Big Air- Building Air Barrier Testing

Torrance Kramer

Accurate-Airtight Exteriors

abaa EDUCATION

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AIA

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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.**

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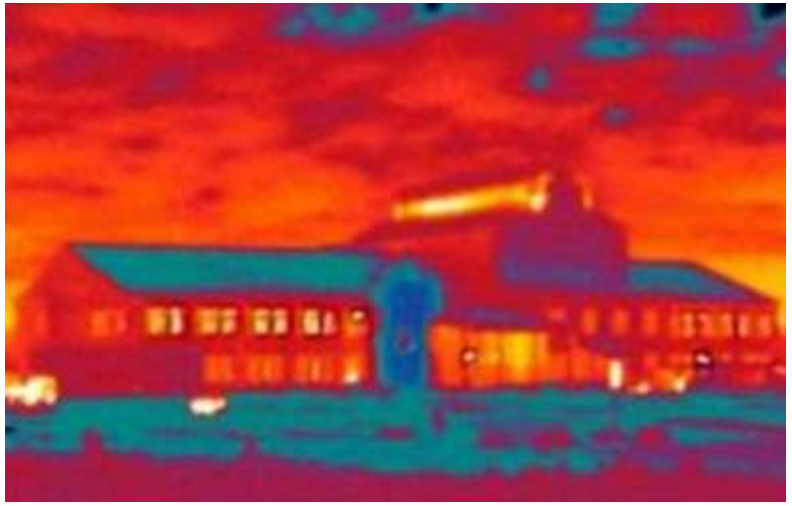
Why Test

- Good intentions do not always equal good performance
  - Testing identifies value comparison
    - EB vs NC
  - Even the most thorough can miss
- Air loss quantifies to an energy loss
  - Difficult to quantify in certain buildings
- Promotes better built buildings
  - This one and the next
  - Standards/Military
- Building integrity- moisture, mold



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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?

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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

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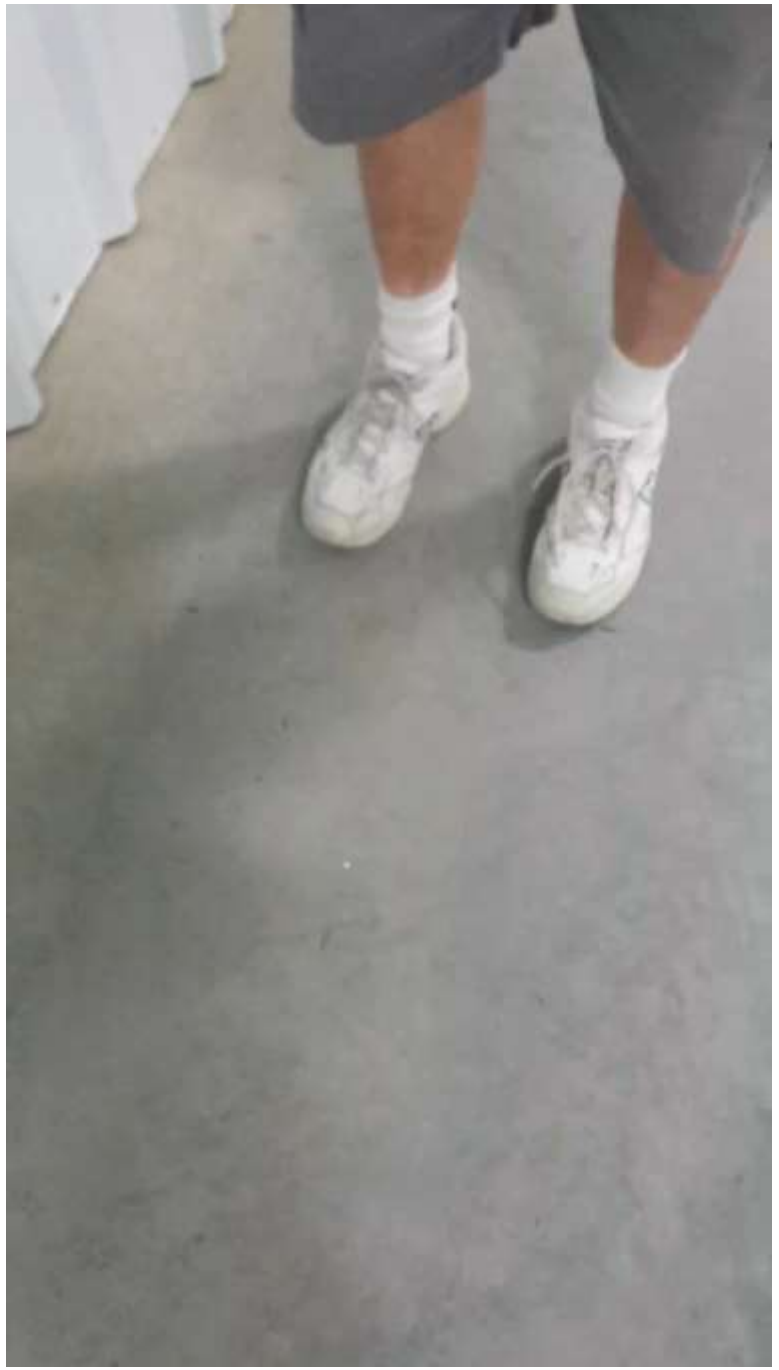
Visuals sell your position



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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

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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

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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

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Testing Existing vs New Construction

- Why Testi? EB
  - Quantifying the value of the work
    - Cubic feet per minute (CFM) dropped
    - Hole size decrease - calculated
    - Air Changes per Hour (ACH) decreased
  - Pre and post repair testing – validation of ROI- QC
  - Understanding our past helps us to better prepare for our future
- 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

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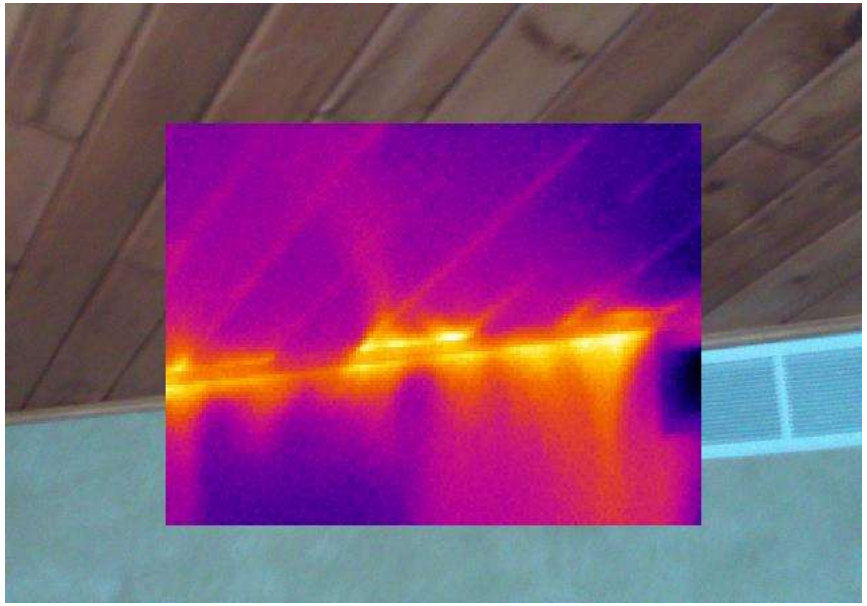
Blower Door Guided Air Sealing

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



Identify Area for Improvement

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Requirements Based on Standard

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

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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
- USACE- Protocol
  - Reference E1827
  - 0.25 CFM75/SF Env
- 2012 and 2015 IECC- Code
  - Reference E1827
  - 0.4 CFM75/SF Env

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Common Standards- Compartmentalization

- ENERGY STAR® MFHR
- LEED Res (condos and apartments too)
- HERs

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Setup is 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)

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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
  - Readings
  - Setup

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Infiltec G-54

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

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Retrotec

- 7,400 CFM CFM at75 Pa
- Hard Panel Easy Set-up
- Color coordinated- untrained staff
- VFD

Photo Courtesy of Retrotec

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Energy Conservatory

- 4,900 CFM at 75 Pa
- Low voltage options
- Works well with temporary power
- Can spin in wrong direction

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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

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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

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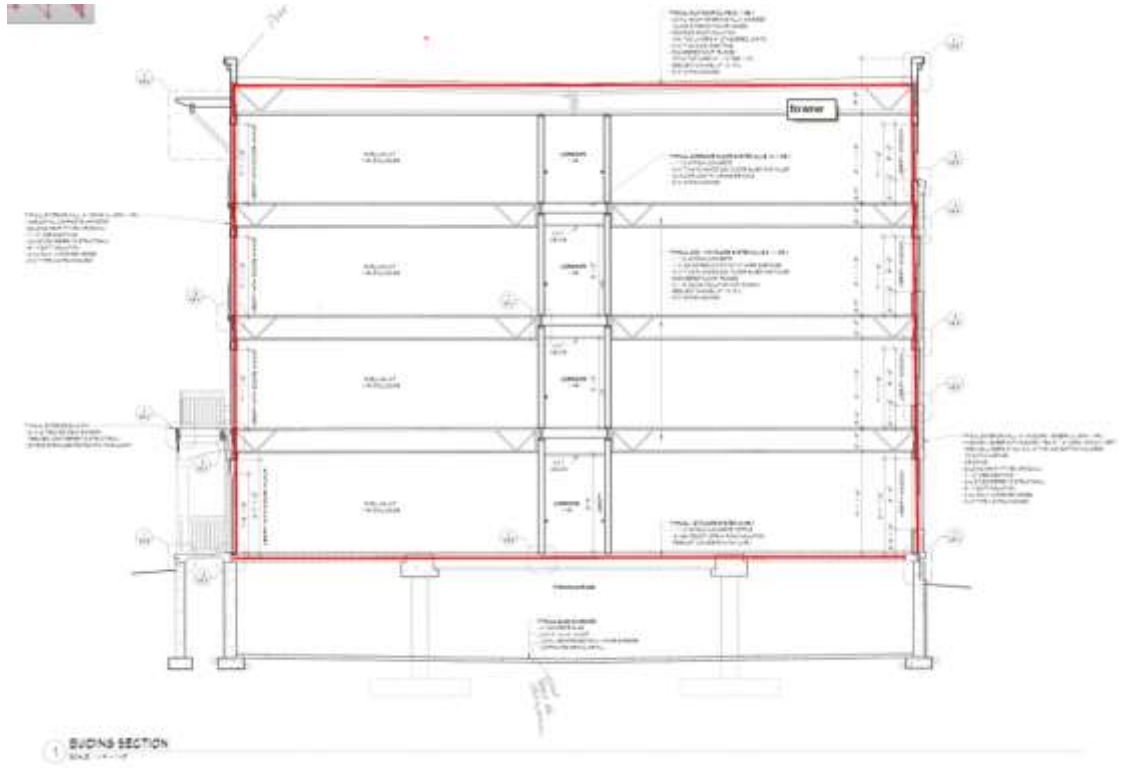
Define the Boundary

Its where you draw the box….

Whole Building



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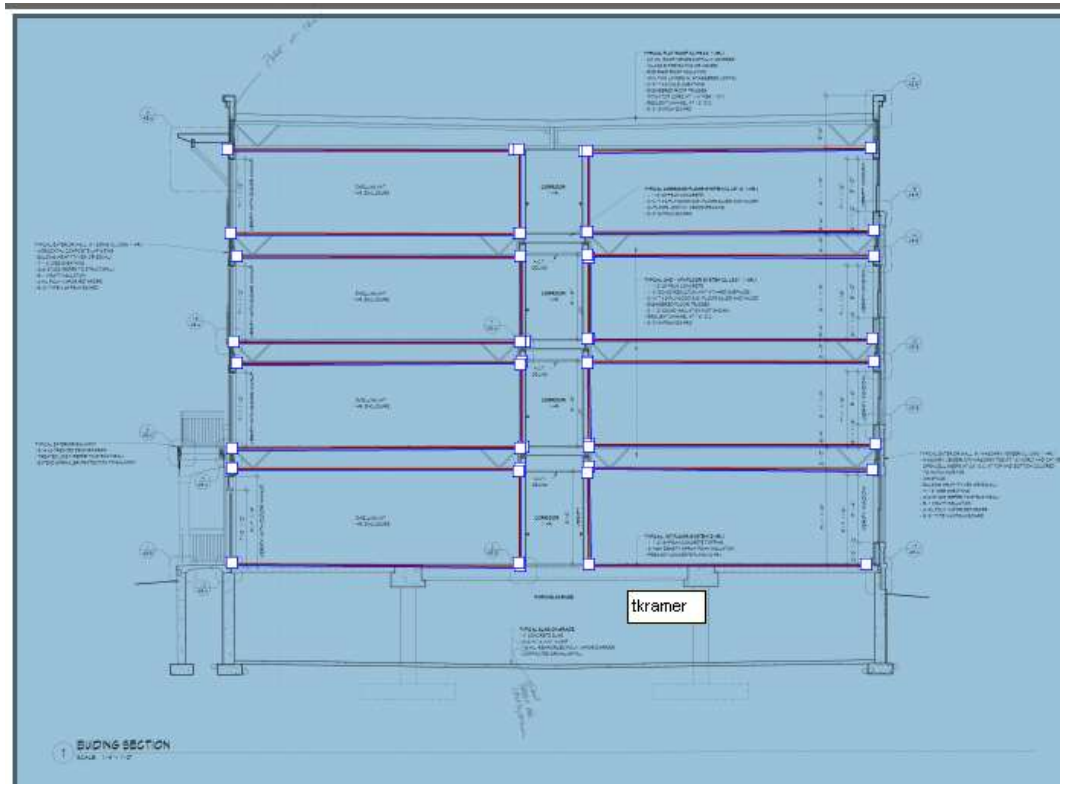
Define the Boundary

It’s where you draw the box….

Compartmentalization



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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

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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

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During The Test

- Blower doors can windmill (TEC)
  - May want to start simultaneously
  - Also start covered
- 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

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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

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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)

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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

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A VIDEO

Yeah TV Mom!

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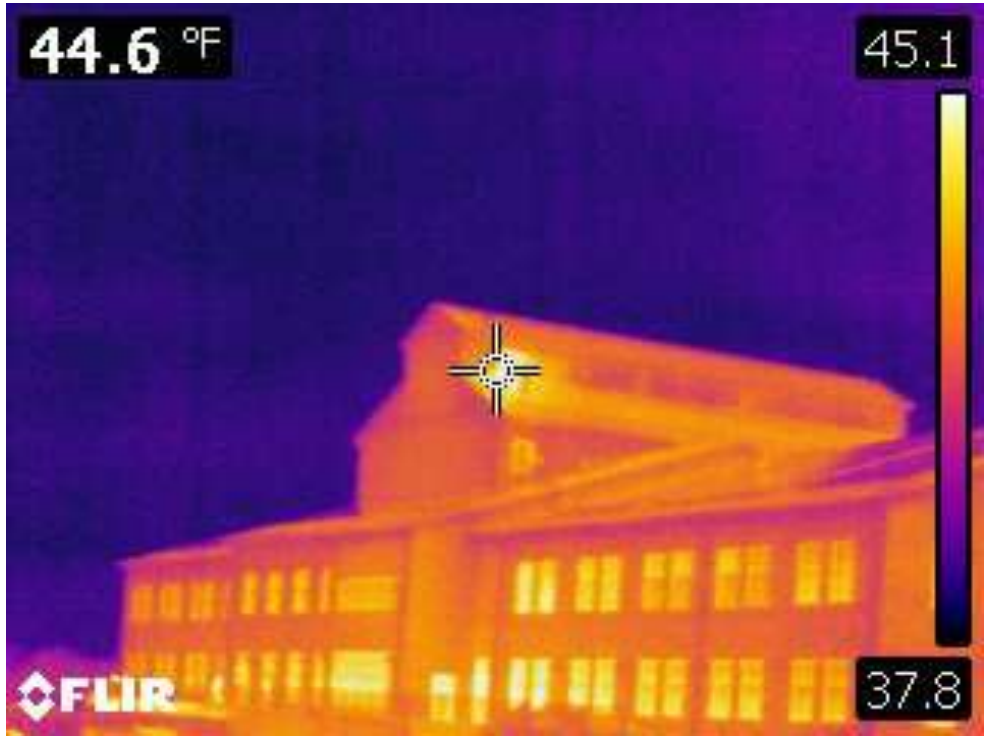
Incorporate Infrared

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

Various standards for, much like AB testing



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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.

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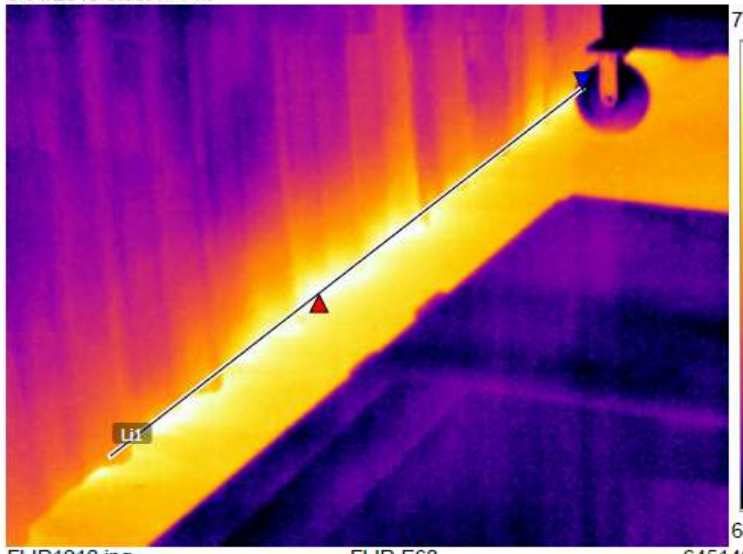

FLIR1210.jpg FLIR E60 64514645

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FLIR1211.jpg

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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.

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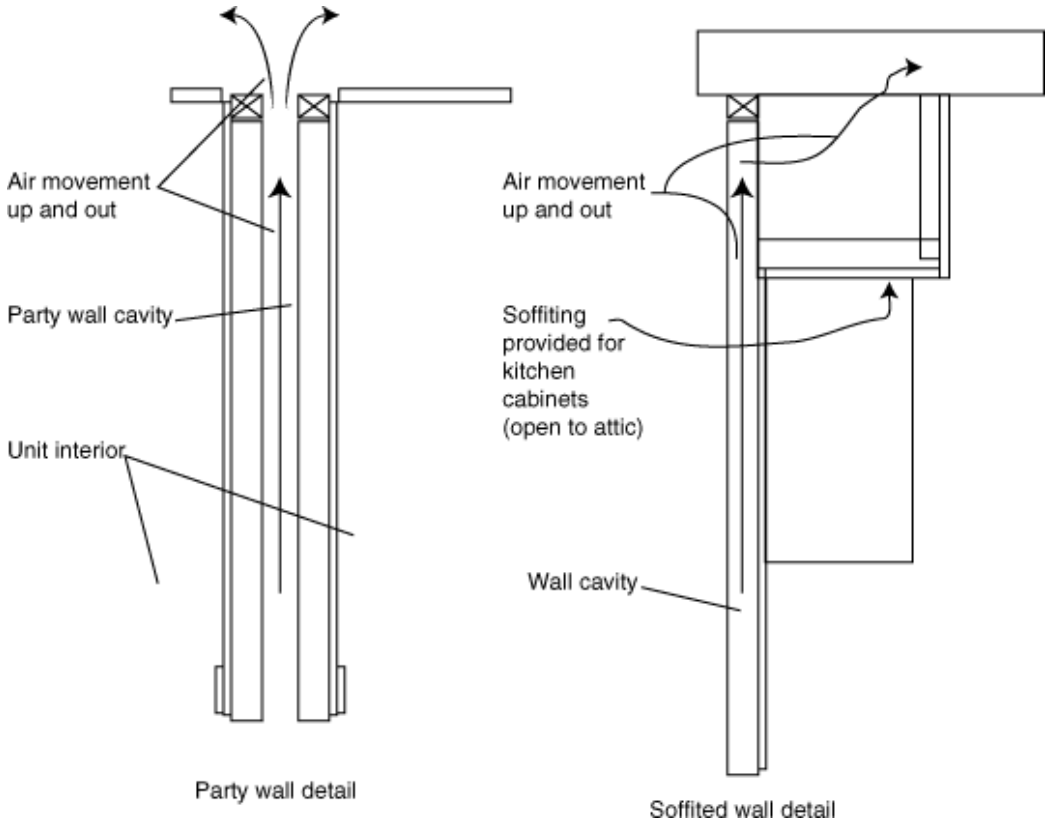
Party Walls and Dropped Soffits



Source: *Unknown*

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Seal the double wall please

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Caulk me…… please

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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?

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Common Errors

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

- Go betweens- floor and attic

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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

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This will not work. EVER!

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

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Common in Low Bid Construction

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This will not work either

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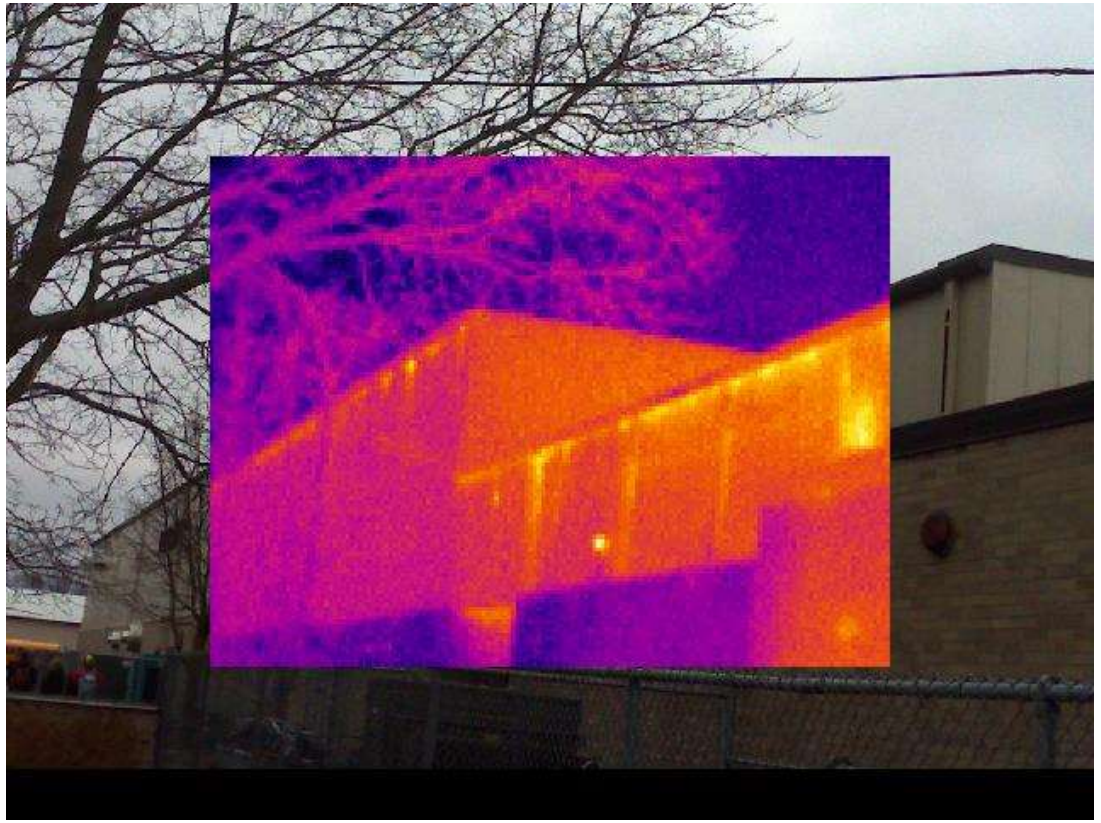
Roof to Wall Connections

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



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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.

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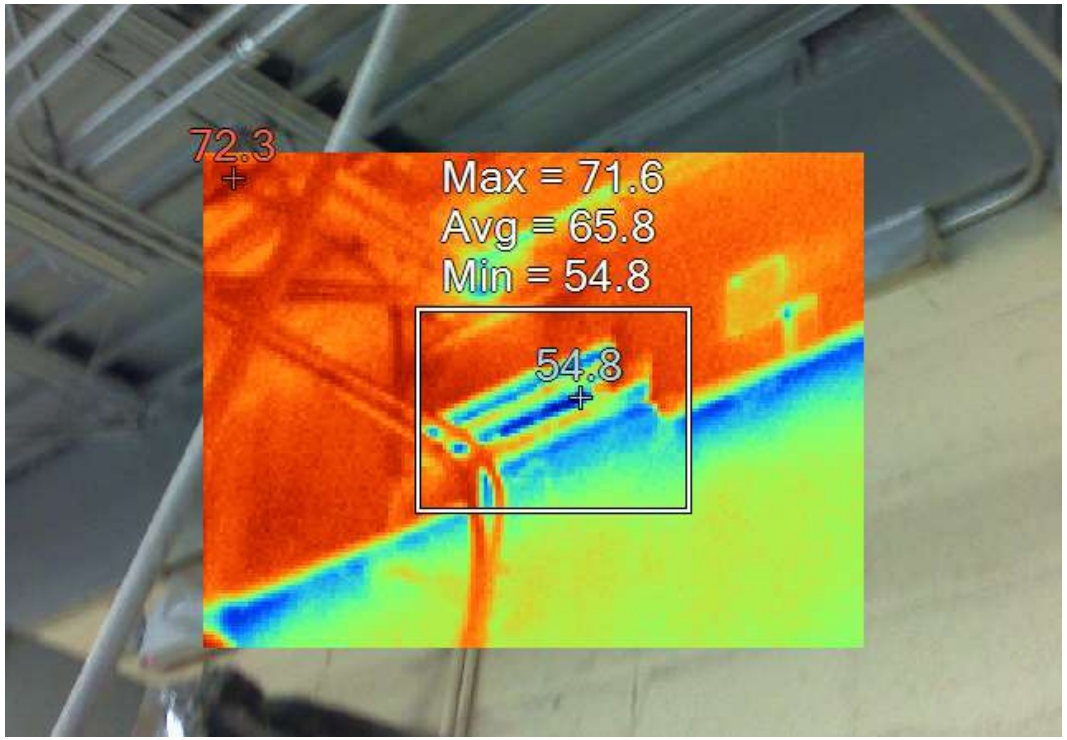
Roof to wall connections



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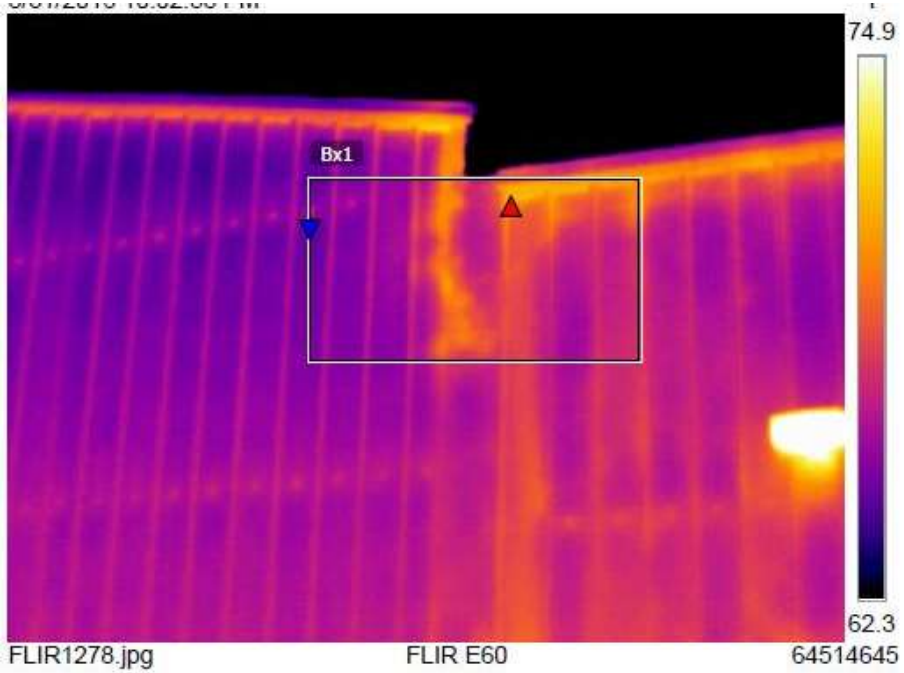
Additions



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

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Common Errors

- Cantilevered Roof Lines

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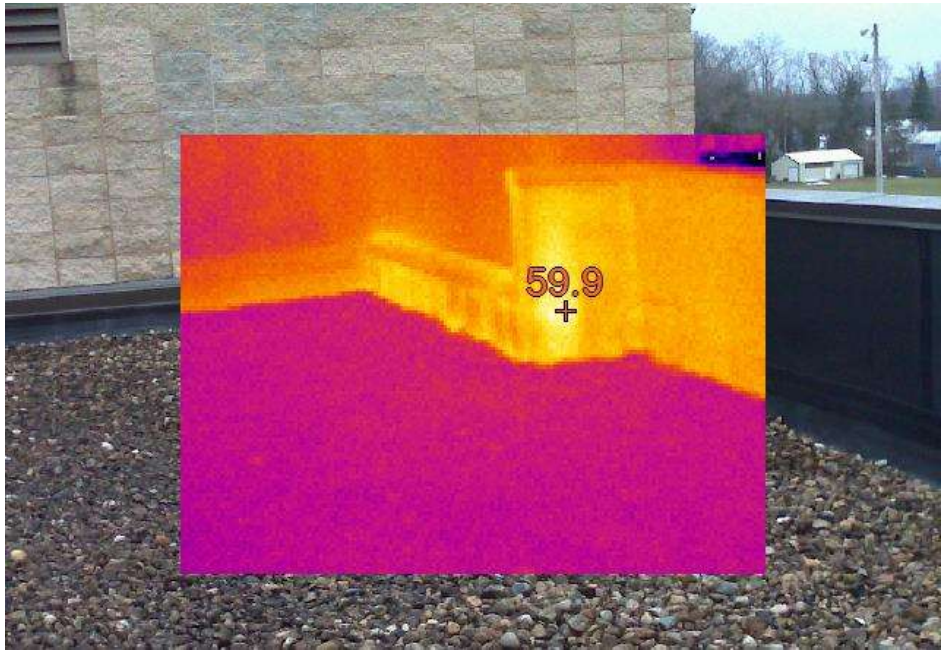
Parapets



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

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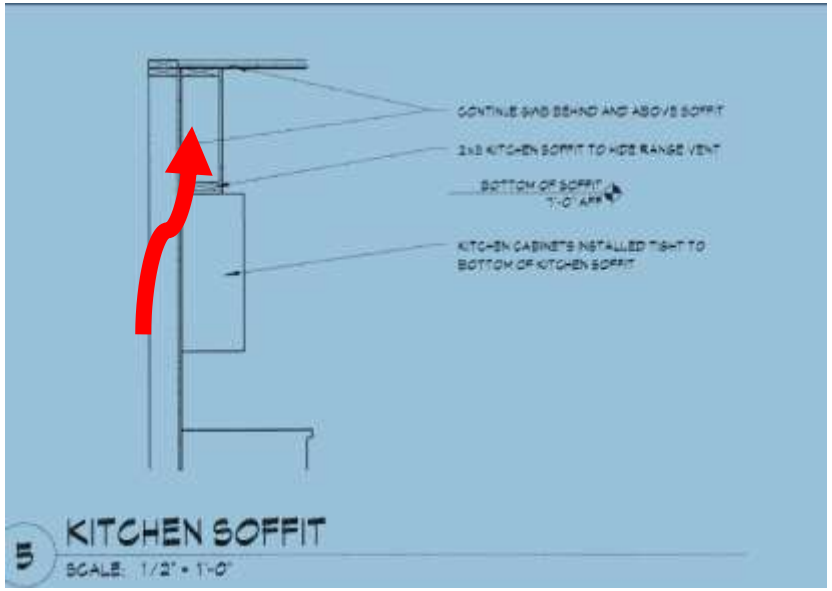
In the Details



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

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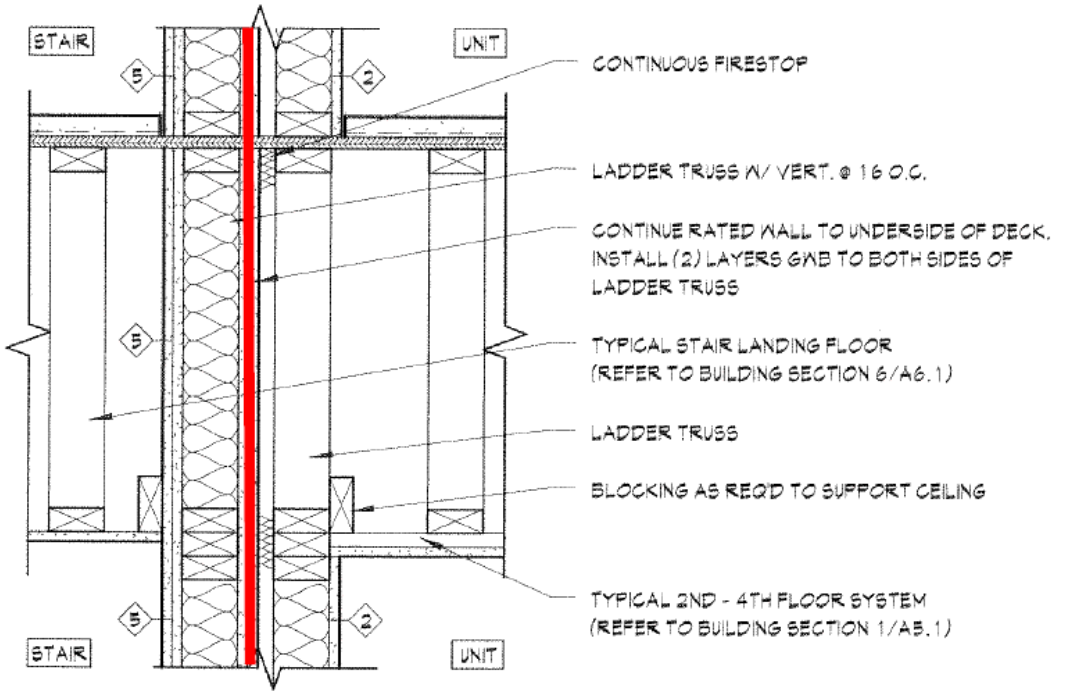
Stairs- Compartmentalization



4 FIRE BARRIER AT STAIR / UNIT FLOOR

SCALE: 1" = 1'-0"

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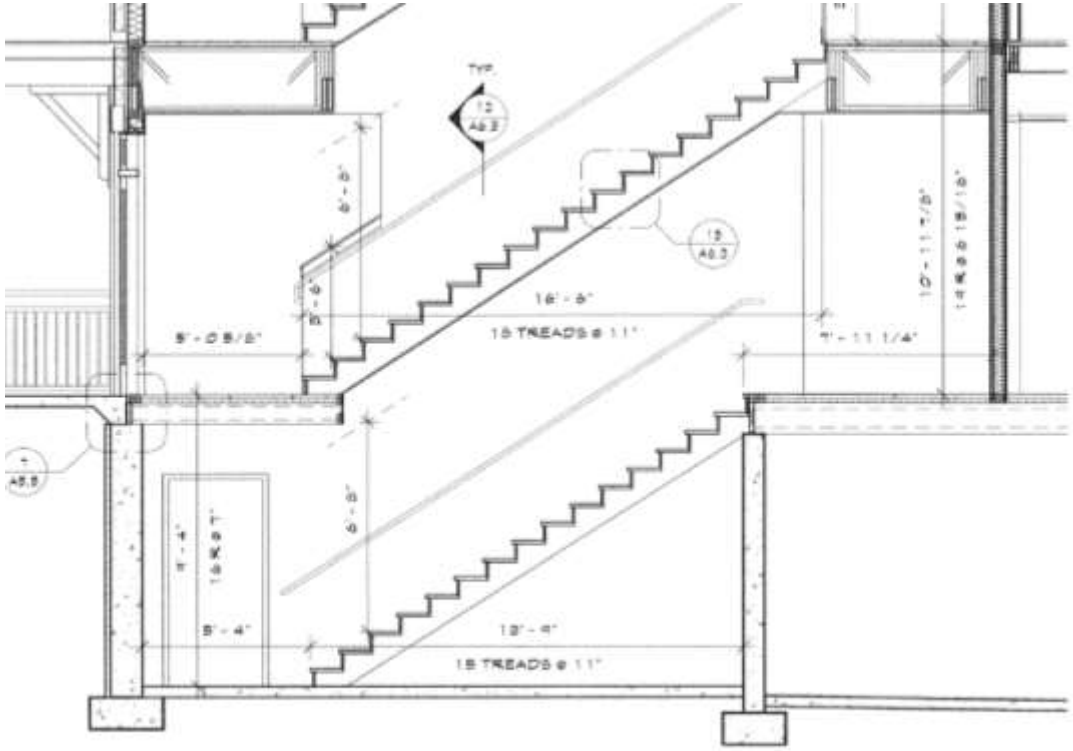
Seal conditioned stairwell to underground parking connection



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Common Architectural Problem Areas

Overhangs

Columns

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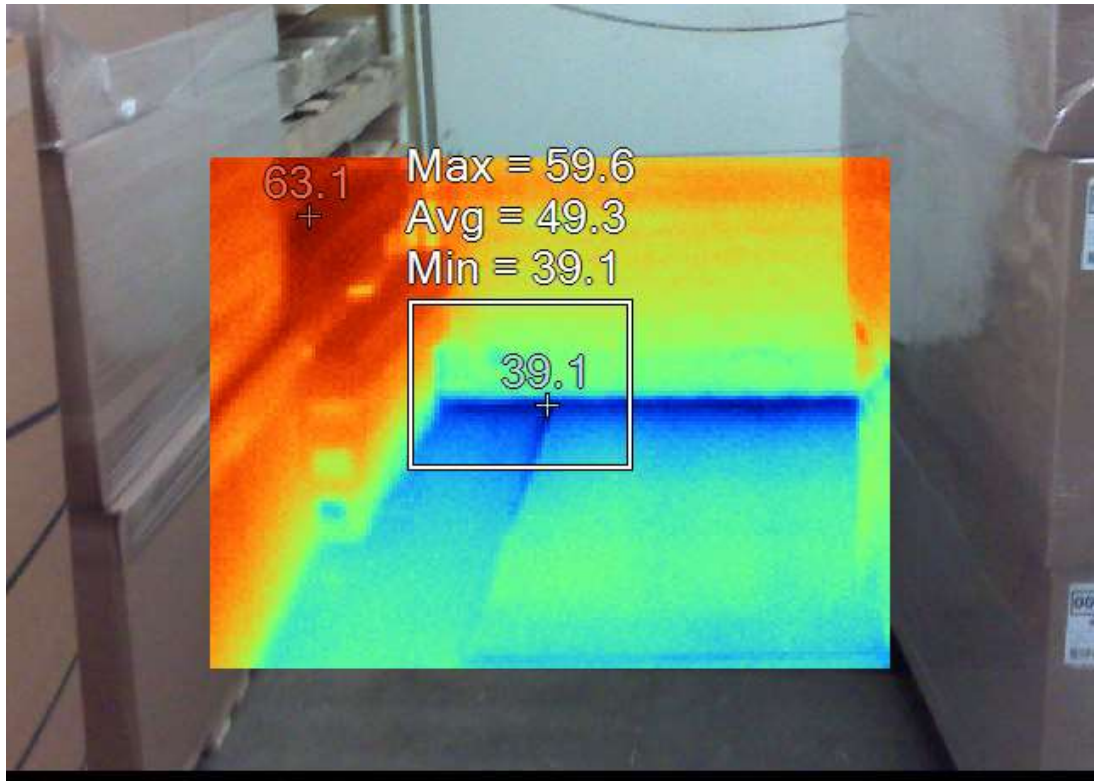
Overhead doors



- Consider spring loaded hinges and proper sweeps

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Fixture as viewed from attic

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Can you tell where the drop ceiling is?

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They covered the spauling brick with a sign

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That is not an air barrier- Too many schools

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Again! So many different building types

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That’s an air barrier!

- Planned
- Detailed
- Proper layering
- Interim inspections
- Collaborative efforts-

TEAM from day one

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