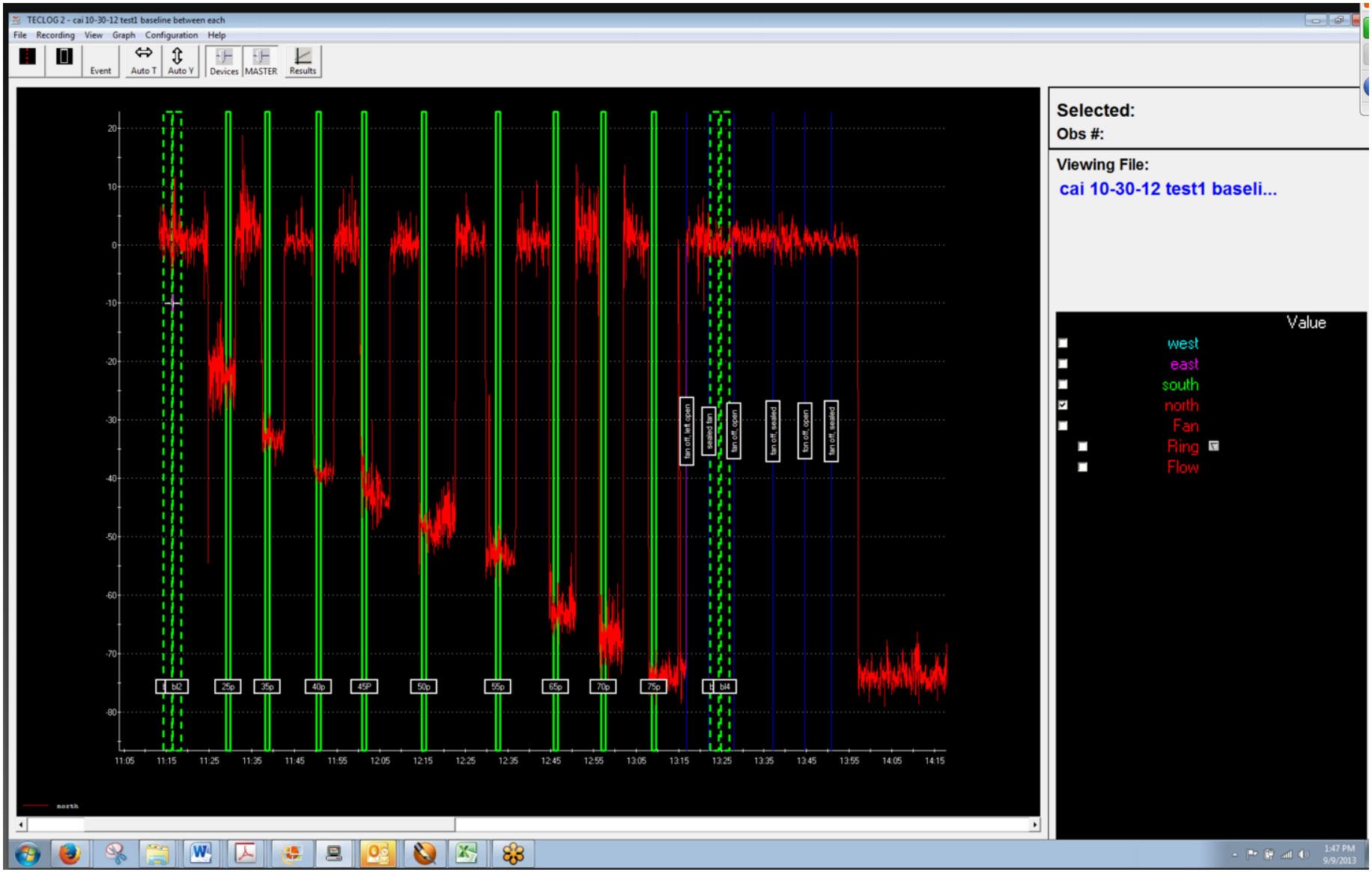
ASTM E783 Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows & Doors

- Relies on blower doors or other devices to generate a significant pressure difference across the test specimen, up to 300 Pa is typical for field testing.
- Can measure rate of leakage at window components (frame to sash or frame to glass)
- Alternatively can be used to test whole window assembly & the connection to the wall to verify leakage but not the rate.
- This test method relies heavily on a extremely air tight seal between the (necessary) test chamber & the window frame (or wall surface).



Air Barrier of Association of America

- Standard Test Method for Building Enclosure Air Tightness Compliance Testing
  - Expands testing conditions beyond ASTM limits
  - Requires computer controlled data logging and pressure monitoring equipment.
  - Allows ASTM E779 or E1827 test procedures
  - Provides default conditions for building preparation air barrier and operational testing.
  - Provides guidance on Pass Fail



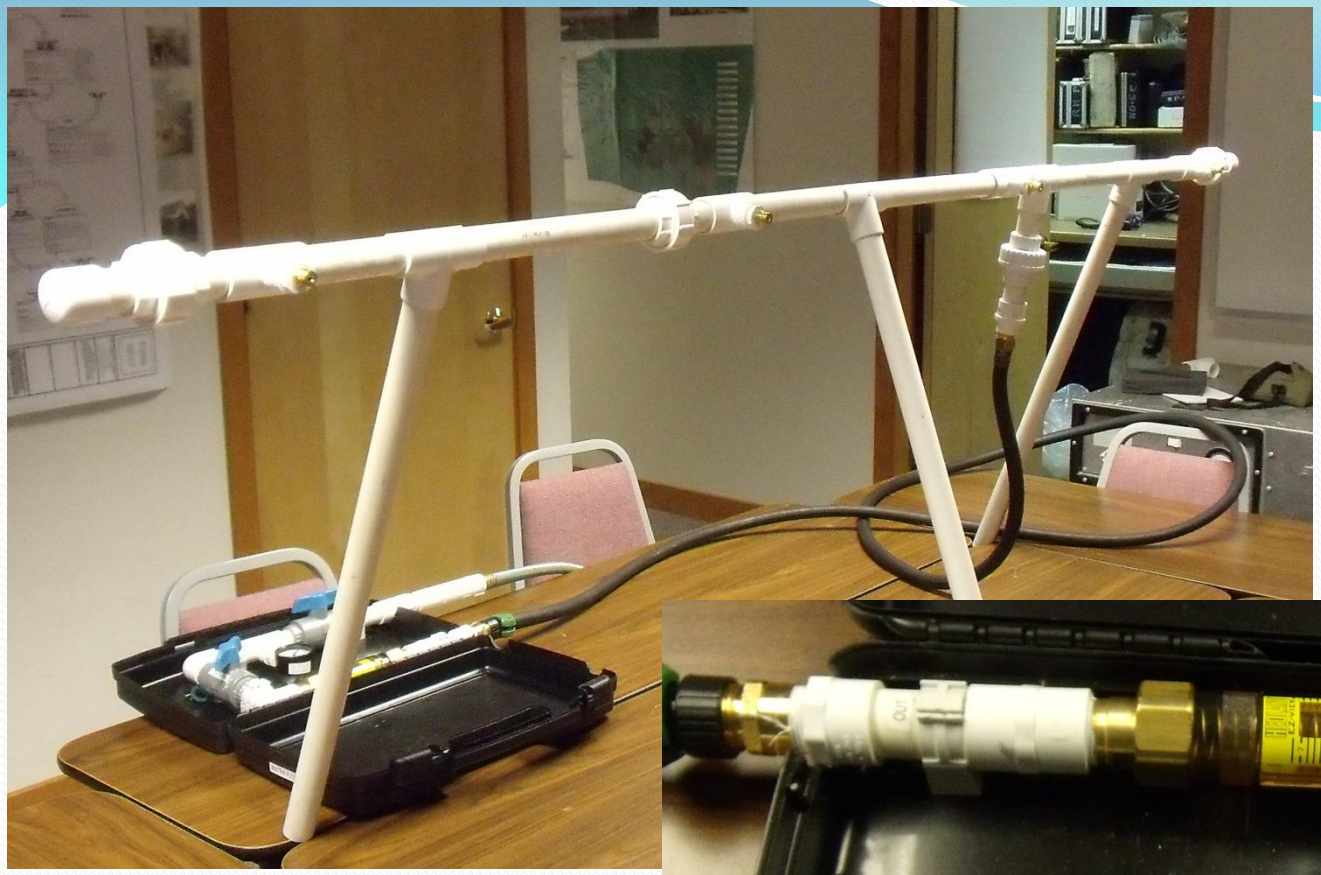
Common Field Preformed Water Intrusion tests

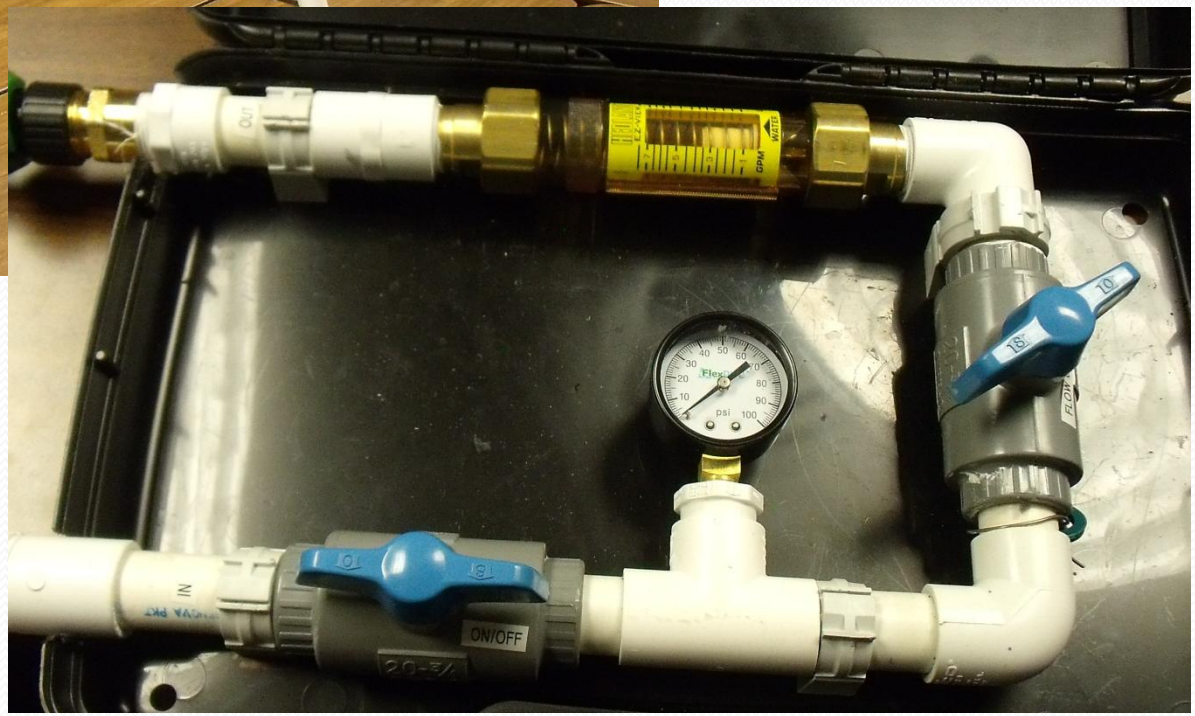
- ASTM E1105
- AAMA 501.2, AAMA 501.1, (Basically the E1105 test)
- ASTM D5957

ASTM E1105 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.

- Used to test resistance to water penetration through curtain walls in total or in parts, windows, doors, skylights, & roofs.

Expandable Spray Rack & Flow Controller





ASTM E1105 Water Penetration

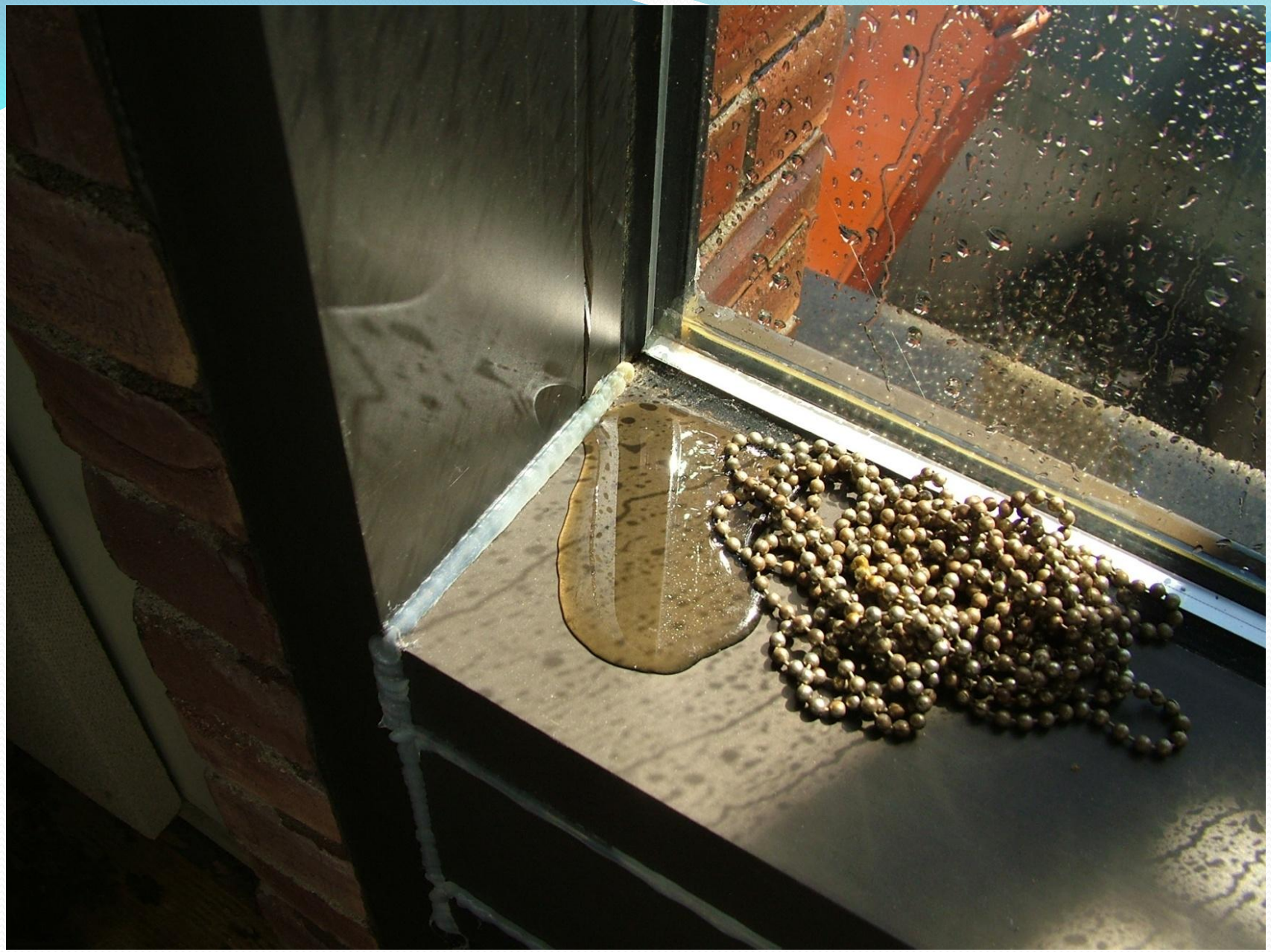
- Test pressures vary from 50 to 300 Pa depending on the test specimen & test requirements.

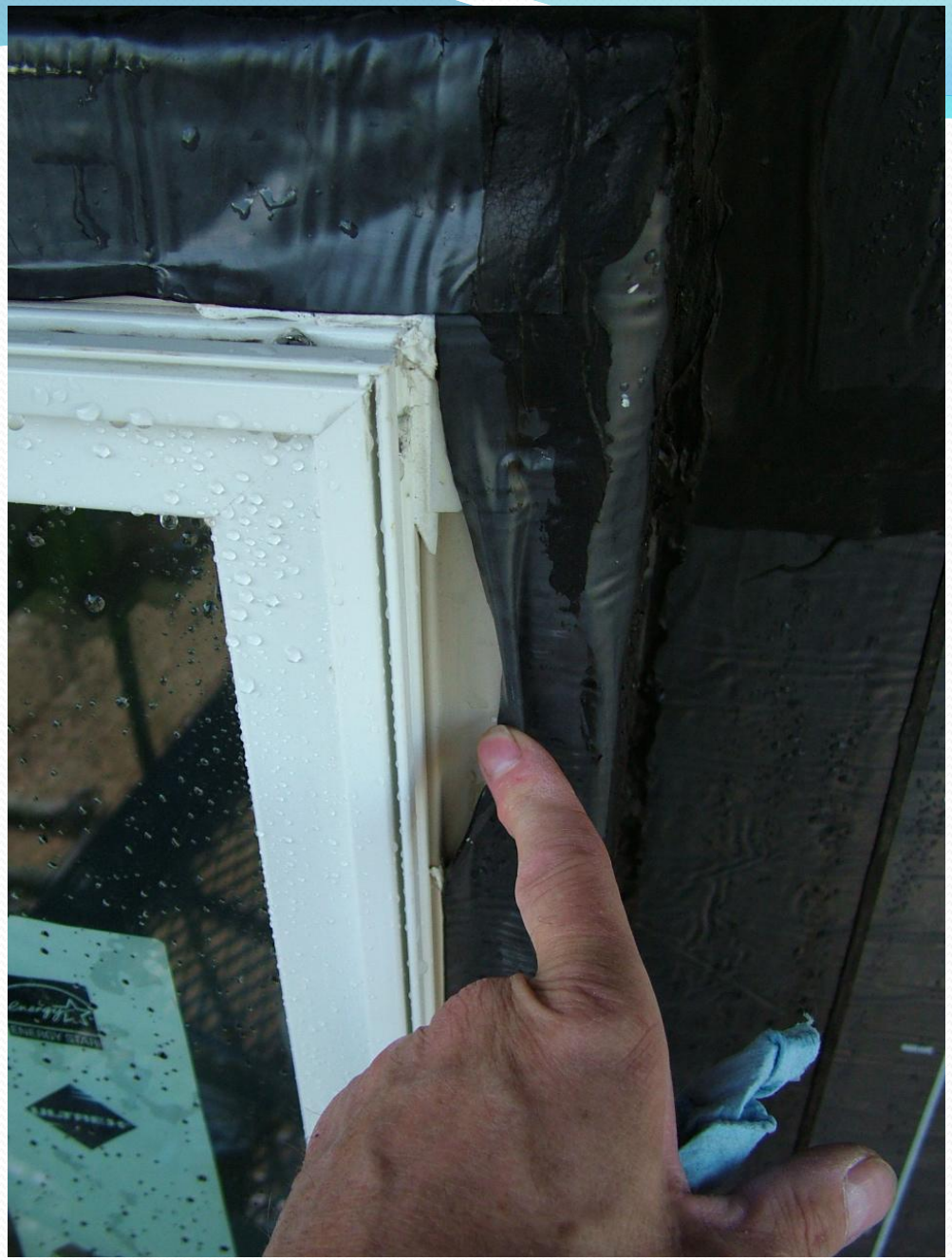
- Water flow rate can vary

  typically about 5 GPH/FT^2

ASTM E 1105 Water Penetration

- The test requires an air pressure difference be generated over the areas of the test specimen & applying water to the high pressure side of the test specimen & observing the low pressure side for the appearance of water.
- Can be very selective in test areas or very broad .
- Test can use static (non varying pressure differences) of dynamic pressure difference (sometimes thought to better represent actual wind conditions).

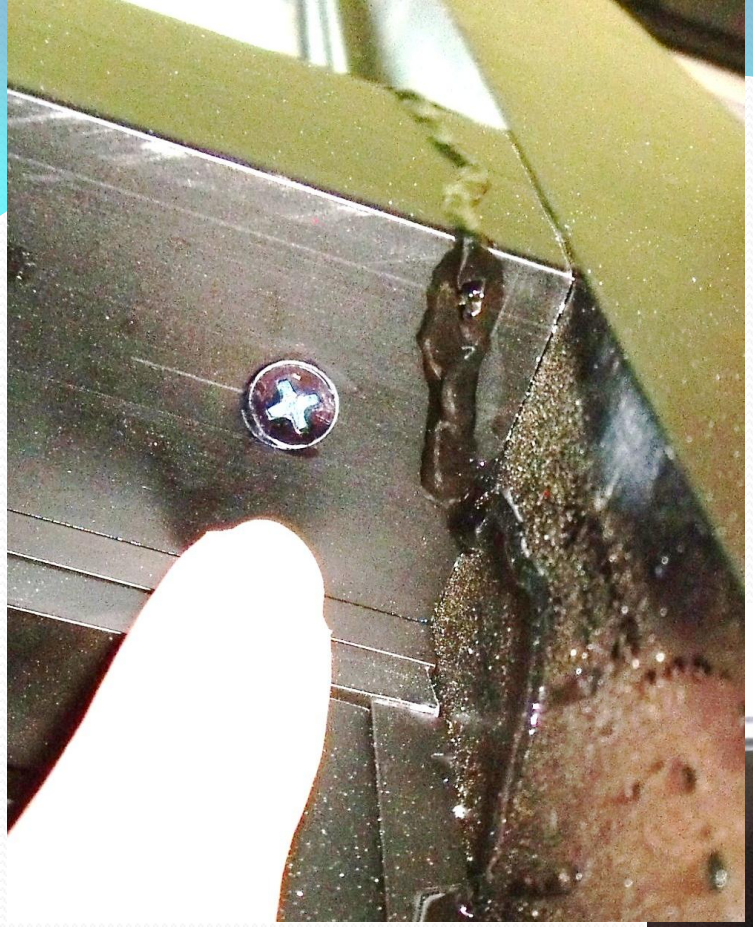




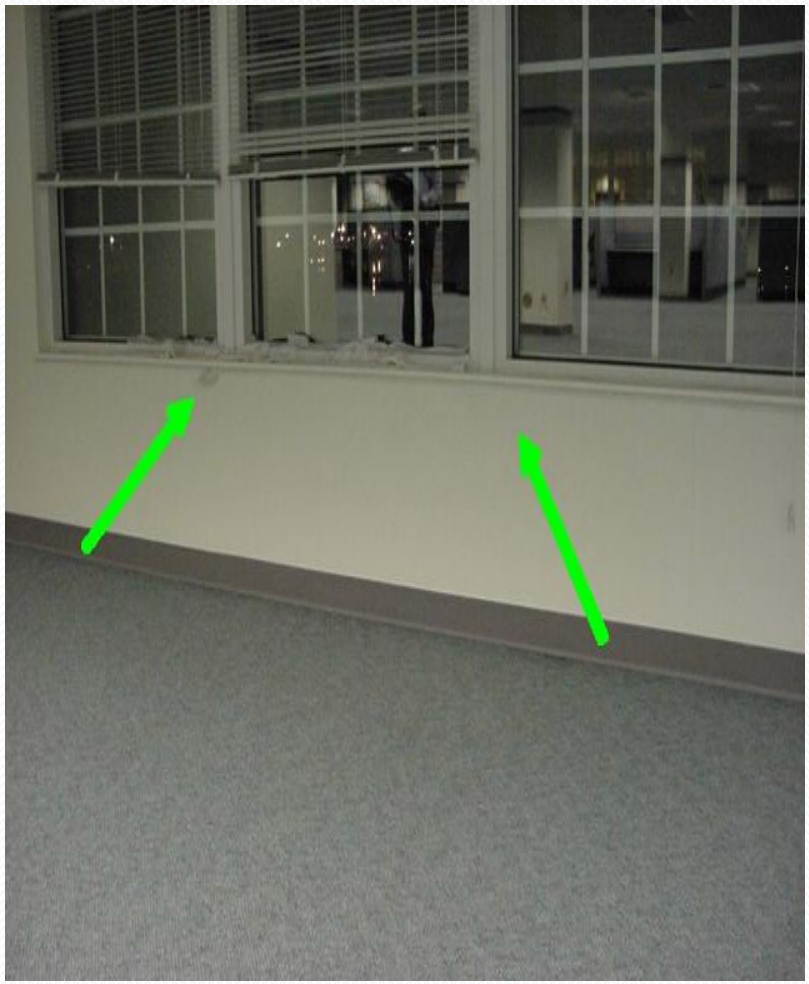
Debris from hole drilling left in gasket of window caused a water leak.

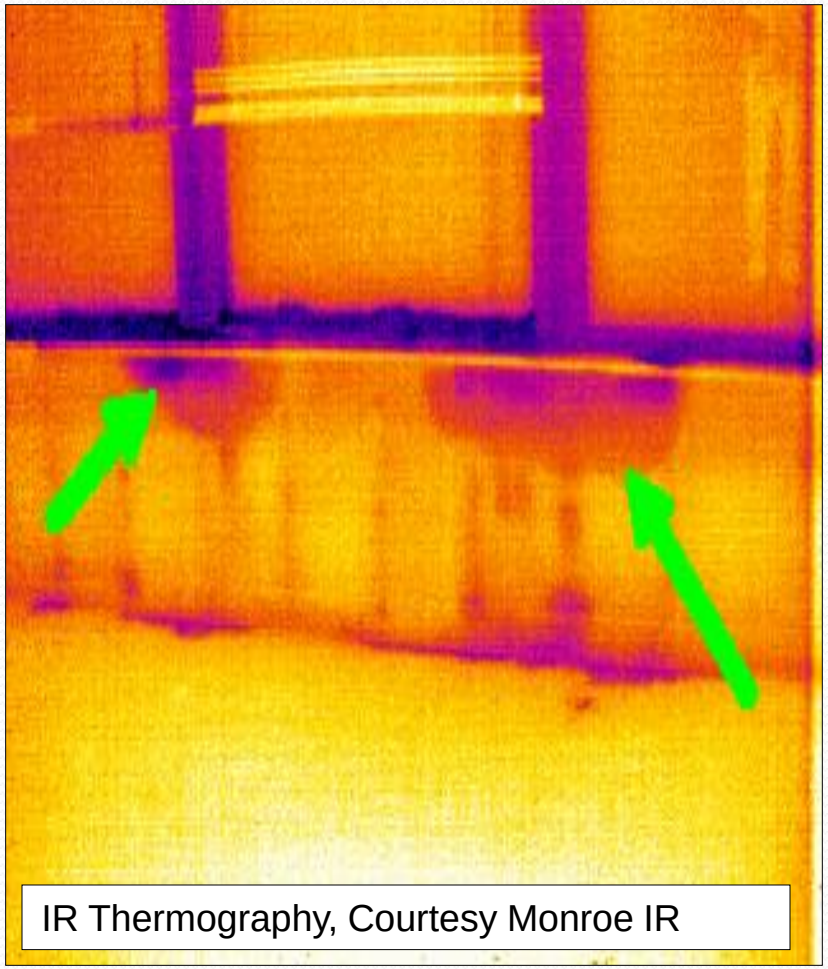
Door Assembly Testing

Door Assembly Testing



Finding Window Leaks





IR Thermography, Courtesy Monroe IR

Test Results ASTM E1105

- Water visually shall not penetrate past the window/door frame or membrane.

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.

- AAMA test similar to ASTM 1105 (which is referenced in the AAMA material although dynamic testing is the preferred method).

AAMA 501, 502 and 503 test

- Flow rates and pressures will vary based on the type and class of window.

- Did have or may still have de-rating of leakage rates from factory test to field test. (need to check with most recent published test documents.

ASTM D5957 Guide for Flood Testing Horizontal Waterproofing Installations.

- Usually preformed on flat (low pitched roofs).
- Flood roof with water 2 to 4 inches deep (note recommend seeking advise need from structural engineer to add water beyond 4 inches in depth.)
- Minimum wait time is 24 hours.
- May not identify exact location of leak.

Flood Testing?
Companion Tests or Alternates

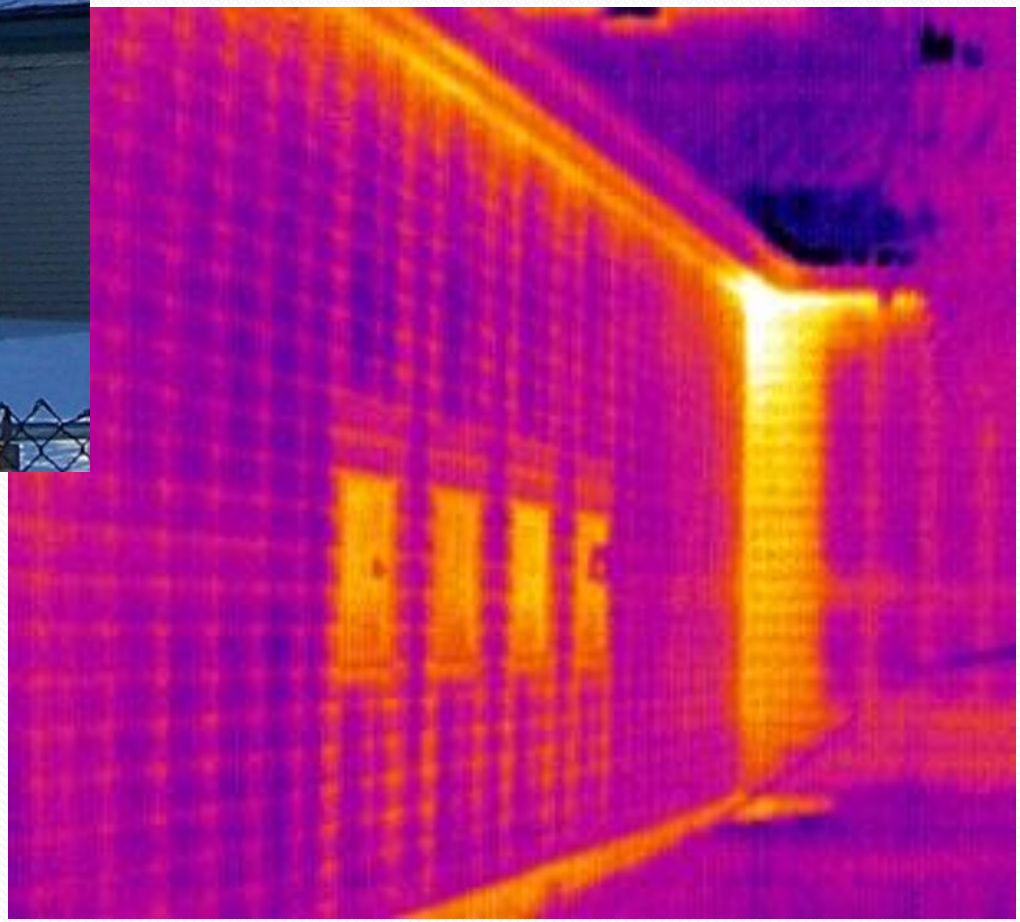
- Depending upon roofing type and installation, Electronic Weak Detection (ELD) or Nuclear Radioisotopic Thermalization may also be considered to supplement or replace this evaluation.
- ELD or Nuclear may be required to locate actual leak area.
- ASTM E1105 is also a good option if air pressure differences can be generated across the test specimen

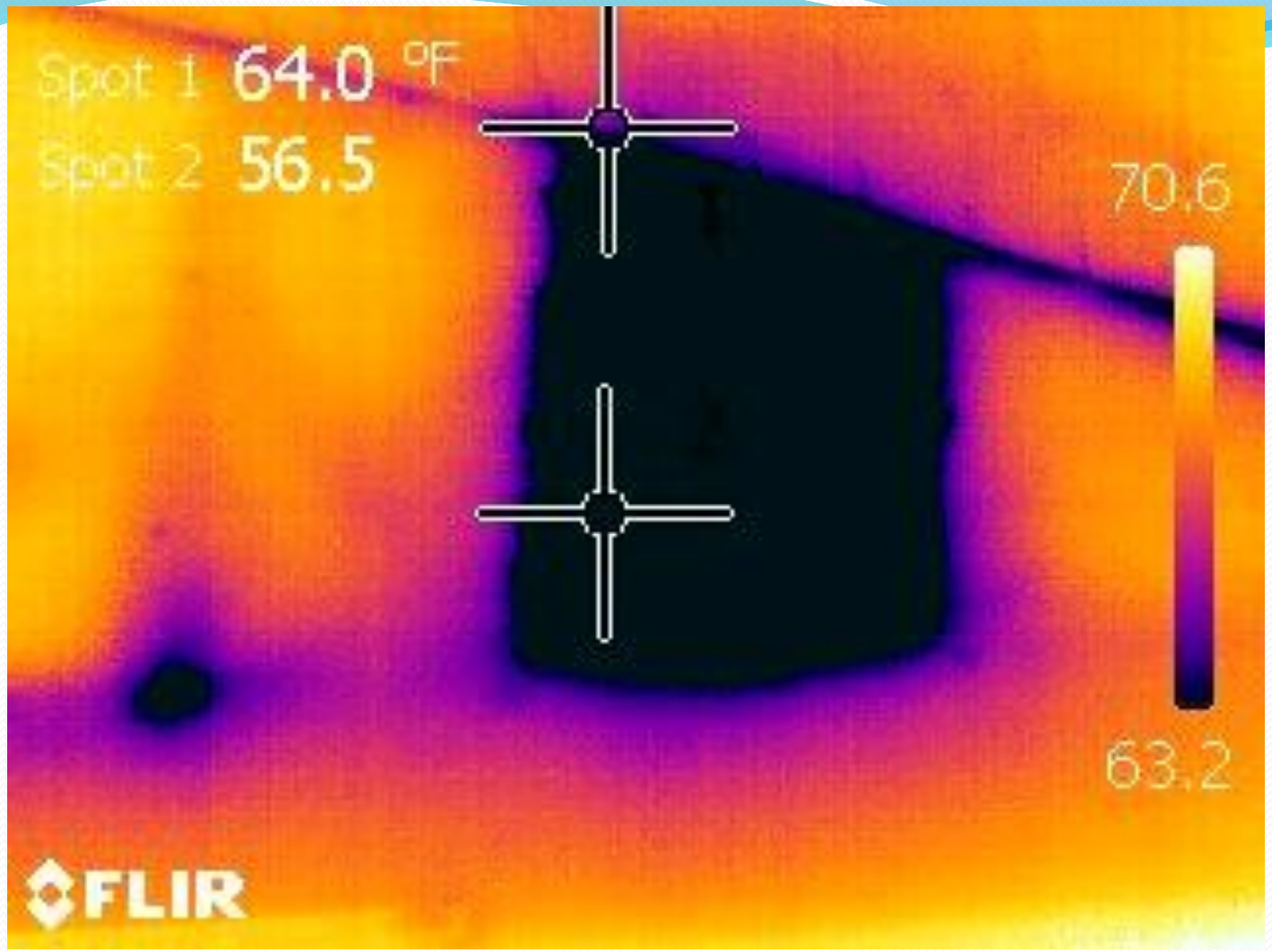
Courtesy of Detec Systems, LLC)

Common field tests for **thermal performance** (of insulation)

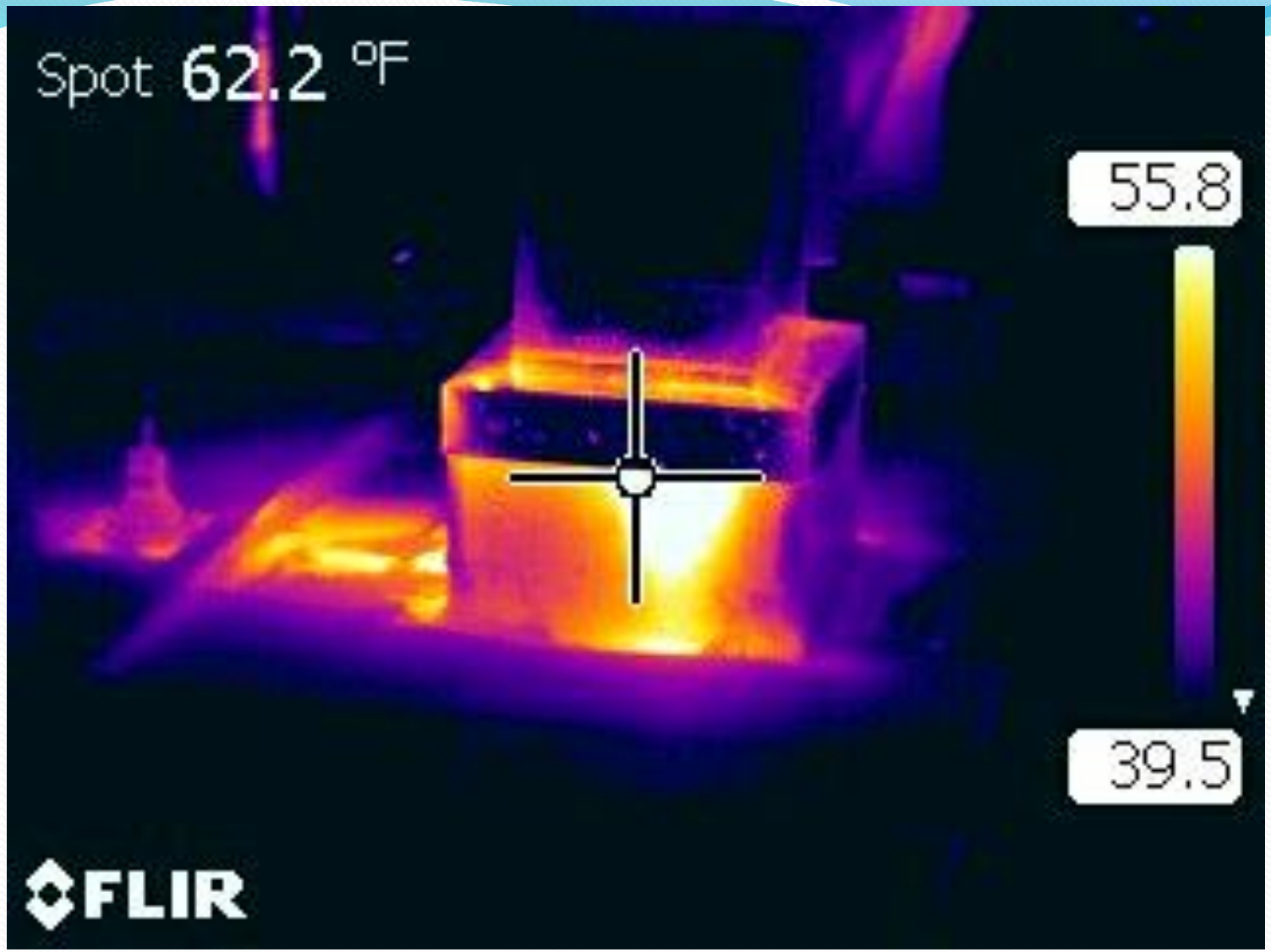
- Thermal performance of field constructed assemblies
  - ASTM C1153
  - ASTM C1060

ASTM C1160 Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings





ASTM C1153 Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging



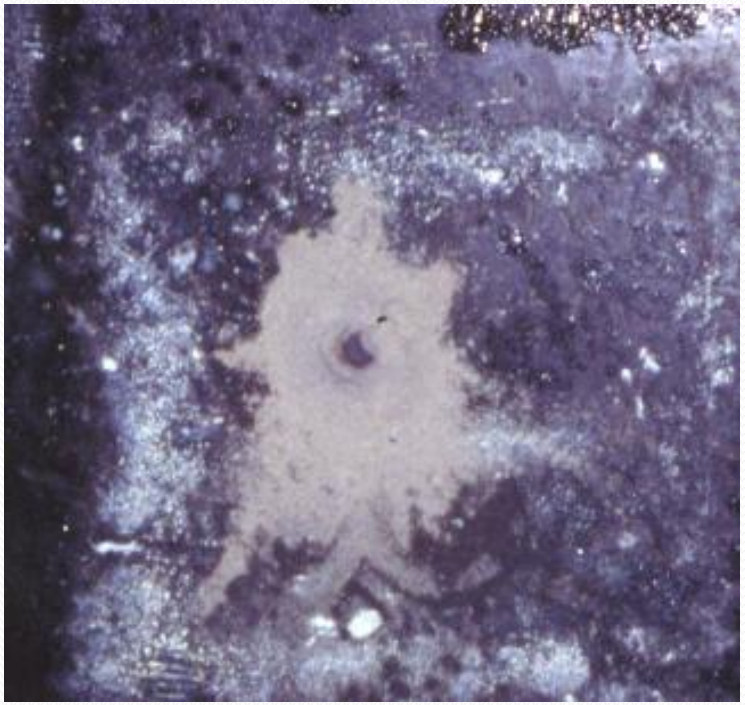
Common Field Tests to Determine **Moisture Content**

- Include:
  - ASTM F1869 (Calcium Chloride)
  - ASTM F2170 (In situ Probe)
  - ASTM F2420 (Insulated Hood)
  - ASTM D4263 (Under Plastic Sheet)

  - All having to do with the moisture content of concrete especially ground contact or other slabs subjected to diminished or absent drying pathways .

ASTM F1869 Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

ASTM F2170 Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes



Concrete Moisture Testing

Concrete Moisture Meter

Concrete Moisture Test Results

Emission		Drill	
Rate		Hole	surface
Lbs per		Meter	meter
1000ft²	vented		%
24hr	unvented	%RH	moisture
2.81	unvented	97.2	4.6
1.90	unvented	83.9	4
1.12	vented	79.3	3.2
1.25	vented	87.4	3.1
9.01	unvented	96.3	6

Is There a Vapor Barrier or Capillary Break Present?

ASTM F2420 Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement & Insulated Hood

Evaluations

Please let us know if you received useful information from this workshop by filling out the evaluation form,

and let us know what you would like more information on in any future opportunities like this

Thank you for your participation!