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**CONFERENCE
& TRADE SHOW**

MAY 8-9

2018

SALT LAKE

CITY

**AIR BARRIER EDUCATION TRACKS FOR
THE CONSTRUCTION INDUSTRY**

Big Air- Building Air Barrier Testing

Torrance Kramer

Accurate-Airtight Exteriors



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Torrance Kramer

CEM®, BECxP, LEED AP®, BPI® MF

TorranceK@a-aexteriors.com

Office: 866-582-4320

Cell: 608-217-3487

www.TheAirBarrier.com



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Learning Objectives

- **Understand the need for air barrier testing.**
- **Knowing what standards can be used.**
- **Knowing what an air barrier test may look like.**
- **Knowledge of common, and repeatable errors in the air barrier.**

Why Test?

- Good intentions do not always equal good performance
 - Testing identifies value comparison
 - EB vs NC
 - Even the most thorough can miss
- Promotes better built buildings
 - This one and the next
 - Standards/Military
- Building integrity- moisture, mold

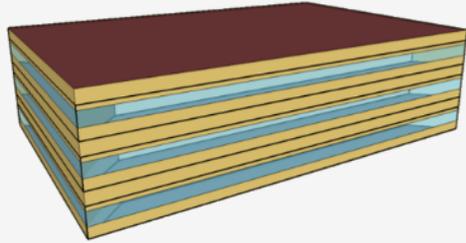


Air Loss = Energy Loss

- Oak Ridge and ABAA - Infiltration Calculator
- <https://airleakage-calc.ornl.gov/#/infiltration>

Location:

Building Type: Floor Area:



Leakage Rates:

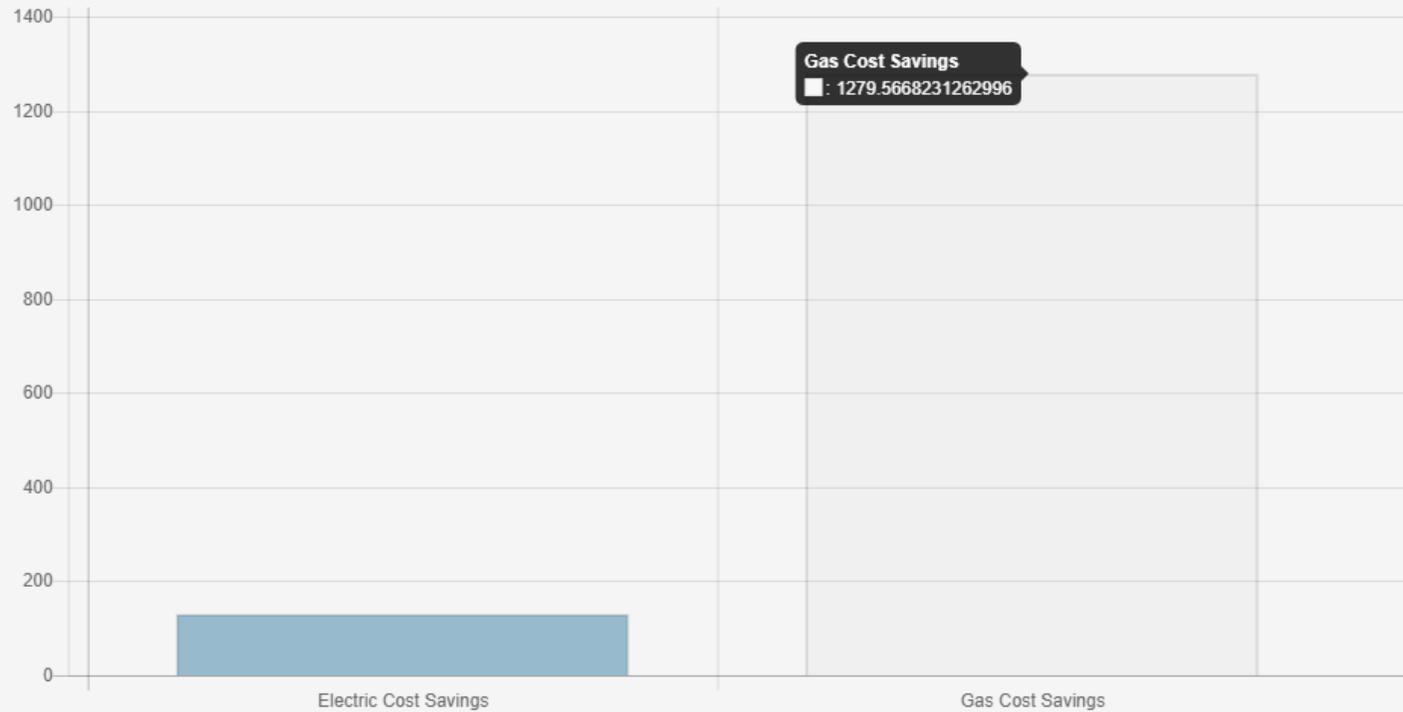
Base case: Retrofitted building:

Energy Costs:

Air Loss = Energy Loss

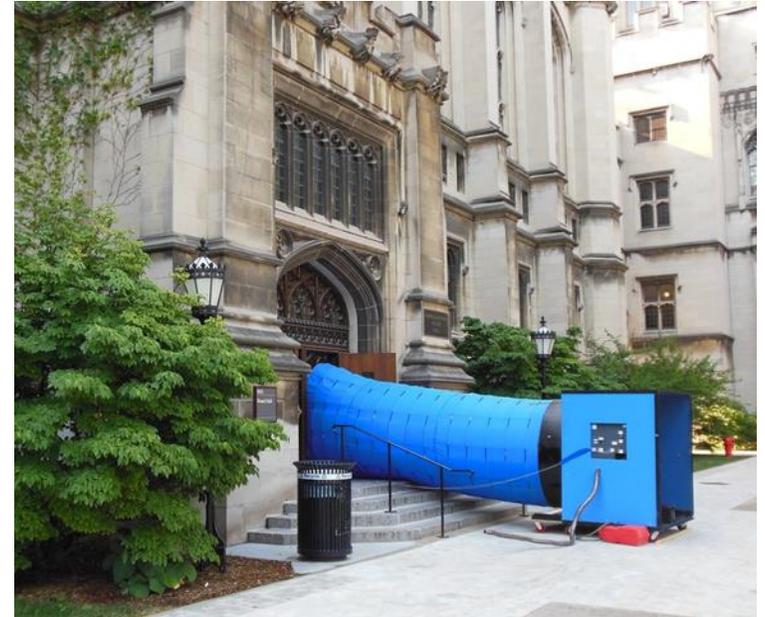
Predicted Savings

Energy		Cost		
Electricity	Natural Gas	Electricity	Natural Gas	Total
1,191 kWh	146,260 1000 ft ³	\$ 130.99	\$ 1,279.57	\$ 1,410.56



Promoting Testing

- Potential infiltration reduction is possible
 - What volume of air can be reduced?
 - What is the complexity of the project?- scope building
- Effects of comprehensive air sealing
 - Was the work done consistently?
 - Is there room for improvement?
 - Was there a major reduction?



Testing Promotes Results

- Get purchaser buy-in
- Post testing proves results.
- Proof sells the project.
- Promotes positive performance- “You will be tested on this at the end, so you better study for the exam.” No 11th hour cramming.
 - Compensation based on performance

Visuals sell
your position



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Need For Testing

- Lots of insulation, poor air sealing details caused ice in attic
- Good intentions do not equal good results
- Guidance and a mock test could've saved this before insulation install



Training Development Team- Future Projects

“Exterior Enclosure Air barriers:

-Bid and contract documents must demonstrate a continuous, unbroken air barrier separating the conditioned space of the building from the exterior, unconditioned spaces within the building, mechanical rooms vented with unconditioned air, mechanical chases opening to unconditioned spaces, elevator shafts and garages or other vehicle/equipment storage facilities. **All air barrier materials must be compatible with other air barrier elements to which they connect.**

-Bid and contract documents must include detailed information that shows the air barrier continuity through the various conditions of the exterior enclosure (e.g., transitions between dissimilar materials and penetrations) and that serves as an index to relevant details.”

ENERGY STAR® MFHR T&V

Minimum Performance Standard -Compartmentalization

Apartments shall be sealed to reduce air exchange between the apartment and outside as well as the apartment and other adjacent spaces. A maximum air leakage rate of 0.30 CFM50/ square foot of enclosure is allowed.

–ENERGY STAR® MFHR T&V

- PRE FINAL- Sample a unit to provide guidance on areas of needed improvement.
 - Areas needing improvement will be acknowledged

Testing Existing vs New Construction

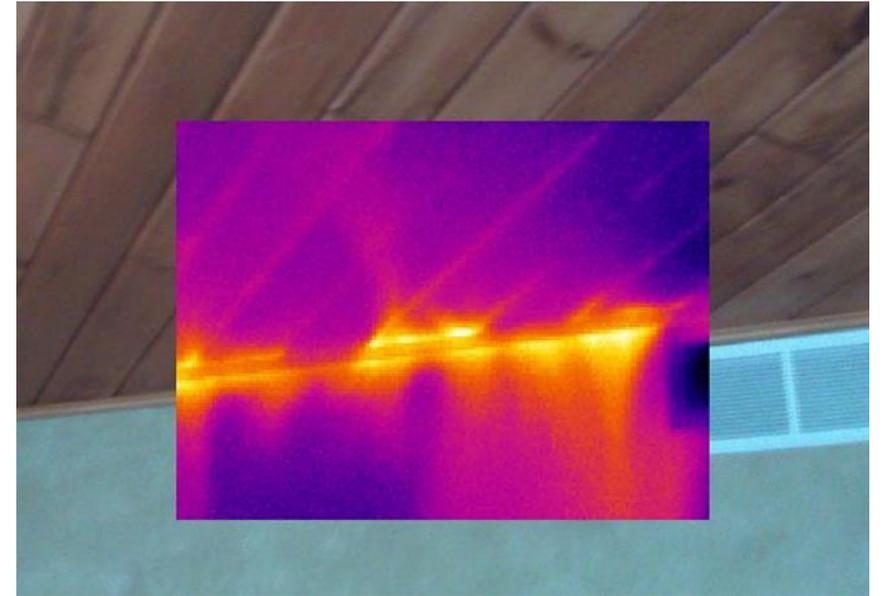
- Why Test? EB
 - Quantifying the value of the work
 - CFM drop
 - Hole size decrease - calculated
 - Air Changes per Hour (ACH) decreased
 - Pre and post repair testing – validation of ROI- QC
- Why Test? NC
 - Quantifying the value of the work
 - CFM per square foot of envelope
 - Hole size left
 - Air Changes per Hour (ACH) needed for proper ventilation
 - Validation of ROI for air barrier



Understanding our past will help us to better prepare for our future

Blower Door Guided Air Sealing

- Document easily rectifiable problems
 - Team communication- *look here*
 - Work Order
- Identify large bypasses
 - Quality of improvement
- Identify locations to address concerns
 - What customer paid for



Identify Area for Improvement

Requirements Based on Standard OR

- Whole Building Test?
- Compartmentalization?
- Mock-Up Test?
- Guided Air Sealing? Or Testing to Fix a Particular Problem?

Common Standards- Whole Building

- ASTM E779: Determining Air Leakage Rate by Fan Pressurization
 - 10 Pa- 60 Pa, Pressure or DePressure Test
- ASTM E741: Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution
- E1827 Single and Multipoint Tests
 - CFM50
- ISO 9972: Determination of Air Permeability of Buildings- Fan Pressurization Method
 - CFM50

Common Standards- Whole Building

- USACE- Protocol
 - Reference E1827
 - 0.25 CFM75/SF Env
- 2012 and 2015 IECC- Code
 - Reference E1827
 - 0.4 CFM75/SF Env
- ASHRAE Standard 189
 - 0.4 CFM75/SF Env or 0.31 CFM50/SF Env

Common Standards- Whole Building

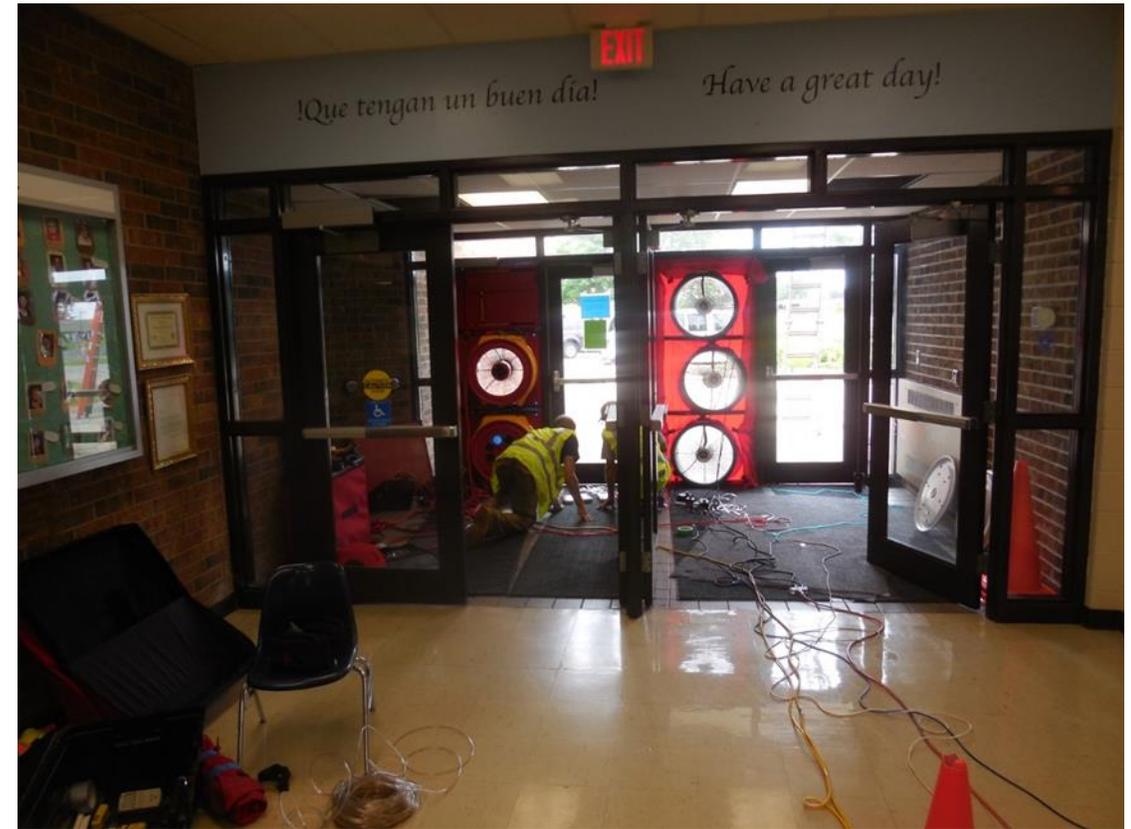
- ABAA- Standard Method for Building Enclosure Airtightness Compliance Testing
- More than E779 or E1827
 - Multipoint test- ASTM E779
 - Repeated single point test- ASTM E1827
 - Repeated two point test- ASTM E1827

Common Standards- Compartmentalization

- ENERGY STAR® MF Highrise
 - 0.30 CFM50/SF Env
- LEED Res (condos and apartments too)
 - 0.30-0.225 CFM50/SF Env
- HERs
- ASHRAE Standard 62.2-2013
 - MF- 3 stories and below
 - 0.20 CFM50/SF Env

Setup May Be Based on Standard or Protocol

- Blower Door prep
 - Define Pressure Boundary
 - What openings to seal
 - Mechanical rooms, vestibules, stairs
 - Establish Anomalies for Blower door test
 - Locations, power, traffic
 - Hardware and Controller positions
 - Which doors are best control and traffic
 - Normal Winter Operating Conditions
 - (If requirement)
 - Security (EB- theft and traffic)
 - Security (NC- often heavy traffic)



STANDARDS- The Test

- Multiple Baselines – Pre and/or Post
- Minimum 10 data points- more the better
- 75 Pa down to 10
 - Lower units may be invaluable if windy
- Observe Wind
 - Visual
 - APT
 - Weather-station
- Document- WHAT NEEDS TO BE DOCUMENTED (Standard)
 - Readings
 - Setup

Infiltec G-54



60,000 and 65,000 CFM at 75 Pa
Gas powered

Retrotec

- 7,400 CFM CFM at 75 Pa
- Hard Panel Easy Set-up
- Color coordinated-untrained staff
- VFD
- *No temp power*



Energy Conservatory

- 4,900 CFM at 75 Pa
- Low voltage options
- Works well with temporary power
- Lightweight
- *Beware of backward spin*



Plan and Prepare

- Make sure you can reach test goals or values that can be converted
 - 0.75 to 1.5 CFM50/Ft² of envelope
 - Most commercial testing done starting CFM75
- Location of equipment
- Location of staff
- Define desired pressure boundary



Define- Testable Boundary

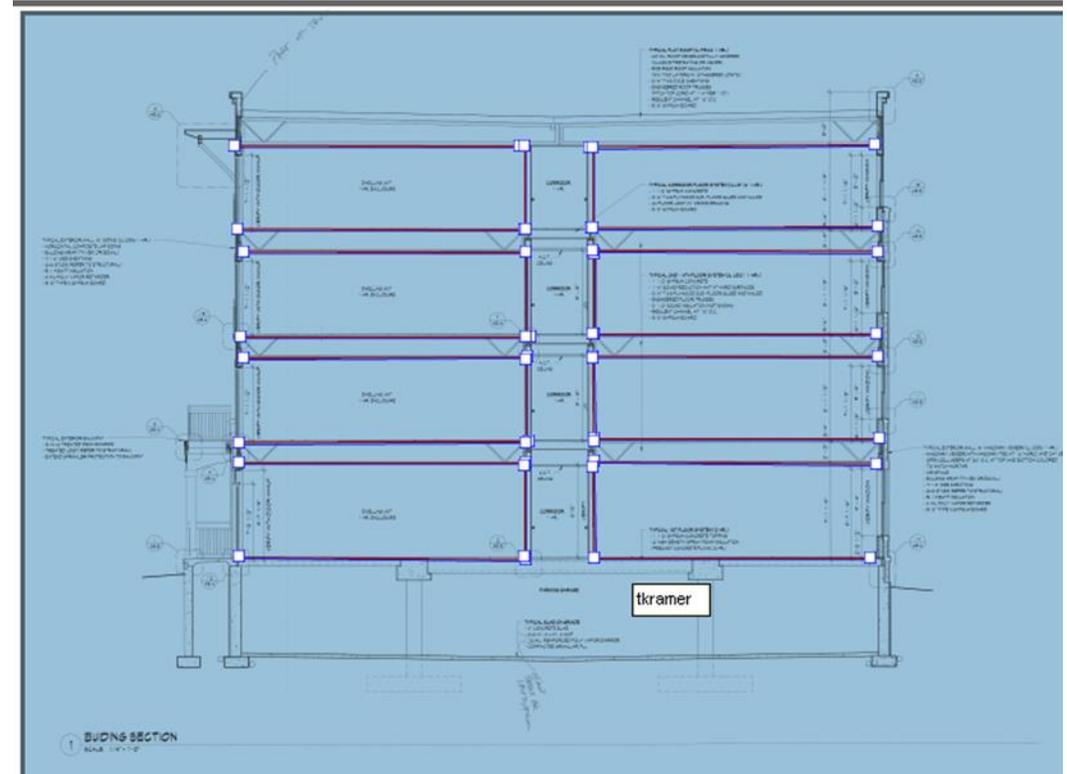
- Underground Parking- Out
- Basements
- Vestibules- Heated?
- Mechanical Rooms
 - If open combustion, should be treated as outside
- Attic/Penthouse- Use?
- Additions- Separate Tests?
- Integrity to be able to be tested



Define the Boundary

It's where you draw the box....

Compartmentalization



Test Setup- To Do's

- HVAC equipment shut-down
- Blower Doors in position
 - Watch for flow restrictions...interior/exterior
- Single Zone- *Test Zone*
- Multiple Reference- Ideally single averaged reference
- Interior scouting- proper setup of building, and equipment
- Exterior scouting- open windows, missed dampers
- Traffic Flow- Prelim

Test Setup- To Do's

Zone Isolation

- Mechanical Room
 - Block makeup air?
 - May seal mechanical room from building if completing sealing
- Underground parking
 - Open garage door
- Location of WiFi

During The Test

- Blower doors can windmill (TEC)
 - May want to start simultaneously
 - Also start covered
- Hard power (Retrotec)
- Two Way Radios are difficult to communicate on
 - Blower Doors loud
 - 1 at a time
 - Batteries- be powered
- Verify quality test before break down
 - Simple Detailed

Test Supervision

- Occupants- BIGGEST CONCERN- EB and NC
- Weather
 - Wind- *higher pressures*
 - Humidity- *water in line*
 - Precipitation- *water in line*
 - Temperature
 - Tenant Complaints (EB)
 - Skewed Data (Viscosity)
 - Standards may have requirements
- Hardware Setup
- Controllers
 - Even the experienced

Automated or Manual Test

Both have their benefits

- Automated
 - More raw data collection potential
 - Ease of modifications to retrieval data set (averaging, point volume)
 - Staff experience, test can be easier
 - Remote
- Manual
 - Setup can be easier
 - Can be easier to get accurate data in wind (find space in between gusts- the flag)
 - Concentrate on desired data set (more at 75 or 25 Pa)

Automated or Manual

Both have their cons

- Automated
 - Data retrieval difficult in higher winds
 - Set-up can be more complicated and take longer
 - More components for setup
 - Difficult in high traffic locals
- Manual
 - Data points may be overly simplified- may need to retest
 - May not show same quality analysis of building problems

A VIDEO
Yeah TV Mom!

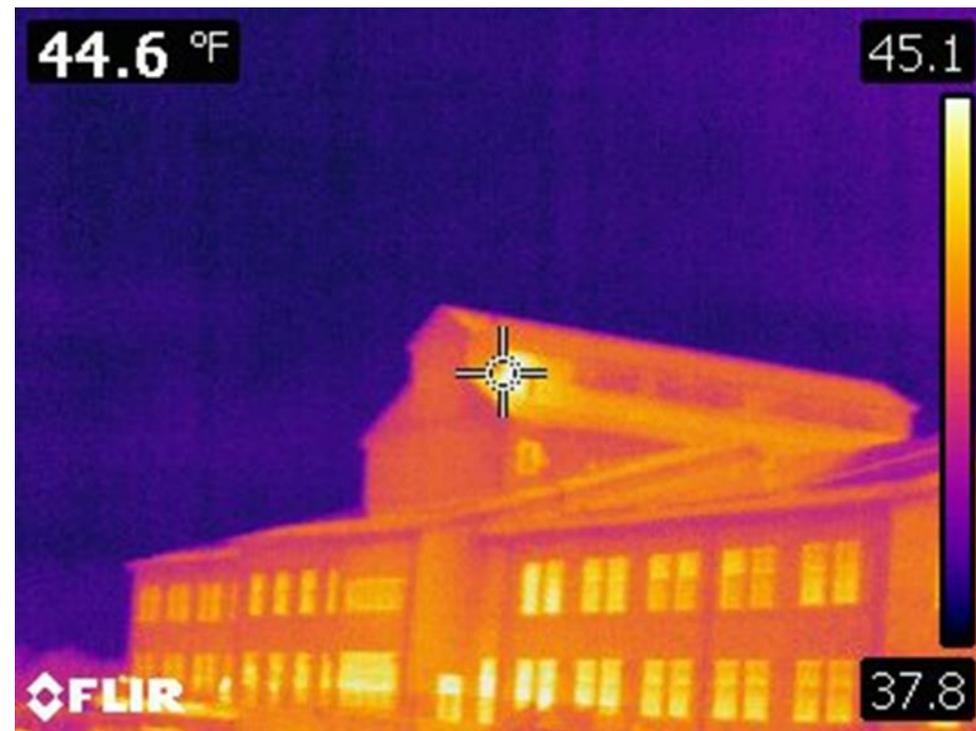
TheAirBarrier.com

PART 1:
The Setup

Incorporate Infrared

- Most specifications require infrared to be incorporated
 - Pre-test (No sun loading)
 - During Pressurization from outside
 - During DePressurization from inside

Various standards for testing, much like AB testing



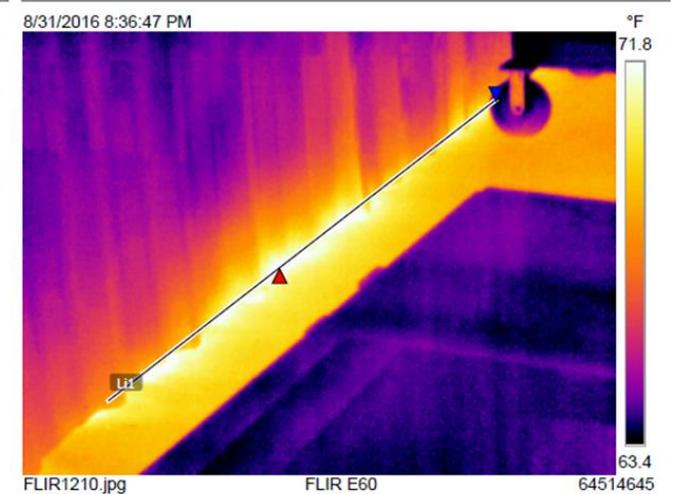
Add Infrared Reporting

- Infrared reporting makes the case for improvements
- Decide on level of information going to provide (who is the audience)

Measurements		°F
Li1	Max	72.4
	Min	63.3
	Average	70.4

Parameters	
Emissivity	0.95
Refl. temp.	68 °F

Note
South wall of new arena. Wall to floor connection.
Outside Temp 70° Inside Temp 62°
Blower door in depressurization mode.
As is common throughout most of the building, floor to wall juncture do not have a tight seal.
The images shows direct outside temperatures at floor to wall connection. The temperature on the rubber wheel shows near inside temperatures. The stiped nature of the warm temperatures shows the air migration.



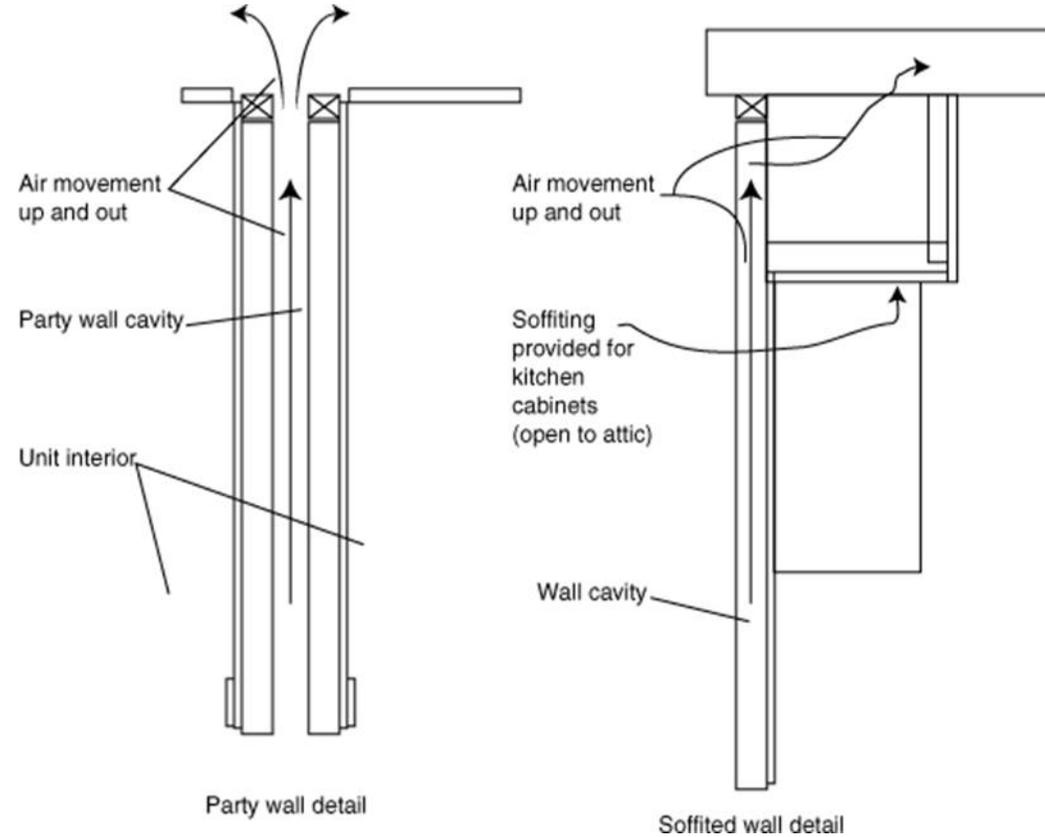
Common Building Errors

- Attic Access- seems too simple
- Residential MF
 - Shared/Party - walls between apartments or between apartment and corridor
 - Dropped ceiling
 - Above kitchen cabinets, bathtubs, closets- Drops
 - Heating ducts (where ducts cross into conditioned spaces)

Electrical wires, electrical boxes on outside walls.



Party Walls and Dropped Soffits



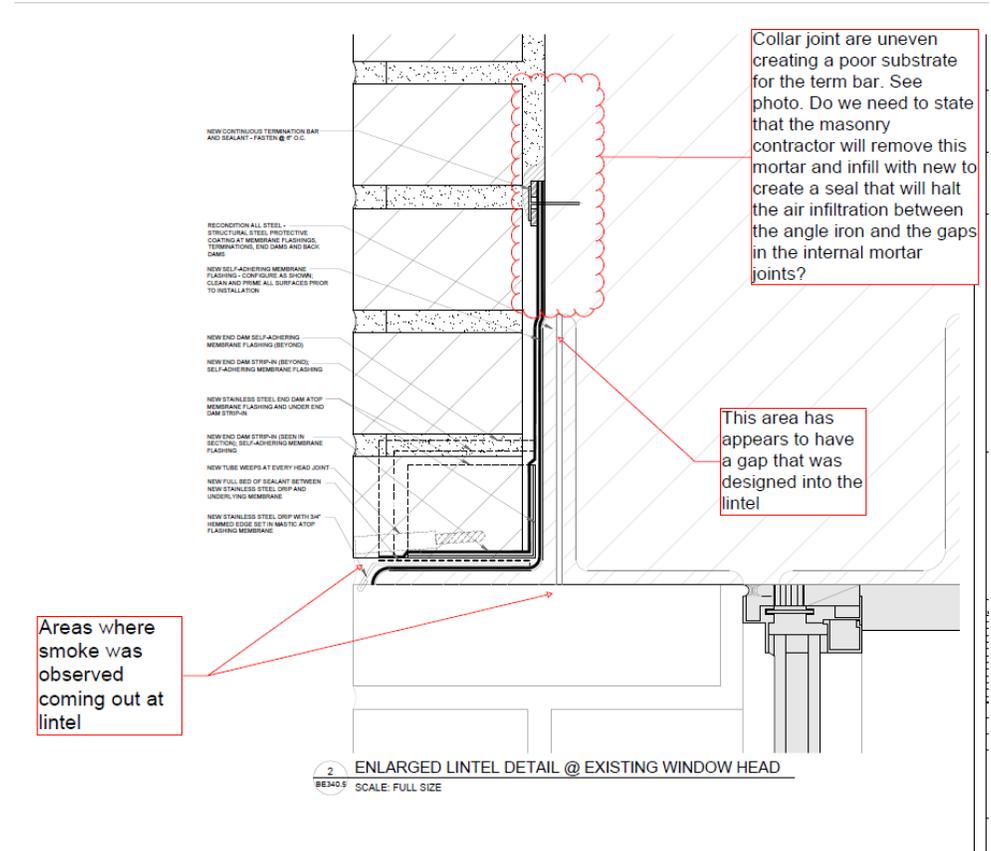
Seal the double wall please



Caulk me..... please



Common Errors- Its in the Details



Common Error

- Demising wall
 - Variations on when to apply sealant
- Elevator shaft at attic
 - Break/seal at floors
 - Seal shaft from conditioned space
 - Type? Open to roof?



Seal Demising Wall



Elevator Shaft

Floor



Common Errors

- Chaseways between floors and attic
 - Chimneys
 - Garbage chutes
 - Elevators (plunger)
- Go betweens- floor and attic



Common Errors- Roof to Wall

- Roof Wall Connections
- Corrugated Materials
 - Flutes
 - Punch Hole
 - Inject Foam Into Flutes
 - Sealing materials must resist stack effect
 - Taller the building the more stack effect
 - Must resist weather loads
- Short transition walls



This will not work. EVER!



- Tape will fail
- Hard to detail properly
- Lack of consistency

Common in Low Bid Construction



This will not work either



Roof to Wall Connections

- Often seals have to be put up before walls
- If it isn't called out in the plans, it won't get done



Roof to Wall Connections

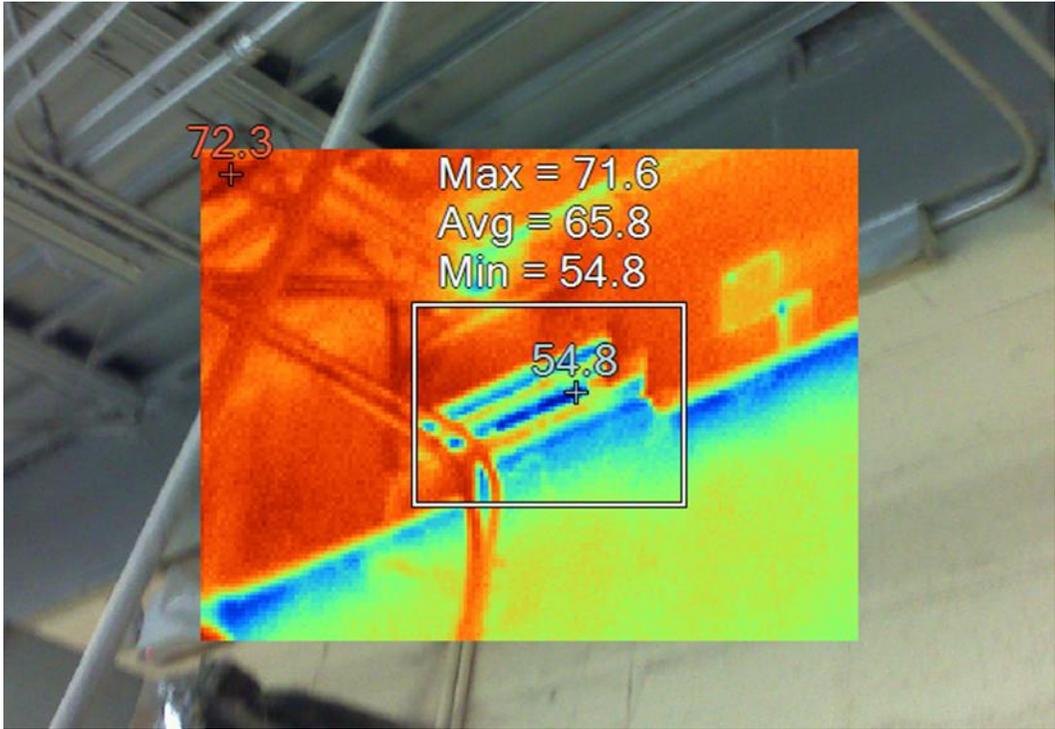
Measurements		°F
Bx1	Max	52.0
	Min	38.0
	Average	42.4

Parameters	
Emissivity	0.95
Refl. temp.	68 °F

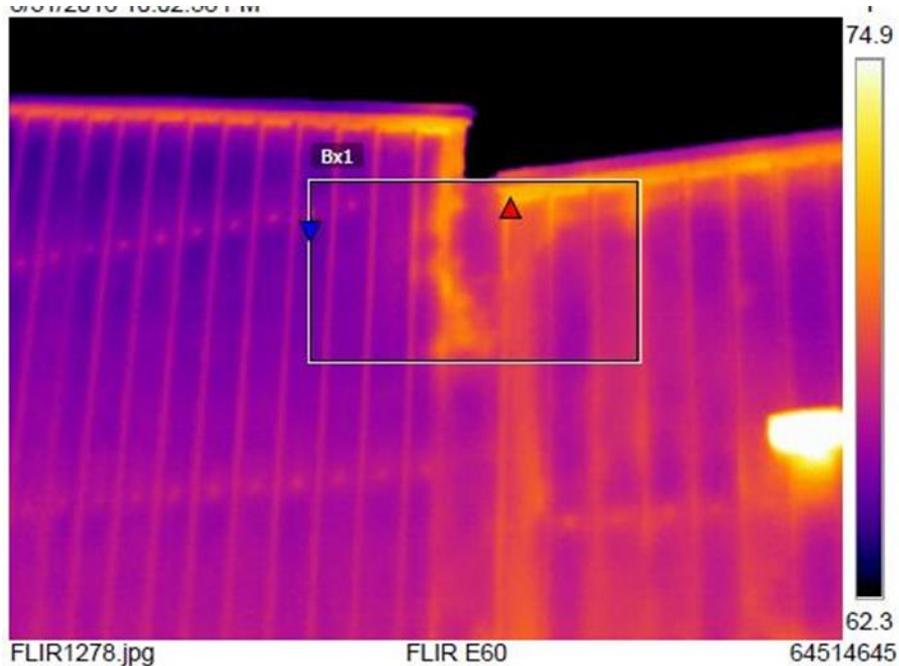
Note
During pressurization test.
Roof to wall connections showed signs of air bypass.



Roof to wall connections



Additions



- Additions are often problem areas
- Roof wall junctures need to be detailed
- Who's job is it to connect the buildings?!?

Common Errors

- Cantilevered Roof Lines



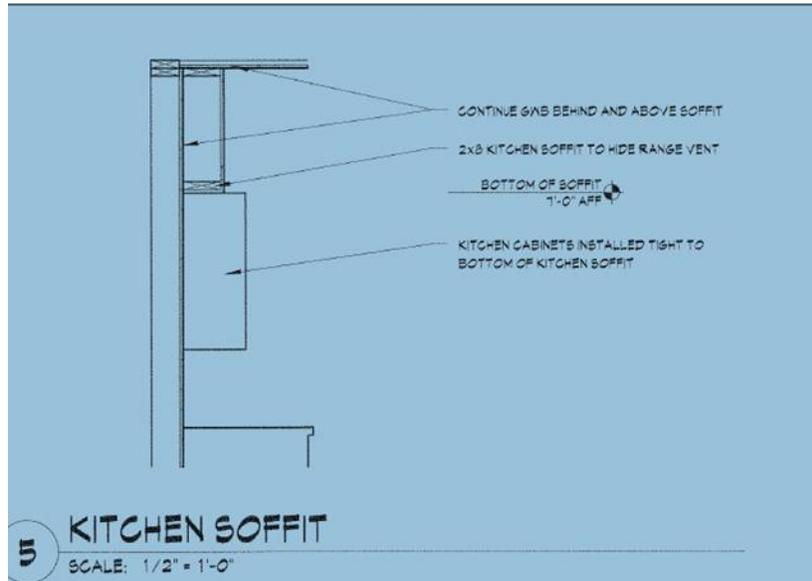
Parapets



- Need to be broken and detailed
- If corrugated decking is used, use proper sealants



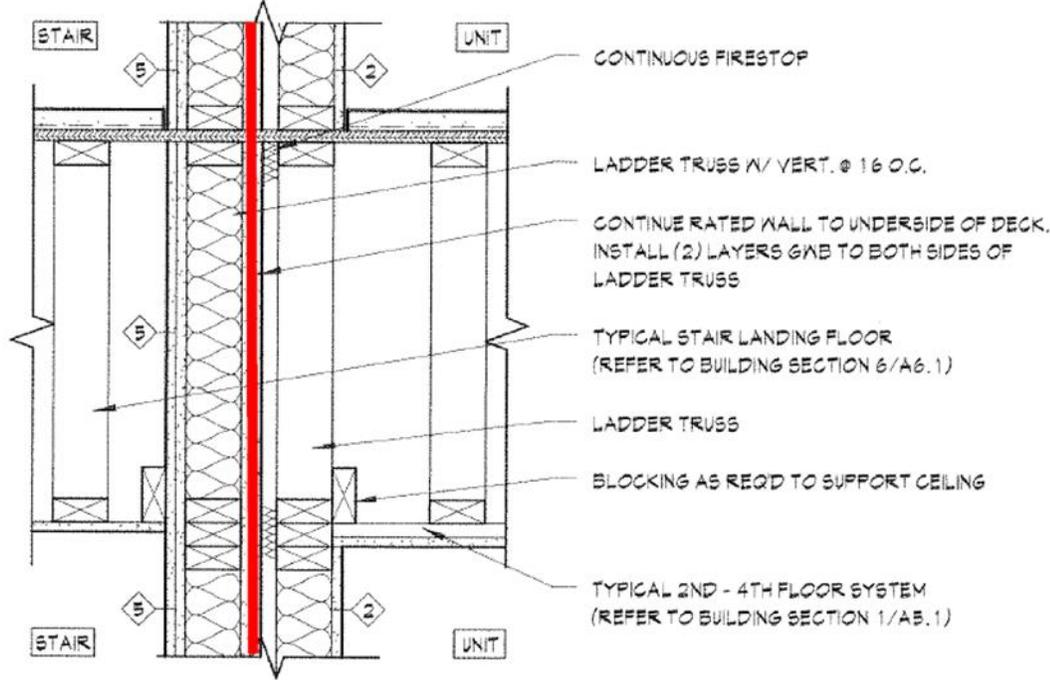
In the Details



- Much is in the details
- Not all is in the details
- Very often inspection leads to further details drawn



Stairs- Compartmentalization

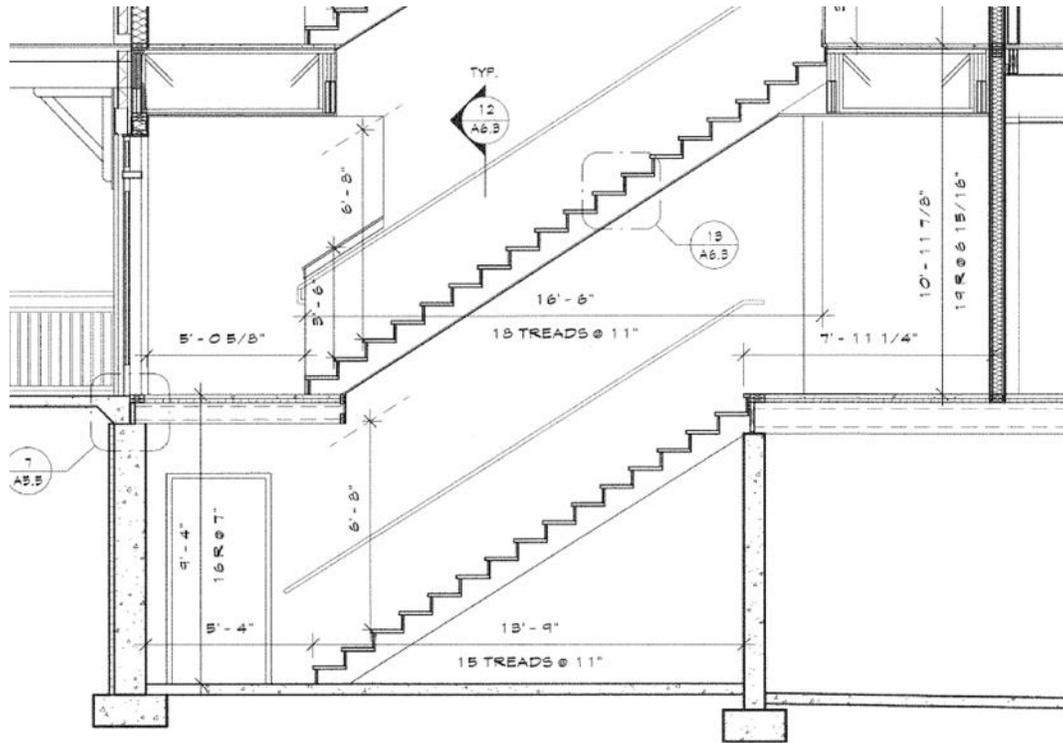


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FIRE BARRIER AT STAIR / UNIT FLOOR

SCALE: 1" = 1'-0"

Seal conditioned stairwell to underground parking connection



Common Architectural Problem Areas

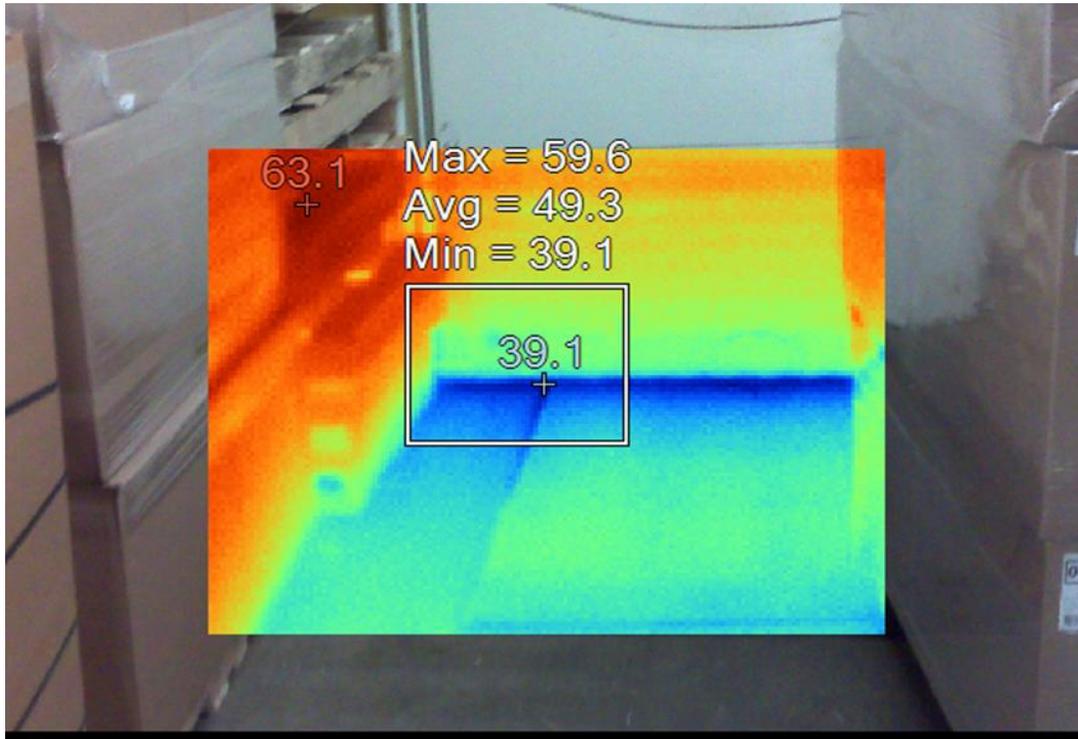


Overhangs

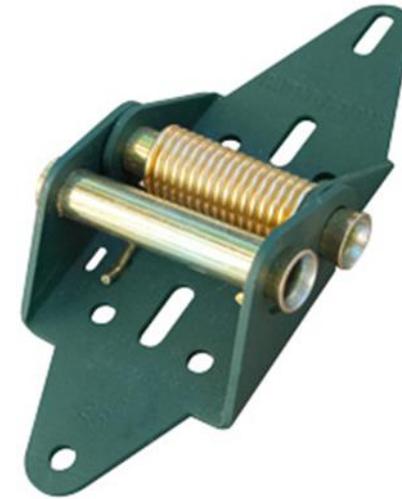


Columns

Overhead doors



- Consider spring loaded hinges and proper sweeps



Can you tell where the drop ceiling is?



They covered the spauling brick with a sign



Testing Some Buildings- No Testing

- Some difficult to even test
 - Lack of air barrier- “building” integrity



Again! So many different building types



That's an air barrier!

- Planned
- Detailed
- Proper layering
- Interim inspections
- Collaborative efforts-
TEAM from day one



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