California Commissioning Collaborative

Enclosure Sealing Webinar: Overview

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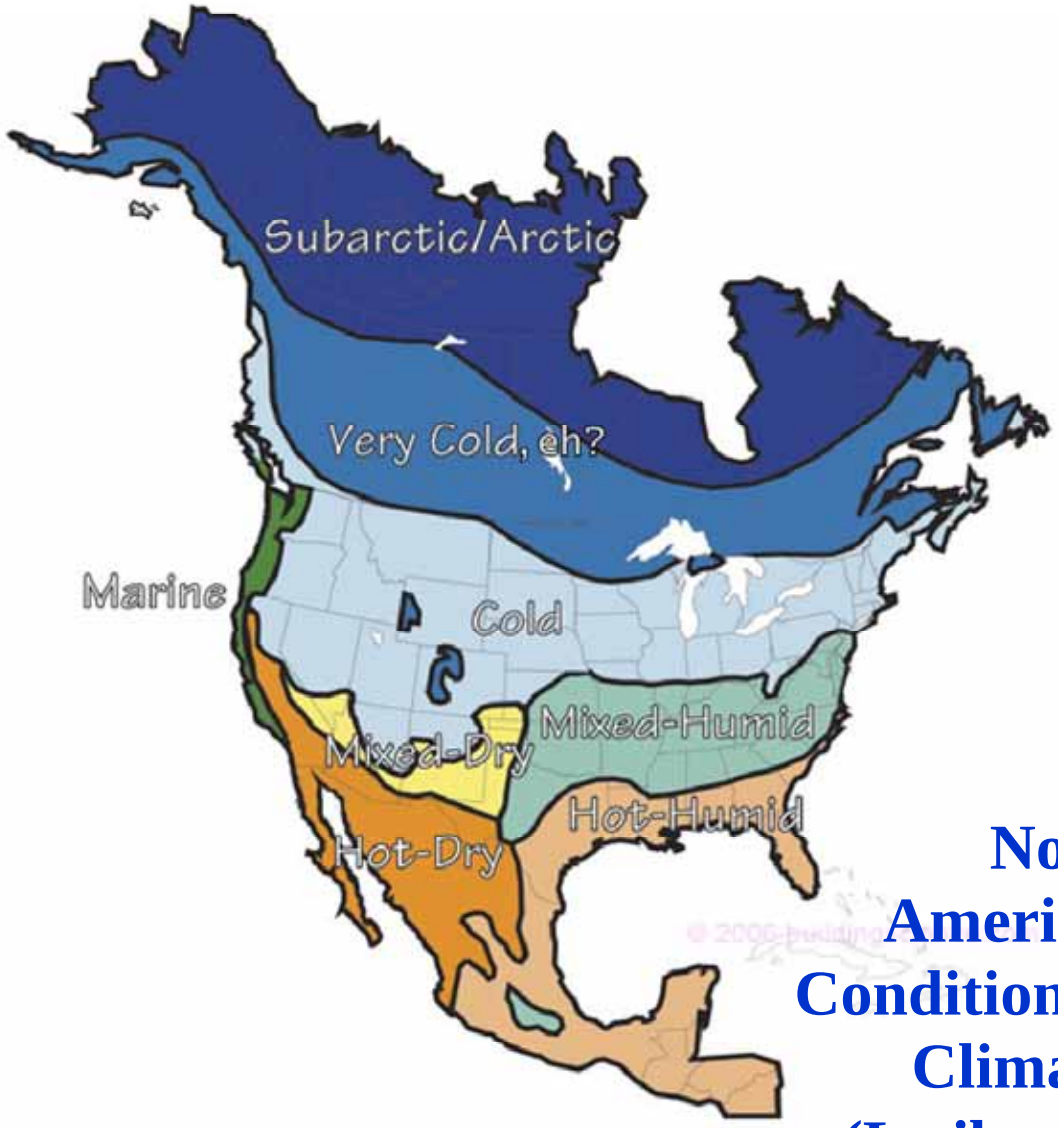
Commissioning CA Cx Collaborative


Do To The *Cold* Weather
Please Leave The Faucets
Running

Why buildings?

Buildings allow us to create a dry, Mediterranean climate in every gods-forsaken-place on the planet.

The enclosure is a climatic transition zone for most of the year, in most North American climates



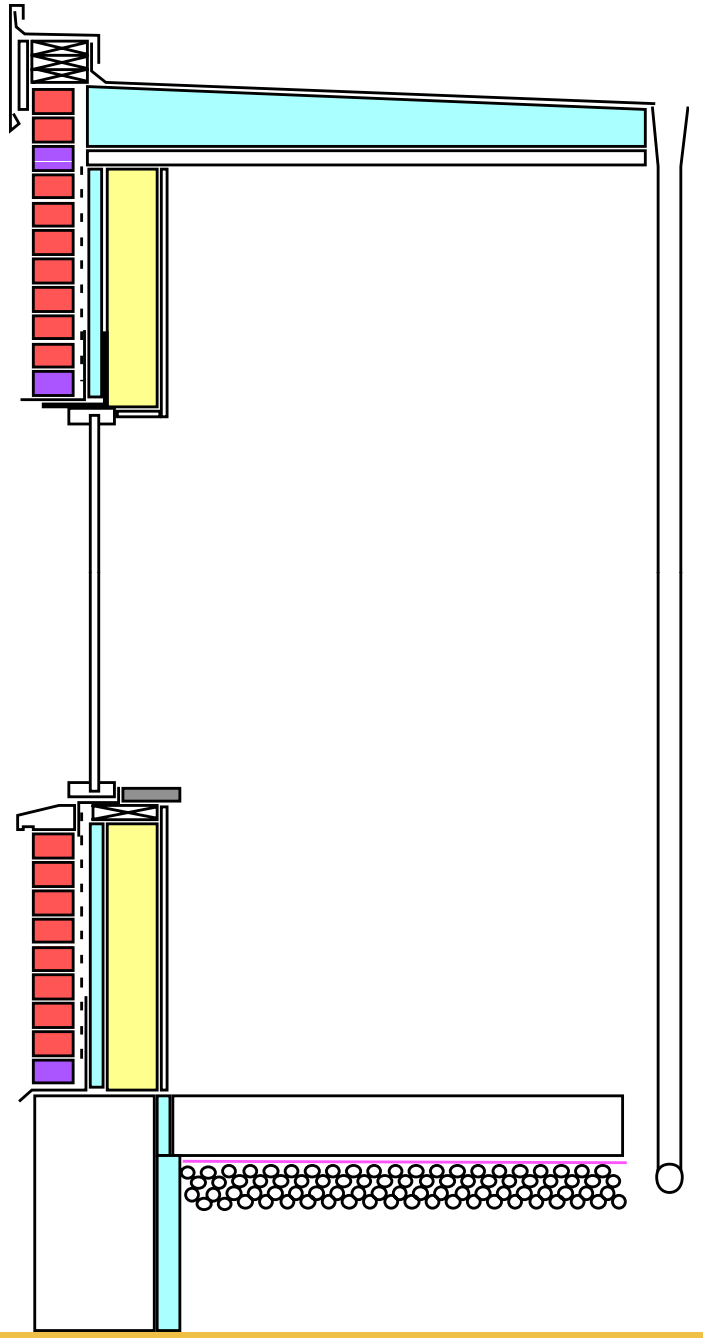
North American Conditioning Climates (Lstiburek)

To Avoid Problems the Enclosure Must:

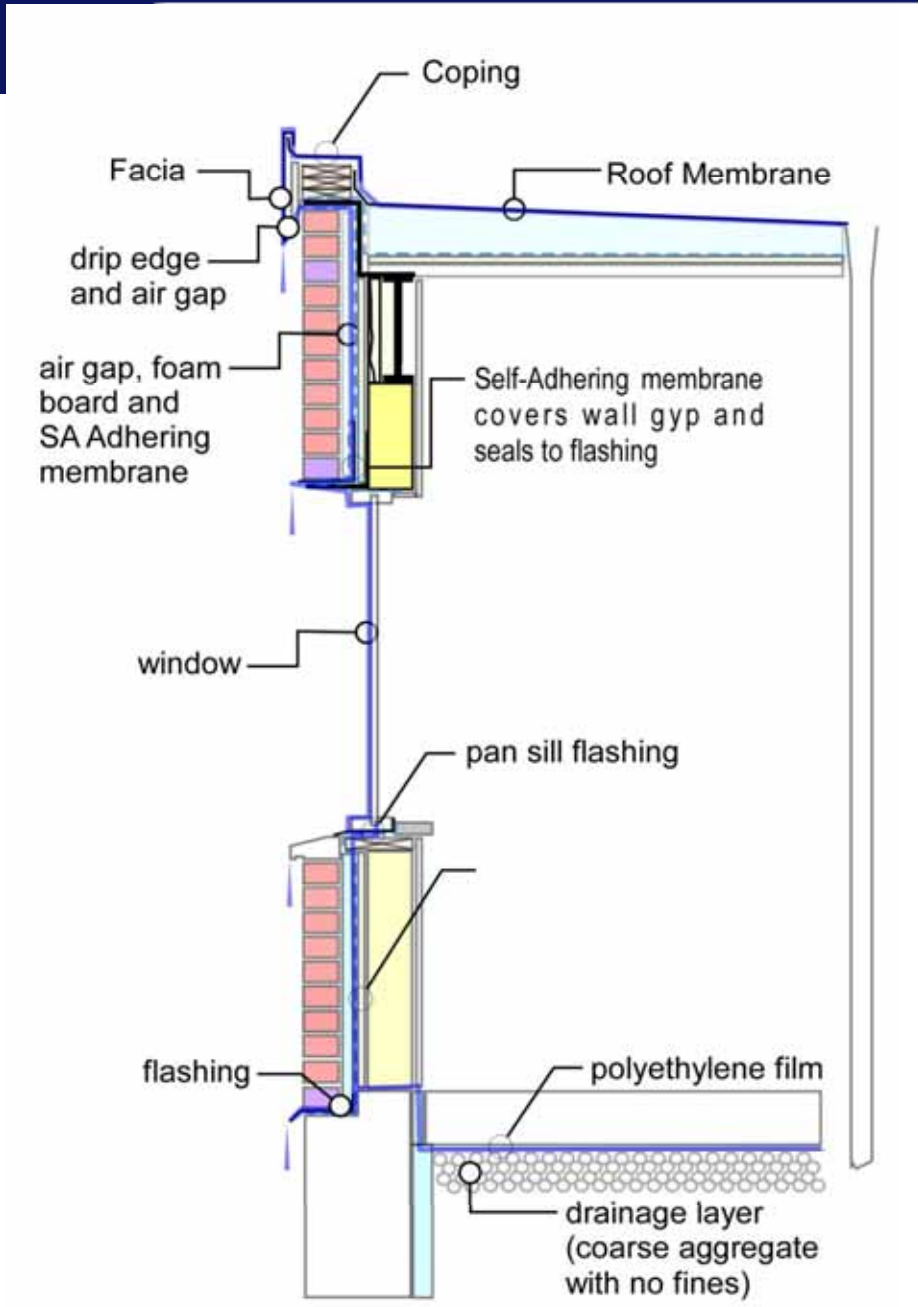
- Manage the flow of rainwater/groundwater
- Manage the flow of heat (and sunlight)
- Manage the flow of water vapor
- Manage the flow of air

The Enclosure

Continuity Test for control of air, rainwater, heat. Tracing vapor retarder continuity is inadequate for most US climates.

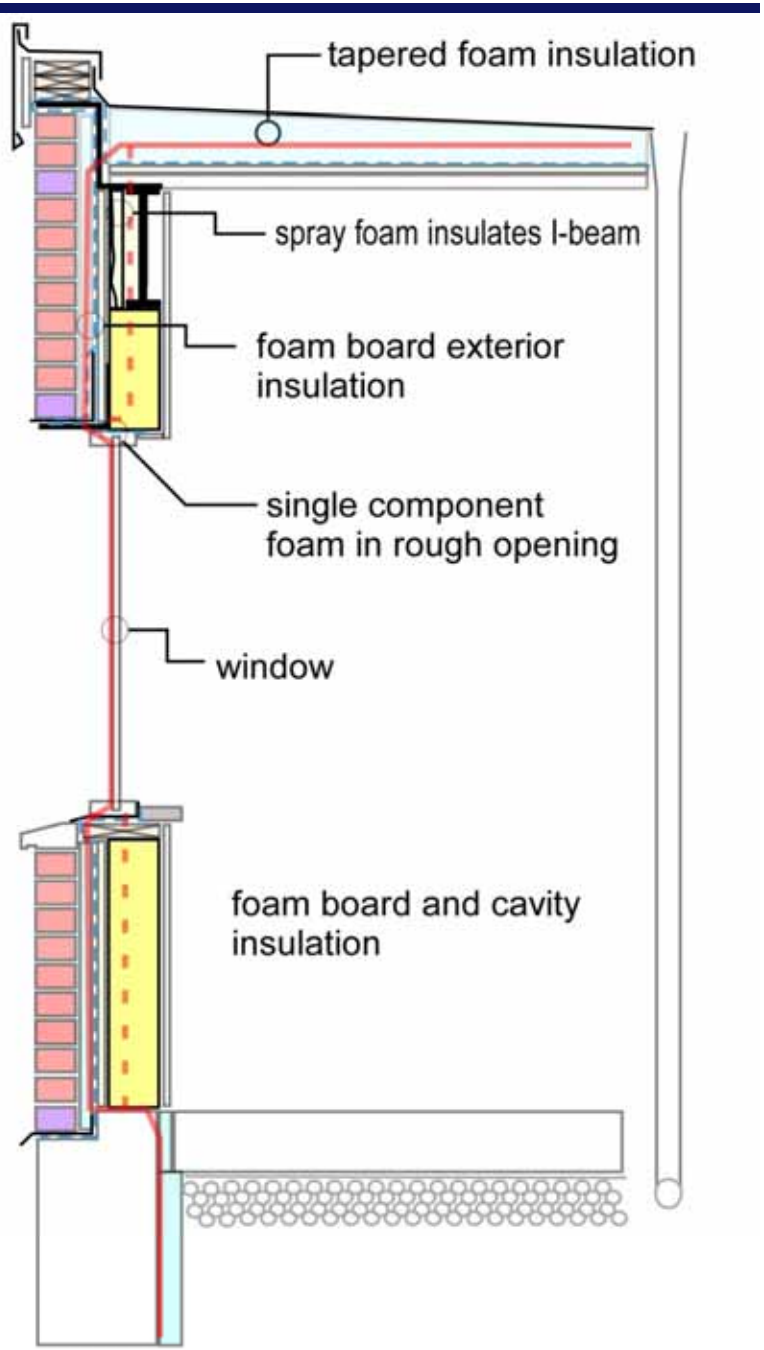


Tracing rainwater control from the center of the roof to the center of the foundation

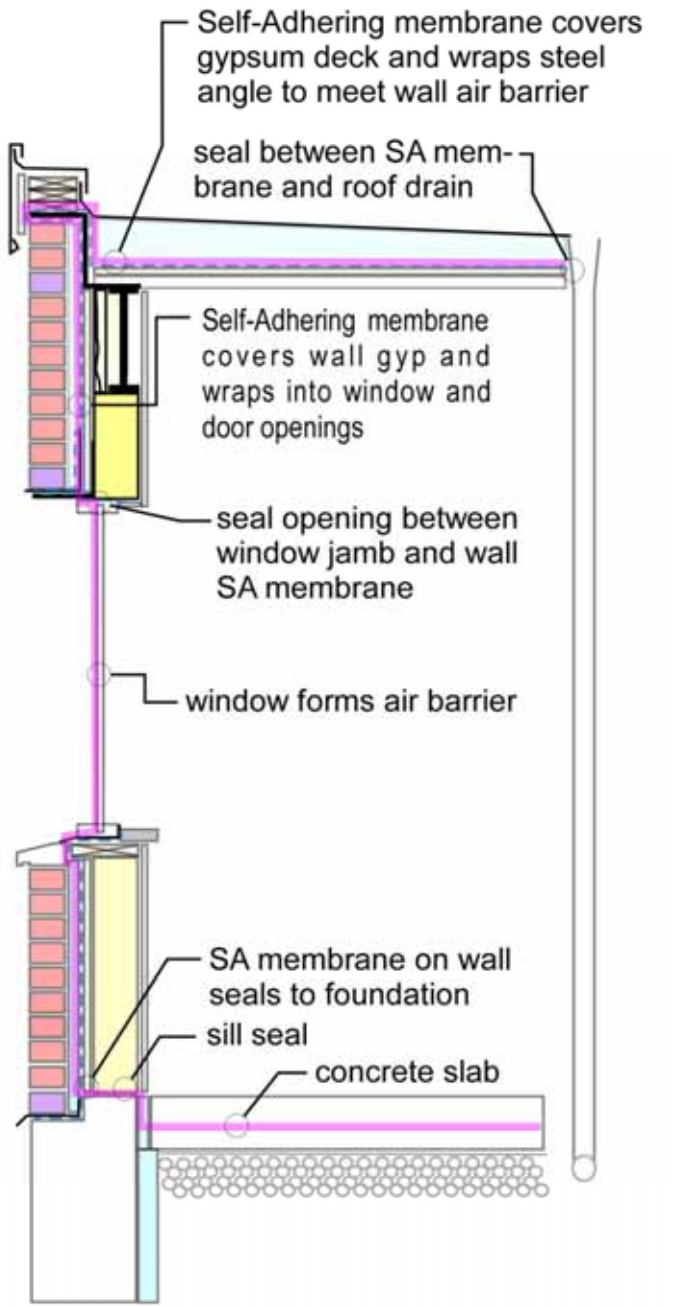


Source: EPA Moisture Control Guide

Tracing continuity of thermal control from the center of the roof to the bottom of the foundation.



Tracing continuity of air flow control from the center of the roof to the center of the foundation floor.



Avoiding Condensation

- Make it airtight
- Put all the materials with low perm (perm less than 2) on one side or the other of cavity
- Make one of the low materials at least an inch of foam board insulation
- Winter humidity less than the average January temperature plus 6

Commissioning Enclosures

- NIBS Guideline 3
- ASHRAE Guideline 0-2005
- ASTM WK26027 Building Enclosure Commissioning
- NEBB Standards for Whole Building Commissioning
- **“The role of standards and guidelines. Are they a substitute for understanding a problem or a protection against the consequences of ignorance” -** *Tim Padfield*

What goes into the specs and drawings?

- Moisture control
- Air barriers
- Insulation
- Condensation control
- Verification?

Why air seal?

ASHRAE 1478-TRP Measuring Air-Tightness of Mid- and High-Rise Non-Residential Buildings

Fan pressure test buildings:

- Built since 2000
- Based on ASTM E779; Normalize results to above grade envelope area
- Climate Zones 2 – 7 of the EICC Climate Zone Map
- Analyze the measured data with respect to design and construction variables (e.g. envelope materials)
- Identify major air leakage sites

Air Tightness, Codes and Programs

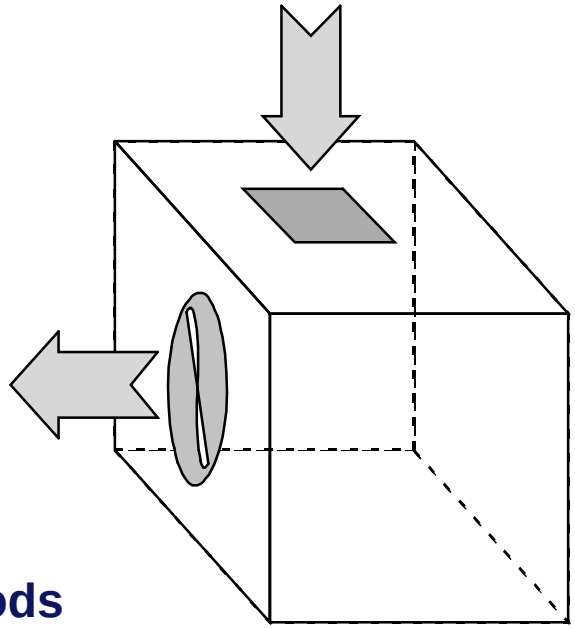
- 2012 IECC requires continuous air barriers and provides three paths to compliance. ASHRAE 189.1 is the same.
- Army Corps of Engineers requires continuous air barriers and an ASTM E779 fan pressure test proving that the enclosure is less than 0.25 cfm75/ft2 of enclosure (all 6 sides) International Green Code has adopted it.
- GSA requires continuous air barriers and the enclosure is less than 0.4 cfm75/ft2 of enclosure (all 6 sides) P100
- LEED 2012
- Passive House requires continuous air barriers and an ASTM E779 fan pressure test proving that the enclosure is less than 0.6 ACH50 (around 0.12 cfm75/ft2 enclosure (all 6 sides)
- Tightest building I’ve tested: commercial 0.05 cfm75/ft2 enclosure; residential 0.28 ACH50 (around 0.01 cfm75/ft2 tested in 1982);
- Leakiest building I’ve ever measured 33 ACH50 (3.3 cfm75/ft2)

Air Tightness QA Programs

- Air Barrier Association of America Quality Assurance Program

Fan Pressurization Airtightness Test

Mass flow in



Mass flow out

Standard Test Methods
ASTM E779 and E1827
EN 13829
CGSB
ATTMA TS1

Characterizing the Air Leakage

Regression analysis on Transformed Nonlinear Function:

$$Q_{cfm} = C*(\Delta P_{pascals})^{n}$$

Where C = flow coefficient

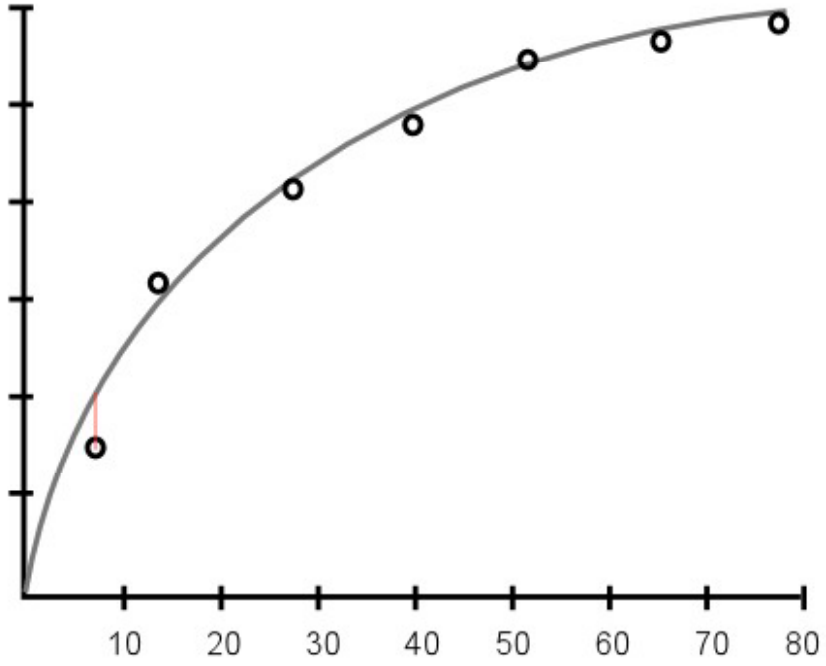
n = flow exponent ($0.5 \leq n \leq 1.0$)

Special case of the sharp-edge orifice

$$Q_{cfm} = 1.06*A_{in^2}*(\Delta P_{pascals})^{0.5}$$

Special case of laminar flow element or thin cracks

$$Q = C*\Delta P$$



This is a simplification. Air density and viscosity also affect flow and the leakage curve really isn't a power law.

Airtightness Units (Mesmerizing Metrics)

- Airflow at a test pressure:
  - CFM at 50 pascals (CFM50)
  - L/s or m3/hr at 50 pascals
- Leakage Area
  - ELA (4 pa)
  - EqLA (10 pa)
- Airflow at a test pressure normalized (divided) by enclosure area
  - CFM at 75 pascals per square foot of enclosure (5 or 6 sides of the box)
  - m^3/hr or L/s at 75 pascals per square meter of enclosure

Airtightness Test Standards

- ASTM E779-10 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
- ASTM E1827-Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
- Army Corps of Engineers
- ABAA Whole Building Fan Pressure Test Committee - Standard Method for Building Enclosure Airtightness Compliance Testing

Sources of Uncertainty in Airtightness Testing

- Error in normalizing to volume or enclosure area
- Error in setting up building
- Error measuring pressure difference across the shell
- Error measuring flow measurements

Sources of Error

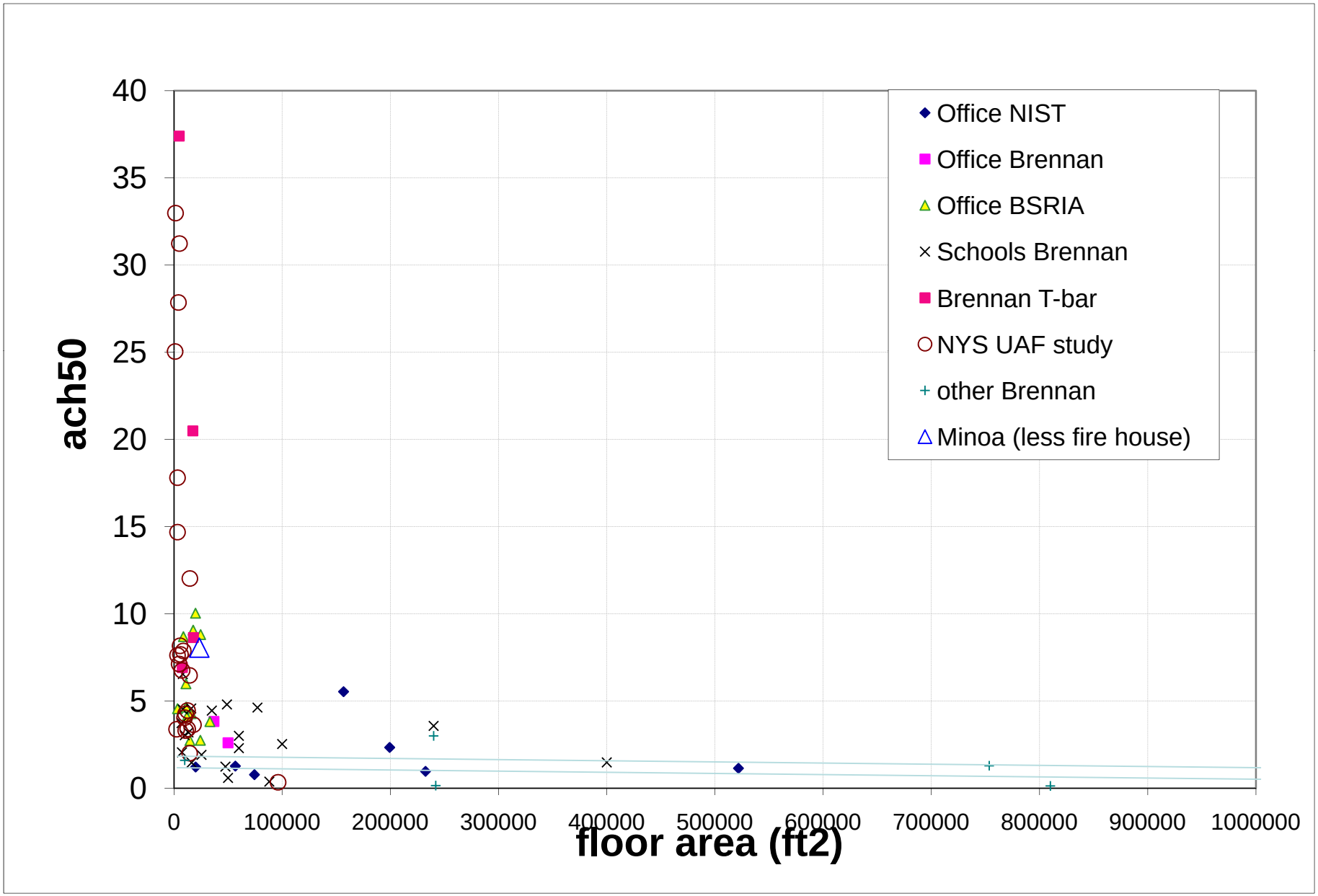
- Calculating surface area
- Building setup
  - Mechanical systems
  - Enclosure
  - Things blow open
  - People in the building
- Wind and stack effect
- Airflow, induced enclosure pressure difference
- Single zone condition?

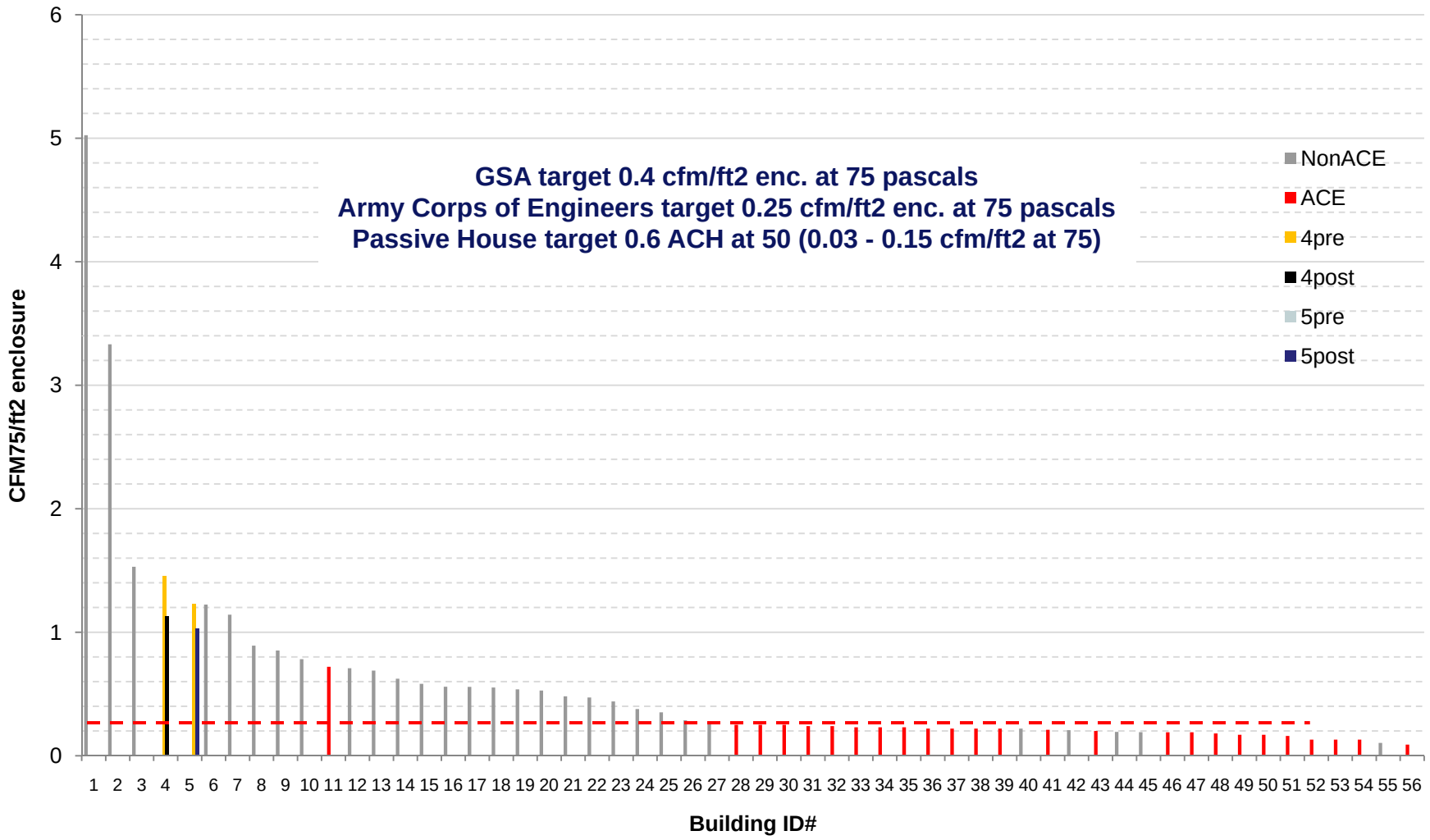
There are three North American manufacturers of whole building test equipment

Retrotec


The Energy Conservatory

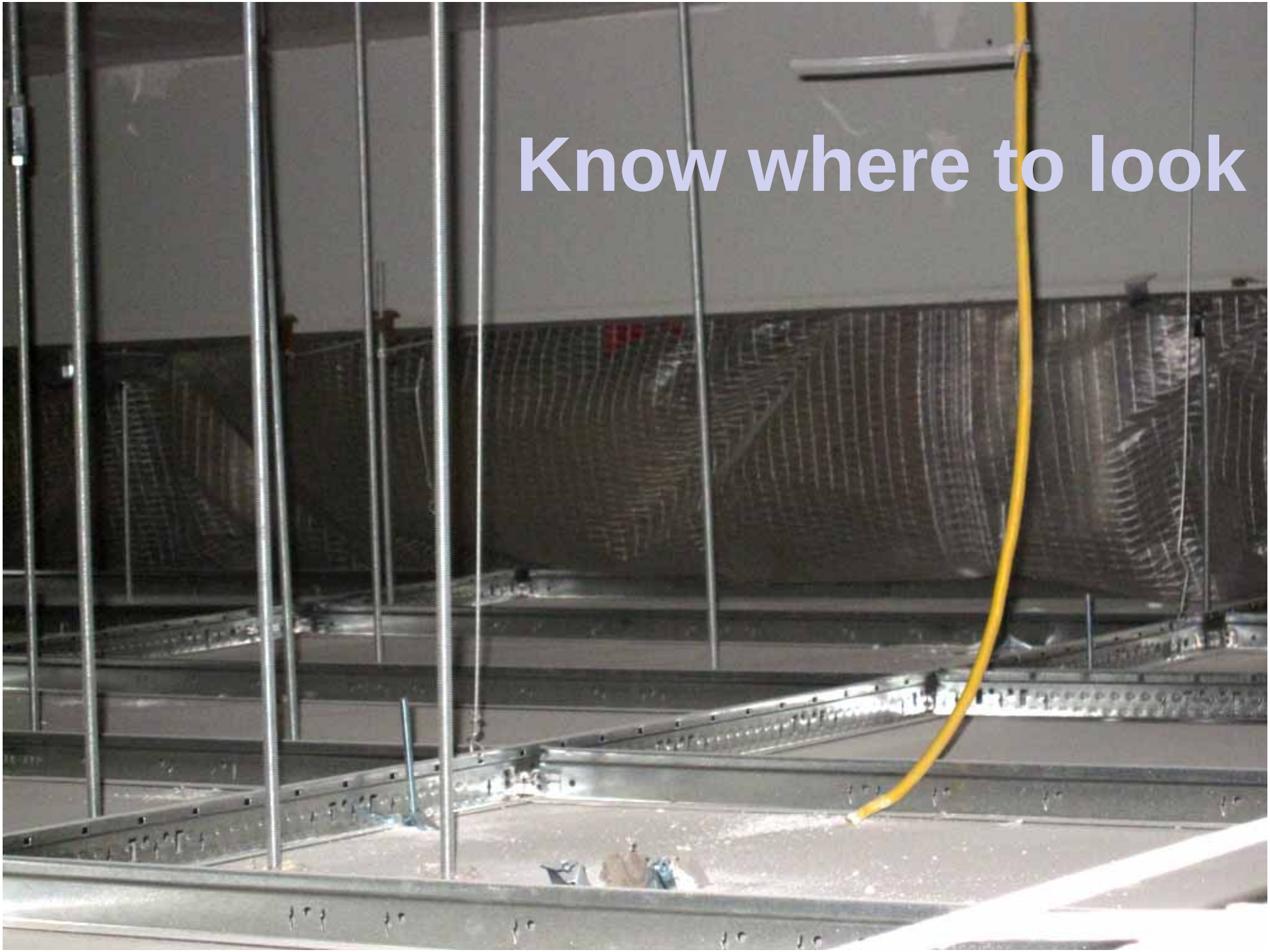
Infiltec





The coolest tools for finding air leaks?

- Your eyes, ears and brain
- Pressurize building and use:
  - Smoke pencils and theatrical fog
  - Infrared imaging
- Tracer gas (eg CO2)


Know where to look

Condensation inside the acrylic cover for a fire alarm pull on an interior corridor wall. Where the hot, humid central Florida air leaking in?