

abaa2025 building enclosure conference

Current and Future Energy Codes- Impacts on the Design, Construction, and Testing of Air Barriers

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BPL Enclosure

AIA
Continuing
Education
Provider



Current and Future Energy Codes- Impacts on the Design, Construction, and Testing of Air Barriers

This presentation provides a comprehensive exploration of air tightness by tracing its theoretical evolution and historical progression, examining the key metrics that define baseline performance levels.

Attendees will gain insights into the holistic phases of enclosure consulting with a focus on air barrier strategies, while also critically evaluating the wide range of air tightness codes and standards to understand their validity, impact, and relevance.



Lee Durston

Lee has been in the building enclosure industry since 2001. During this time, he has overseen and completed hundreds of projects in forensic, design, construction administration, construction observation, and quality control for new construction and rehabilitation projects related to several types of façade assemblies.



Learning Objectives

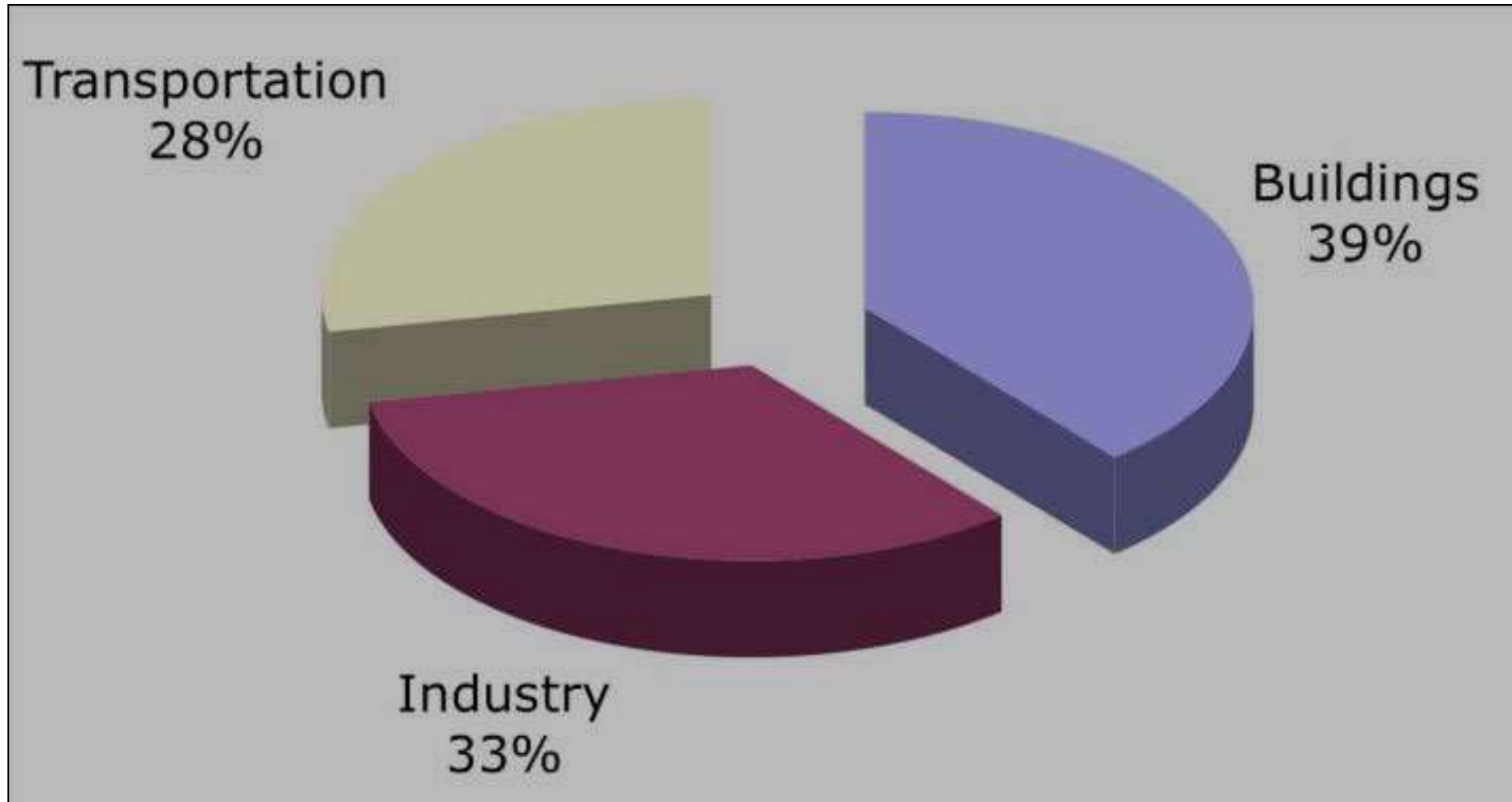
1. Review the theory and historical progression of air tightness requirements and understand the metrics that provide the baseline for levels of air tightness.
2. Understand what ASHRAE 90.1-2019 and IECC 2021 Air Leakage requirements are.
3. Understand the validity, impact, and relevance of the wide range of air-tightness codes and standards.
4. Understand whole building air leakage testing (WBALT) as compared to holistic enclosure consulting.

WHY AIR BARRIERS AND WHY NOW?

- Energy Conservation Measure
 - First Costs/Construction
 - Operational Costs
- Building Envelope Durability
 - H- Heat Barrier
 - A- Air Barrier
 - M_L- Moisture Liquid
 - M_V- Moisture Vapor

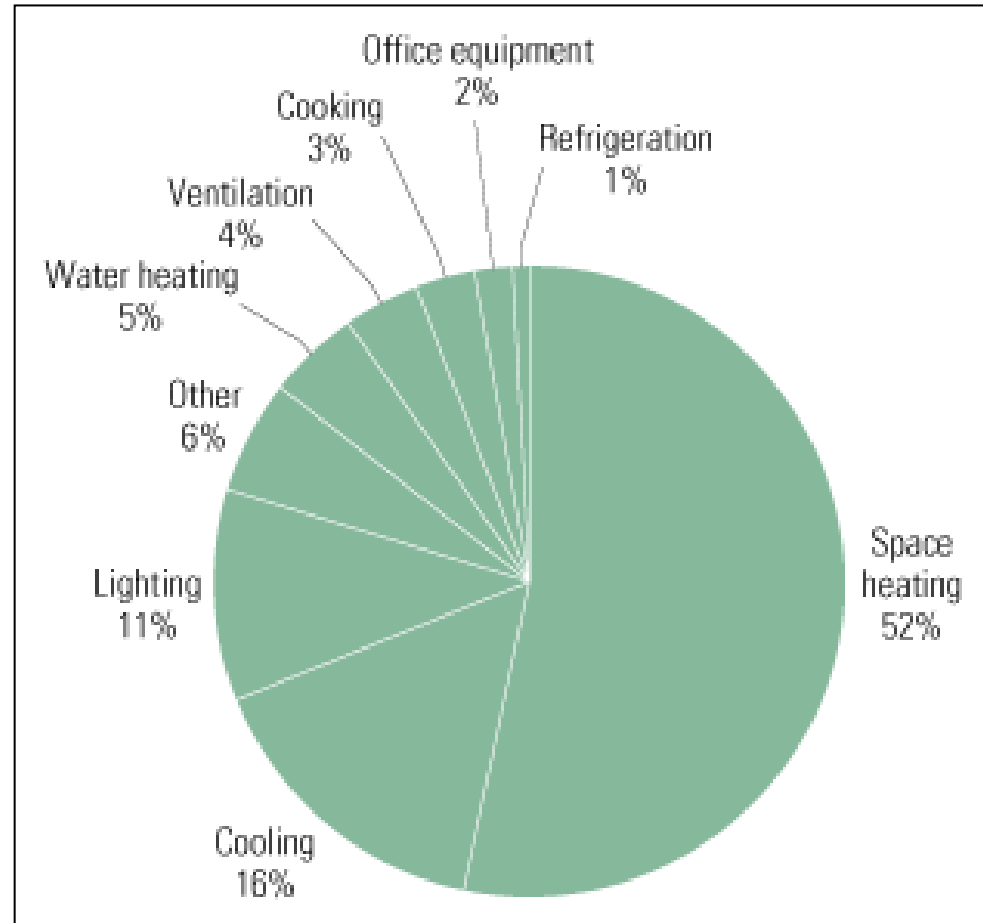


ENERGY



ENERGY

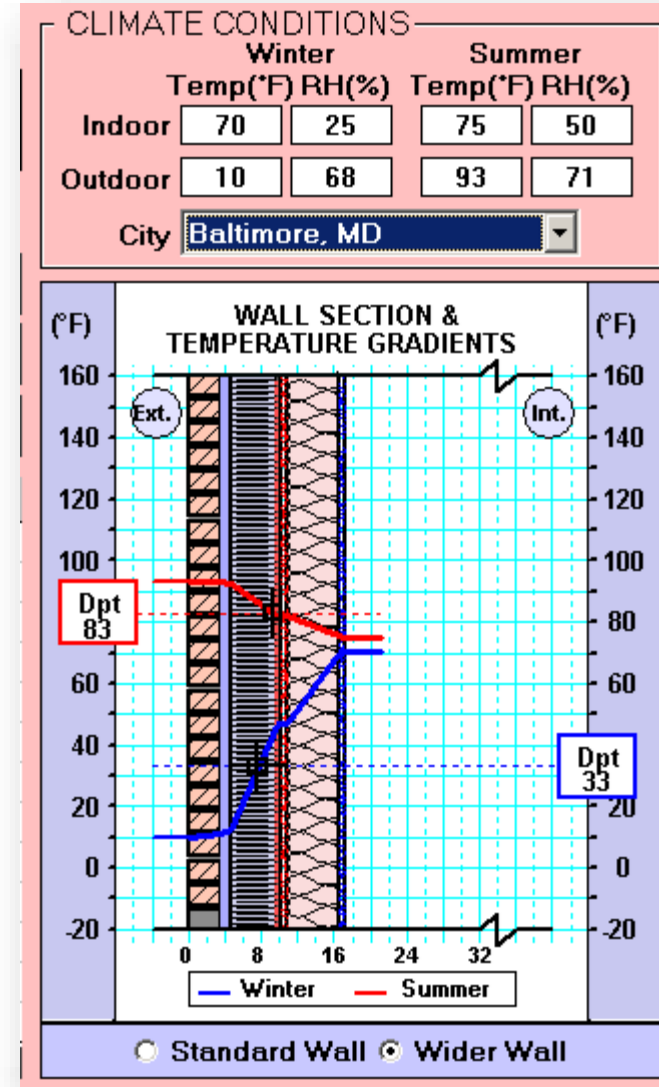
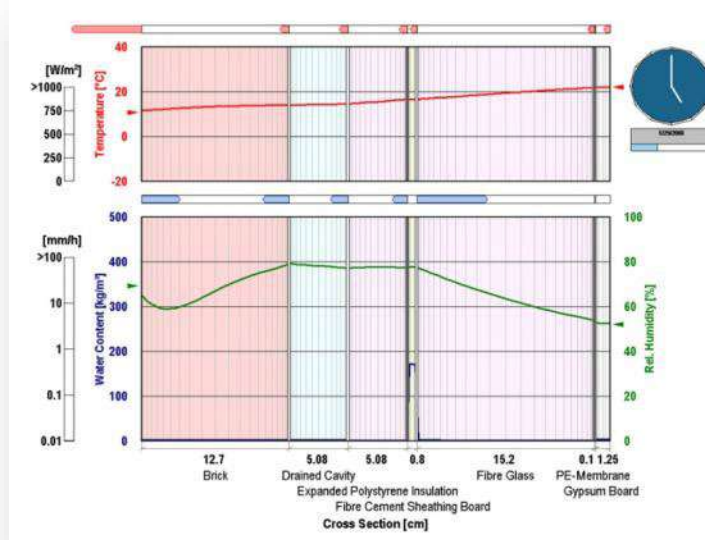
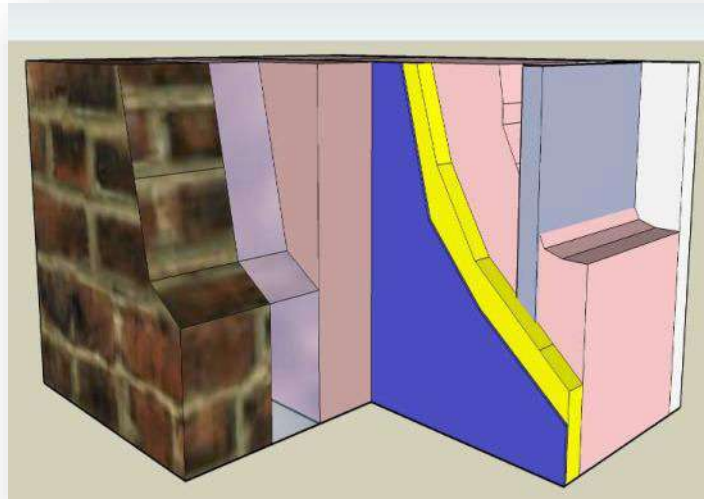
- Building Envelope (walls, roof, windows, and floors)
- Lighting
- Heating, Ventilating, and Air Conditioning (HVAC)
- Internal and Process Loads (cooking, hot water, manufacturing, etc.)



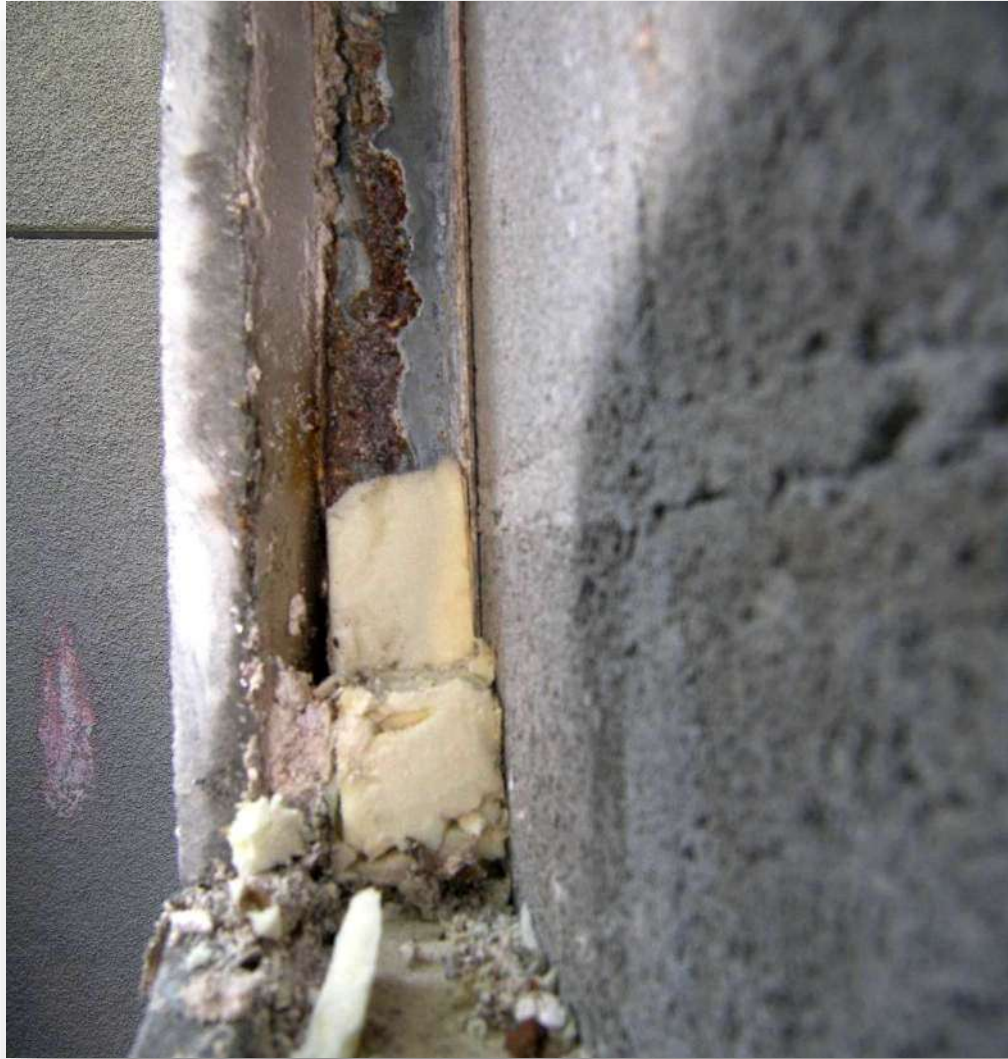
ENERGY



BUILDING ENCLOSURE DESIGN



DURABILITY



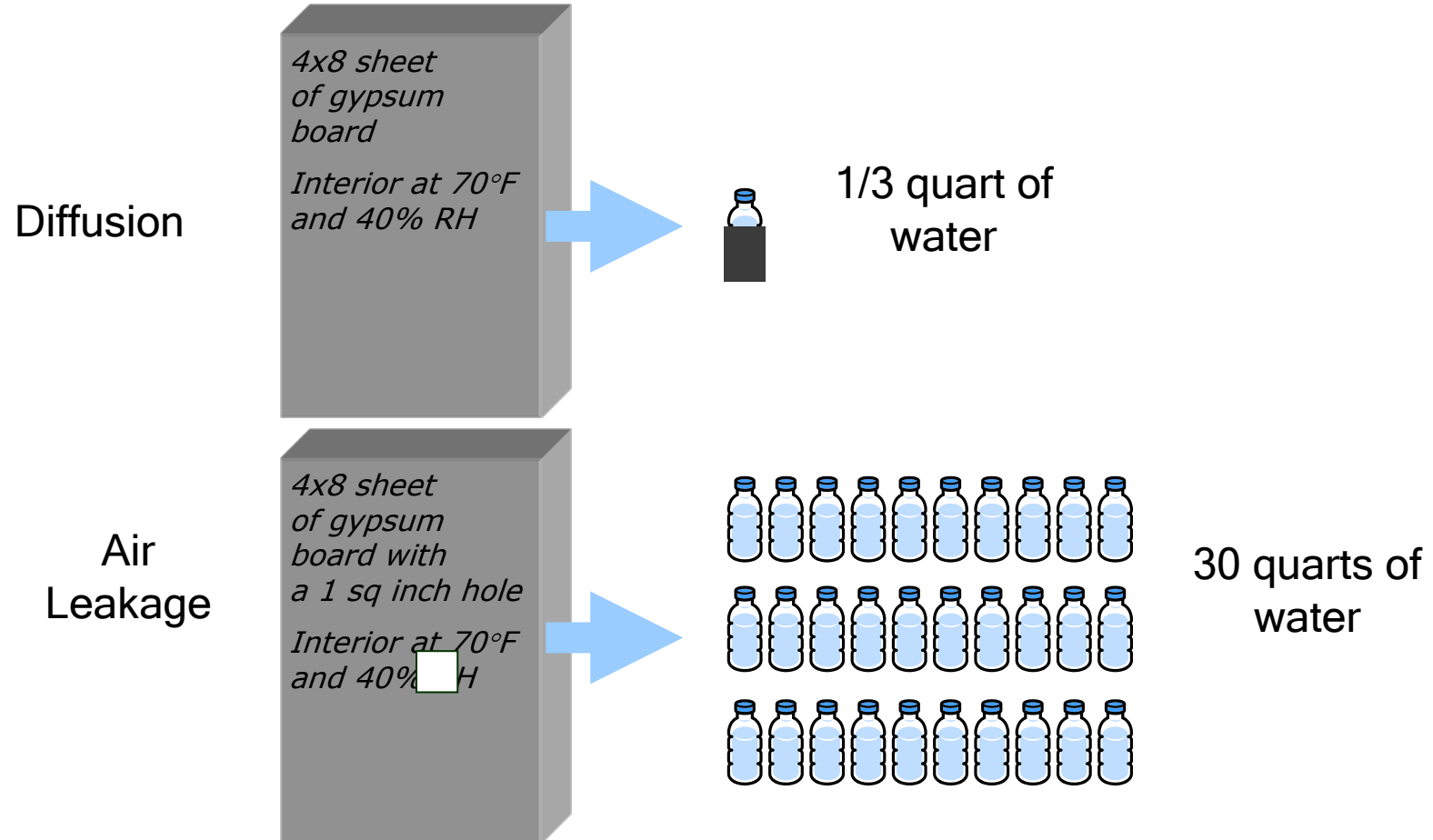
MOISTURE TRANSPORT- VAPOR DIFFUSION



MOISTURE TRANSPORT- AIR LEAKAGE



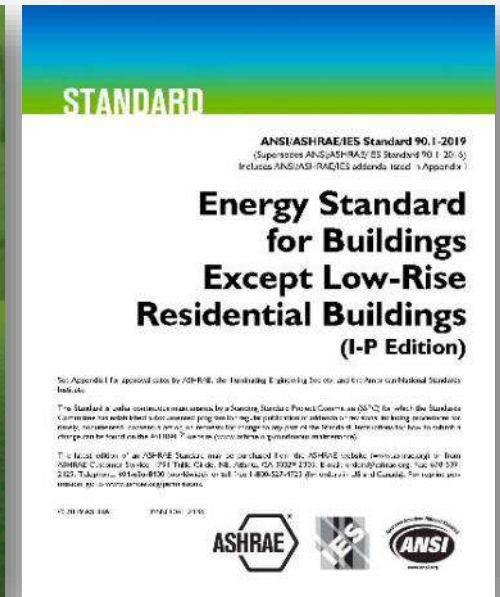
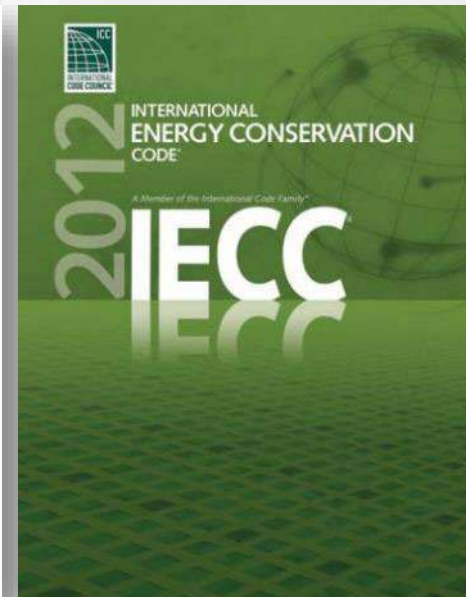
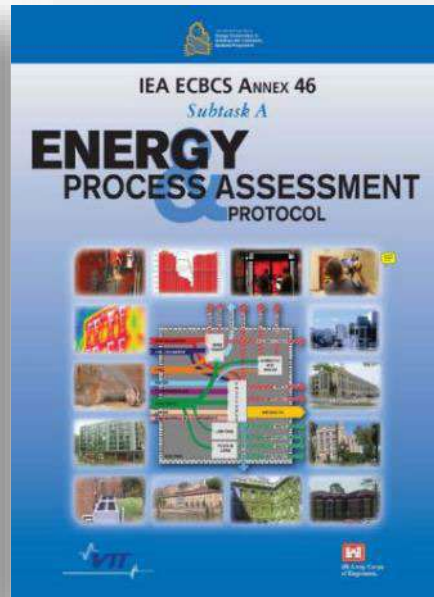
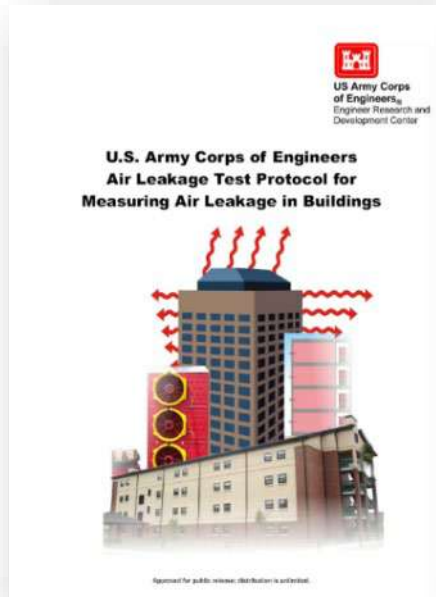
MOISTURE TRANSPORT



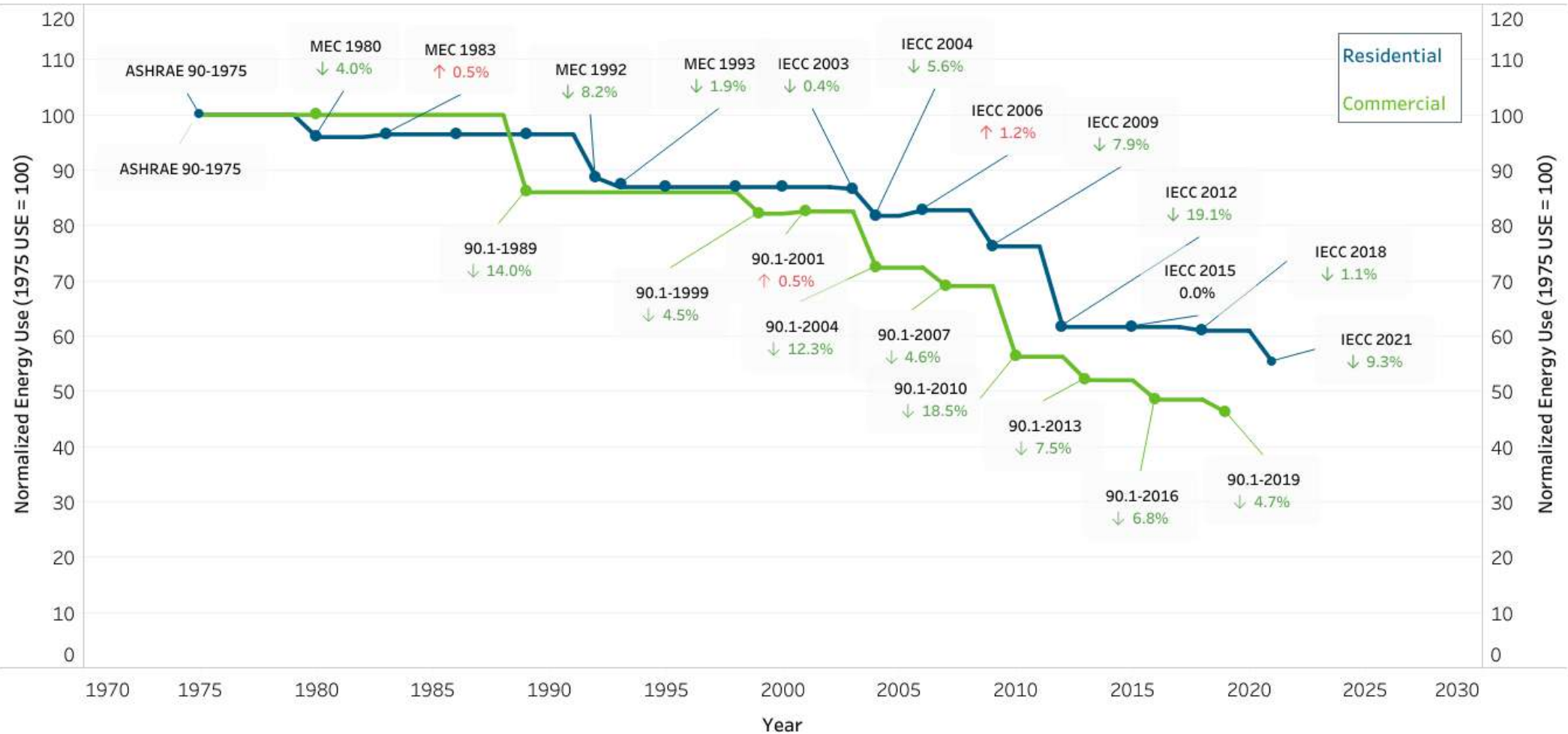
THE SILENT ISSUE



ENERGY TAKES THE FOREFRONT



Estimated Improvement in Residential & Commercial Energy Codes (1975 - 2021)



ENERGY TAKES THE FOREFRONT

- ASHRAE 90.1- 2019
- 5.4.3 Air Leakage

5.4.3 Air Leakage

Air leakage control for the *building envelope* shall comply with this section. Materials and assemblies that are part of the *continuous air barrier* and *fenestration* and *doors* shall comply with Section 5.8.3.

5.4.3.1 Continuous Air Barrier

The *exterior building envelope* and the *semiexterior building envelope* shall have a *continuous air barrier* complying with Sections 5.4.3.1.1 and 5.4.3.1.2.

Exceptions to 5.4.3.1

1. *Semiheated spaces* in Climate Zones 0 through 6, except as required to complete the *continuous air barrier* of an adjacent *conditioned space*.
 2. Single wythe concrete masonry *buildings* in Climate Zone 2B.
-

ASHRAE 90.1

Verification Requirements

- Whole Building Air Leakage Testing (WBALT)
 - ≤ 0.40 cfm/sf75 = PASS
 - >0.60 cfm/sf75 = FAIL
 - Fix Leaks and re-test (destructive)
 - $0.40 - 0.60$ cfm/sf75 = MARGINAL
 - use diagnostic methods to find and fix all leaks (non-destructive)

OR

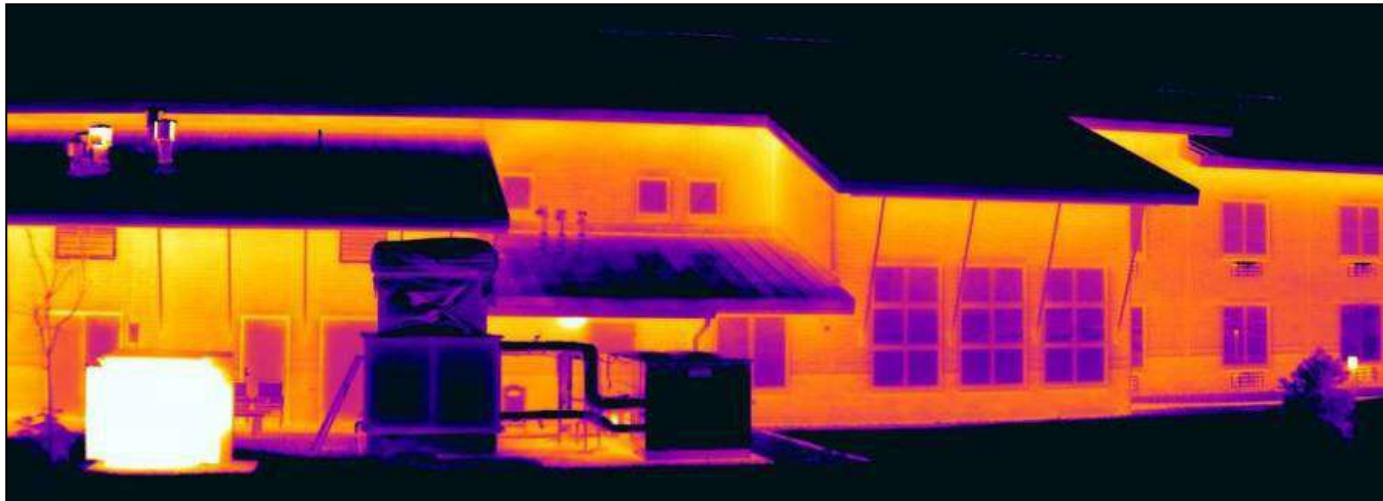
- Air Barrier Design & Installation Verification Program
 - Independent Third-Party
 - Design Review
 - Periodic Site Visits
 - Repair issues during construction
 - (This option is removed in future versions of ASHRAE 90.1)

5.4.3.1.1 - EXCEPTIONS

1. For *buildings* having over 50,000 ft² of *gross conditioned floor area*, air leakage testing shall be permitted to be conducted on less than the whole *building*, provided the following portions of the *building* are tested and their measured air leakage is area-weighted by the surface areas of the *building envelope*:
 - a. The entire *floor* area of all *stories* that have any *spaces* directly under a *roof*.
 - b. The entire *floor* area of all *stories* that have a *building entrance* or loading dock.
 - c. Representative *above-grade wall* sections of the *building* totaling at least 25% of the *wall* area enclosing the remaining *conditioned space*. Floor area tested per (a) and (b) shall not be included in the 25%.

5.4.3.1.1 - EXCEPTIONS

2. Where the measured air leakage rate exceeds 0.40 cfm/ft^2 but does not exceed 0.60 cfm/ft^2 , a diagnostic evaluation, such as a smoke tracer or infrared imaging shall be conducted while the *building* is pressurized, and any leaks noted shall be sealed if such sealing can be made without destruction of *existing building* components. In addition, a visual inspection of the air barrier shall be conducted, and any leaks noted shall be sealed if such sealing can be made without destruction of *existing building* components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the *code official* and the *building* owner and shall be deemed to satisfy the requirements of this section.



LOCATE / FIX / DOCUMENT



5.4.3.1.1 - EXCEPTIONS

3. *Continuous air barrier* design and installation verification program in accordance with Section 5.9.1.2.

5.9.1.2 Verification of the Design and Installation of the Continuous Air Barrier

Verification of the design and installation of the *continuous air barrier* shall be determined in accordance with the following by an independent third party when using Exception 3 of Section 5.4.3.1.1:

- a. A design review shall be conducted to verify and document compliance with the requirements in Sections 5.4.3 and 5.8.3.2.
- b. Periodic field inspection of the *continuous air barrier* materials and assemblies shall be conducted during *construction* while the *continuous air barrier* is still accessible for inspection and *repair* to verify and document compliance with the requirements of Sections 5.4.3.1.2 and 5.8.3.
- c. Reporting shall comply with Section 4.2.5.1.2.

5.4.3.1.2 CONTINUOUS AIR BARRIER DESIGN AND INSTALLATION

5.4.3.1.2 Continuous Air Barrier Design and Installation

The *continuous air barrier* shall be designed and installed in the following manner:

- a. Components designed to provide the *continuous air barrier*, and the component's position within each of the *building envelope* assemblies, shall be clearly identified on *construction documents*.
- b. The joints, interconnections, and penetrations of the *continuous air barrier* components shall be detailed in the *construction documents*.
- c. The *continuous air barrier* shall extend over all surfaces of the *building envelope* and be identified in the *construction documents* to be continuous.
- d. The *continuous air barrier* shall be designed to resist positive and negative pressures from wind, stack effect, and mechanical *ventilation* and allow for anticipated movements.
- e. The following areas of the *continuous air barrier* in the *building envelope* shall be wrapped, sealed, caulked, gasketed, or taped in an approved manner to minimize air leakage:
 1. Joints around *fenestration* and *door* frames
 2. Junctions between *walls* and *floors*, between *walls* at *building* corners, and between *walls* and *roofs*
 3. Penetrations through the *continuous air barrier* in *building envelope roofs*, *walls*, and *floors*
 4. *Building* assemblies used as ducts or plenums
 5. Joints, seams, connections between planes, and other changes in *continuous air barrier* materials

ENERGY TAKES THE FOREFRONT

- Denver 2019
- IECC 2018
- Section C402.5 Air Leakage

Section C402.5 Air leakage—thermal envelope (Mandatory) is replaced as follows:

C402.5 Air leakage—thermal envelope (Mandatory). The *building thermal envelope* shall comply with Sections C402.5.1 through C402.5.8

Section C402.5.1 Air barriers and the exception is replaced as follows:

C402.5.1 Air barriers. A continuous *air barrier* shall be provided throughout the *building thermal envelope*. The continuous *air barrier* shall be located on the inside or outside of the *building thermal envelope*, located within the assemblies comprising the *building thermal envelope*, or any combination thereof. The *air barrier* shall comply with Sections C402.5.1.1, C402.5.1.2 and C402.5.1.3

2019 DENVER AMENDMENTS TO THE 2018 INTERNATIONAL ENERGY CONSERVATION CODE

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Exception: Heated spaces between slabs and dropped ceilings utilizing greater than 3.4 Btu/sq ft. but less than 12Btu/sq ft for space conditioning purposes may eliminate the *air barrier* at the plenum floor, and instead maintain air barrier continuity across the slab following C402.5.1.1. The slab must have minimum R-5 insulation and the plenum floor must have minimum R-19 insulation. Flexible batt insulation shall be supported in a permanent manner by supports no greater than 24 in. on center.

ENERGY TAKES THE FOREFRONT

- Denver 2019
- IECC 2018
- Section C402.5 Air Leakage

Section C402.5.1.2 Air barrier compliance options is replaced as follows:

C402.5.1.2 Air barrier compliance options. A continuous *air barrier* for the opaque *building envelope* shall comply with the following:

All *buildings* or portions of *buildings* shall meet the provisions of Section C402.5.1.2.1 or C402.5.1.2.2, and C402.5.1.2.3. *Buildings* or portions of *buildings* of other than Group I occupancy shall also meet the provisions of Section C402.5.1.2.3. **Section C402.5.1.2.3 Building thermal envelope performance verification is added as follows:**

Section C402.5.1.2.3 Building thermal envelope performance verification. The installation of the continuous *air barrier* shall be verified by a *registered design professional* or *approved agency* in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Sections C402.5.1. A verification report shall be completed by the *registered design professional* or *approved agency* and included in the Energy Compliance Package submitted with the permit application.
2. Inspection of continuous *air barrier* components and assemblies shall be conducted during construction while the *air barrier* is still accessible for inspection and repair to verify compliance with the requirements of Sections C402.5.1.1 and C402.5.1.2. A preliminary commissioning report shall be completed by the *registered design professional* or *approved agency* and provided to the *building owner* or owner's authorized agent and the *code official*.
3. A final commissioning report shall be completed by the *registered design professional* or *approved agency* and provided to the *building owner* or owner's authorized agent and the *code official*. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures used.

Exception: 10% of the air barrier may be unverified as long as the required 0.40 CFM/ft² air leakage metric has been met in accordance with C402.5.1.3. For buildings not required to test for air leakage, full air barrier verification is required.

ENERGY TAKES THE FOREFRONT

- Denver 2019
- IECC 2018
- Section C402.5 Air Leakage

Section C402.5.1.3 Building thermal envelope testing and subsection is added as follows:

C402.5.1.3 Building thermal envelope testing. The *building thermal envelope* shall be tested in accordance with ASTM E 779 or an equivalent method *approved by the code official*.

Exception: Testing shall not be required to include all portions of the *building thermal envelope* where the following portions of the building are tested and the measured air leakage is area-weighted by the surface area of the *building thermal envelope* in each portion:

1. The entire envelope area of all stories that have any spaces directly under a roof,
2. The entire envelope area of all stories that have a *building entrance*, exposed floor, loading dock, or are below grade, and
3. Representative above-grade sections of the *building* totaling at least 25 percent of the wall area enclosing the remaining *conditioned space*.

2019 DENVER AMENDMENTS TO THE 2018 INTERNATIONAL ENERGY CONSERVATION CODE

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C402.5.1.3.1 Building thermal envelope corrective measures. Where the measured air leakage rate exceeds 0.40 cfm/ft² (2.0 L/s · m²) a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the *air barrier*. Any leaks noted shall be sealed where such sealing can be made without destruction of existing *building* components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the *code official* and the *building owner*.

Section C402.5.3 Rooms with fuel-burning appliances is replaced in its entirety as follows (remainder of section unchanged):

C402.5.3 Rooms with fuel-burning appliances. In Climate Zones 3 through 8, where combustion air is supplied through openings in an exterior wall to a room or space containing space conditioning or service water heating fuel-burning appliances, one of the following shall apply:

ENERGY TAKES THE FOREFRONT

- Denver 2019
- IECC 2018
- Section C402.5 Air Leakage
- Requires testing to a 0.30cfm/sf @0.3"w.c.

Section C402.5 Air leakage—thermal envelope is replaced as follows (other subsections remain unchanged, unless noted otherwise):

C402.5 Air leakage—thermal envelope. The *building thermal envelope* shall comply with Sections C402.5.1 through C402.5.11.1 and shall be tested in accordance with Section C402.5.2 for occupancy types R or I, or Section C402.5.3 for all other occupancy types.

Section C402.5.1.5 Building envelope performance verification is modified as follows (Item 3 remains without modification):

C402.5.1.5 Building envelope performance verification. The installation of the continuous air barrier shall be verified by a *registered design professional or approved agency* in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with requirements in Section C402.5.1. A verification report shall be completed by the *registered design professional or approved agency* and included in the submittal with the permit application.
2. Inspection of continuous air barrier components and assemblies shall be conducted during construction while the air barrier is still accessible for inspection and repair to verify compliance with the requirements of Sections C402.5.2 and C402.5.3.

DEBUNKING THE MYTH AND SETTING GOALS

- In 1998 a NIST study and paper showed commercial buildings were not the air tightness champions they were thought to be..... (Persily 1998)
- In 2005 a NIST study and paper was released that concluded that a potential of 40% reduction in energy use could be achieved with a focus on air-tightness in buildings.... (Emmerich, Anis 2005)



IS IT LEGITIMATE?



green·wash

/ˈgrēn,wôSH,ˈgrēn,wäSH/

noun

misleading or deceptive publicity disseminated by an organization so as to present an environmentally responsible public image.

"the recycling bins in the cafeteria are just feeble examples of their corporate greenwash"

STOP THE GREENWASH!

MailOnline

Airline asks passengers to use the toilet before boarding... so they will weigh less and help cut carbon emissions

- ▶ A Japanese airline has started asking passengers to go to the toilet before boarding in a bid to reduce carbon emissions.
- ▶ Nippon Airways (ANA) claims that empty bladders mean lighter passengers, a lighter aircraft and thus lower fuel use.
- ▶ ANA hopes the weight saved will lead to a five-tonne reduction in carbon emissions over the course of 30 days.



STOP THE GREENWASH!



CITY HALL ENERGY USAGE

Seattle's new City Hall is using more electricity than the larger building it replaced.

● NEW BUILDING ● OLD BUILDING

Average kilowatt-hours
per day

7,045

5,940

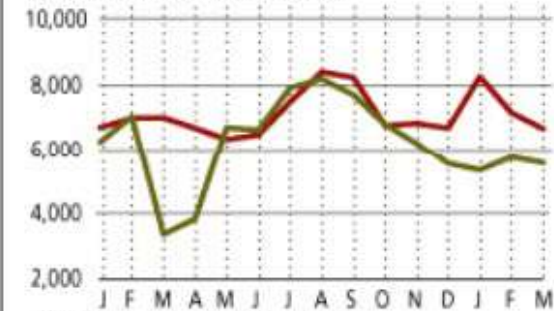
Average kilowatt-hours
per year

2,571,551

2,167,964

Month-by-month comparison*

Average kilowatt-hours per day



*Old building: Jan. 2002-March 2003
New building: Jan. 2004-March 2005

Source: Seattle City Light

SEATTLE POST-INTELLIGENCER

STOP THE GREENWASH!




STOP THE GREENWASH!



STOP THE GREENWASH!



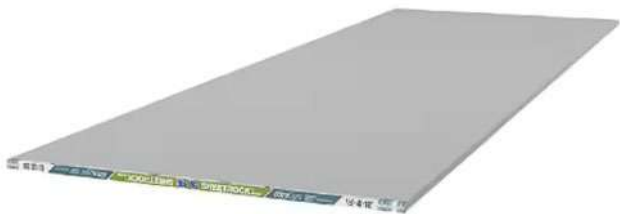
A LOOK AT REQUIREMENTS GLOBALLY

cfm/ ft² [L/s*m²] at 75Pa			
US	ASHRAE 189.1/90.1	0.40 cfm/ft² at 75Pa	0.40/2.02
US	LEED	1.25 in² EfLA @ 4 Pa / 100 ft²	0.30/1.52
US	ASHRAE HOF <i>average</i> handbook of fundamentals	0.30 cfm/ft² at 75Pa	0.30/1.52 Leakier
			
	U.S. DoD Standard	0.25 cfm/ ft² at 75Pa	0.25/1.27
UK	TS-1 Commercial Tight	2 m³/h/m² at 50 Pa	0.14/0.71
CAN	R-2000	1 in² EqLA @10 Pa /100 ft²	0.13/0.66 Tighter
US	ASHRAE HOF <i>tight</i> handbook of fundamentals	0.10 cfm/ft² at 75Pa	0.10/0.51
For a 4 story building, 120 x 110 ft, n=0.65			

 **Passive House 0.06 cfm/ft² at 75Pa**

AIR LEAKAGE BY THE NUMBERS

	ASHRAE 90.1 Append. Z (cfm/ft ² @ .3" w.c.)	US Army Corps Engineers	Canada NBC (L/(s*m ² @75Pa)
Material	0.004	0.004	0.02
Assembly	0.04	0.04	0.2
Building	0.4	0.25	2.0



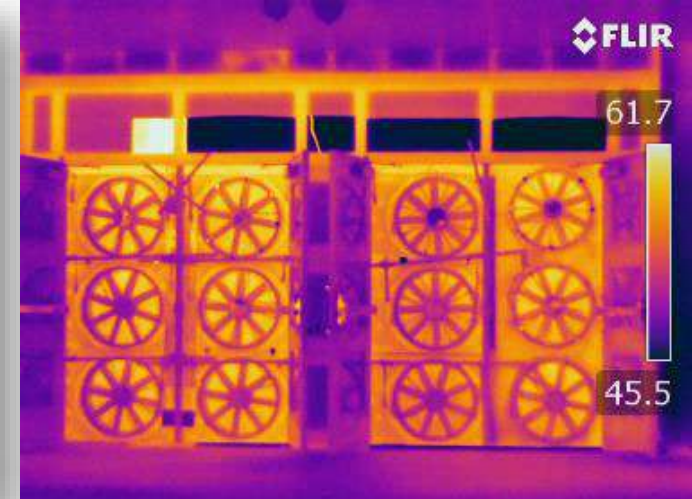
MATERIALS OR ASSEMBLIES OR WBALT



ASTM 2178



ASTM 2357



ASTM e779....ASTM 3158

Shouldn't it be and, and

HOW LEAKY ARE BUILDINGS...?

Example #1



Standard Commercial
Construction

Air Leakage Rate:

0.40 to 1.60 cfm/sf @
0.3" wg

**100,000sf of envelope =
40,000cfm to 160,000cfm**

HOW LEAKY ARE BUILDINGS...?

Example #2

Area of Exterior Envelope
220,000 sf

100,000 sf
Floor Area


220,000 sf x 0.06 cfm/sf = 13,200 cfm (Passive House)

220,000 sf x 0.25 cfm/sf = 55,000 cfm (US DoD)

220,000 sf x 0.4 cfm/sf = 88,000 cfm (ASHRAE)

220,000 sf x 1.0 cfm/sf = 220,000 cfm (Industry Current)

A LOOK AT REQUIREMENTS GLOBALLY

cfm/ ft² [L/s·m²] at 75Pa			
US	ASHRAE 189.1/90.1	0.40 cfm/ft² at 75Pa	0.40/2.02
US	LEED	1.25 in² EfLA @ 4 Pa / 100 ft²	0.30/1.52
US	ASHRAE HOF <i>average</i> handbook of fundamentals	0.30 cfm/ft² at 75Pa	0.30/1.52 Leakier
			
	U.S. DoD Standard	0.25 cfm/ ft² at 75Pa	0.25/1.27
UK	TS-1 Commercial Tight	2 m³/h/m² at 50 Pa	0.14/0.71
CAN	R-2000	1 in² EqLA @10 Pa /100 ft²	0.13/0.66 Tighter
US	ASHRAE HOF <i>tight</i> handbook of fundamentals	0.10 cfm/ft² at 75Pa	0.10/0.51
For a 4 story building, 120 x 110 ft, n=0.65			

 **Passive House 0.06 cfm/ft² at 75Pa**

6 STEPS TO QUALITY AIR BARRIER SYSTEMS

1. System Design/Selection
2. Independent Technical Review
3. Subcontractor Qualifications
4. Mock-Up
5. Managing Work Sequence
6. Independent Audits

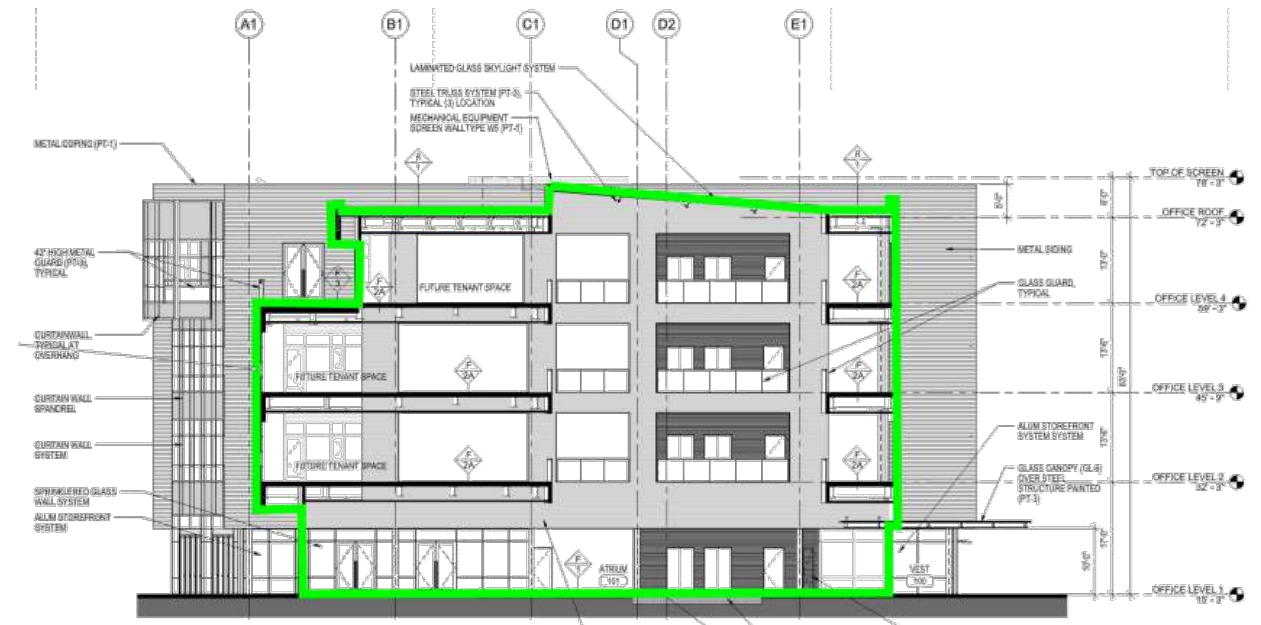


SYSTEM DESIGN AND SELECTION



INDEPENDENT TECHNICAL REVIEWS

- Is The System Design Complete...?
- Will It Deliver The Required Airtightness...?
- Is System Detailed Correctly...?
- Are There Compatibility Problems...?
- Is There A Simpler/Cheaper System...?



SUBCONTRACTOR QUALIFICATIONS

- Training
- Experience
- Manufacturer Approval/Certification
- ABAA Certification



MOCK-UP

- Allows Early Coordination
- Confirms Sequence Of Construction
- Establishes Standard Of Quality
- Identifies Possible Efficiencies
- Identifies If You Are In Trouble.....



MANAGING THE WORK SEQUENCE

- Acceptable substrate
- Weather considerations
- Sequencing system interfaces
- Trade damage
- Coordination with work by other trades



INDEPENDENT AUDITS

- ABAA quality assurance program
- Enclosure Consultant
- Pre-installation meeting
- Review mock-up
- Review installation in progress
- Testing



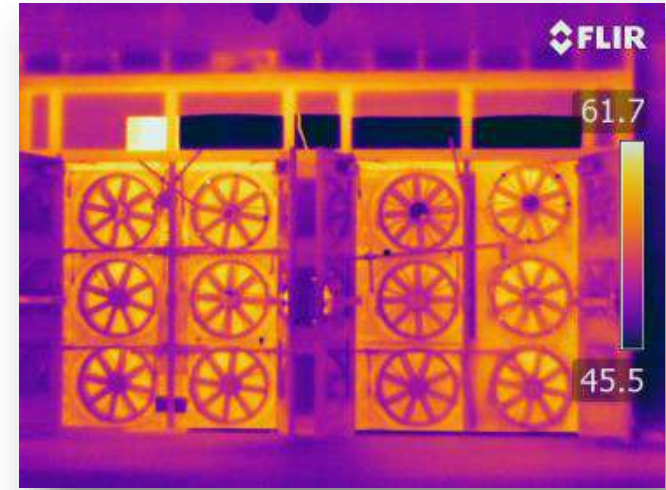
SPECIFYING TESTING

- Location in the Specifications
- Test Method
- Leakage Rate
- Who pays for the testing? Owner?
- What is the impact of failing the test? Contractor pays?
- What measures should be considered to minimize risk of failure?



TESTING AGENCY VERSUS ENCLOSURE CONSULTANT

- Testing Agency
 - Just the testing for code compliance
 - No assistance with diagnosing reason for failure
 - No assistance with recommending how to air seal
- Enclosure Consultant
 - Pre-test assistance
 - Understanding of air barrier systems
 - Recommendations for how to air seal if failure



PERFORMANCE VERIFICATION

- ASHRAE 90.1 2019 = not to exceed 0.40 cfm/sf @ 75 Pa
- IECC 2019= not to exceed 0.40 cfm/sf @ 75 Pa
- IECC 2021= not to exceed 0.30 cfm/sf @ 75 Pa
- USACE = not to exceed 0.25 cfm/sf @ 75 Pa
- LEED-H= not to exceed 0.35 ACH @ 50 Pa
- Washington State Energy Code 0.30 cfm/sf @ 75Pa
- City of Fort Collins= not to exceed 0.25 cfm/sf @ 75 Pa
- Others

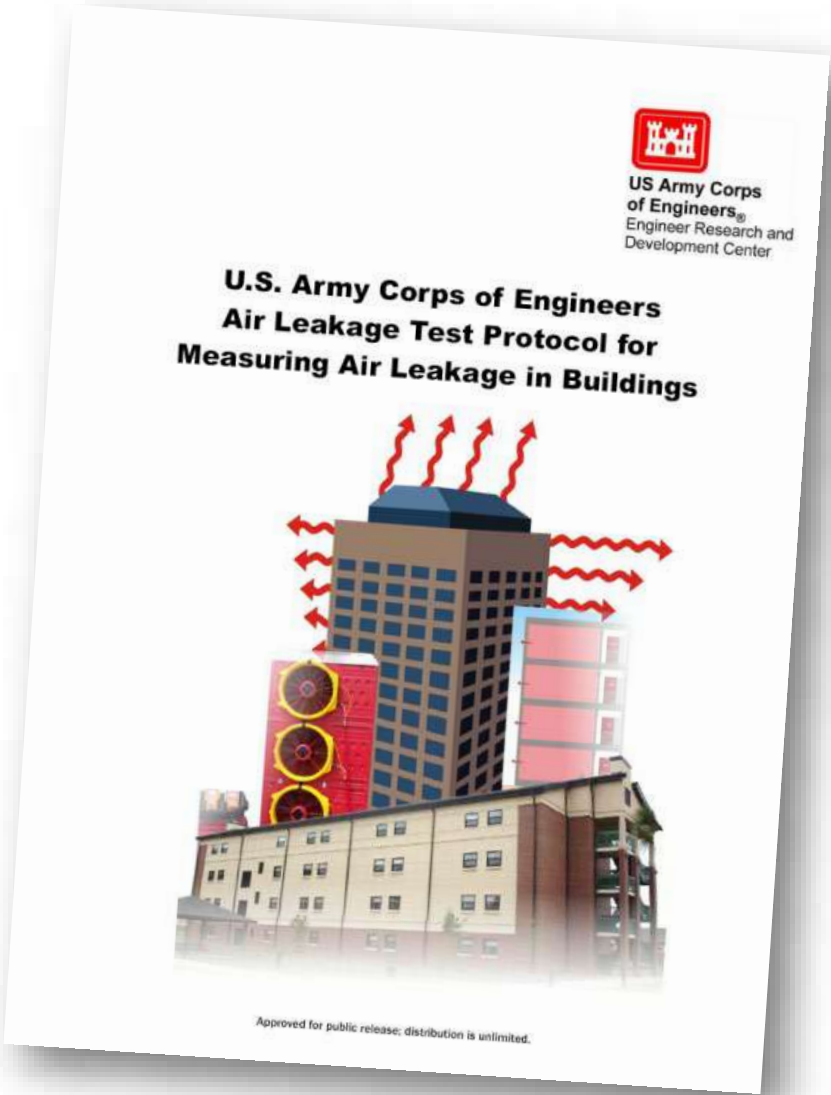


WE WERE WARNED.....

- 0.25 cfm/sf is not achievable
- There are too many building types for one standard
- An air tightness standard will limit construction type
- An air tightness standard will limit material type
- This is space-age technology that requires new materials
- Needed is an education and training process that will take years to usher in



SEND IT!



WBALT TESTING STUDY



US Army Corps
of Engineers®



- 208 DoD buildings
- Time range of 29 months
- 34 DoD installations
- All climate zones in the United States
- One to nine stories
- Building envelope areas ranging from 1,000 ft² to 370,000 ft²
- All building types



CASE STUDY – DETROIT ARSENAL BUILDING 270



DETROIT ARSENAL BLDG. 270



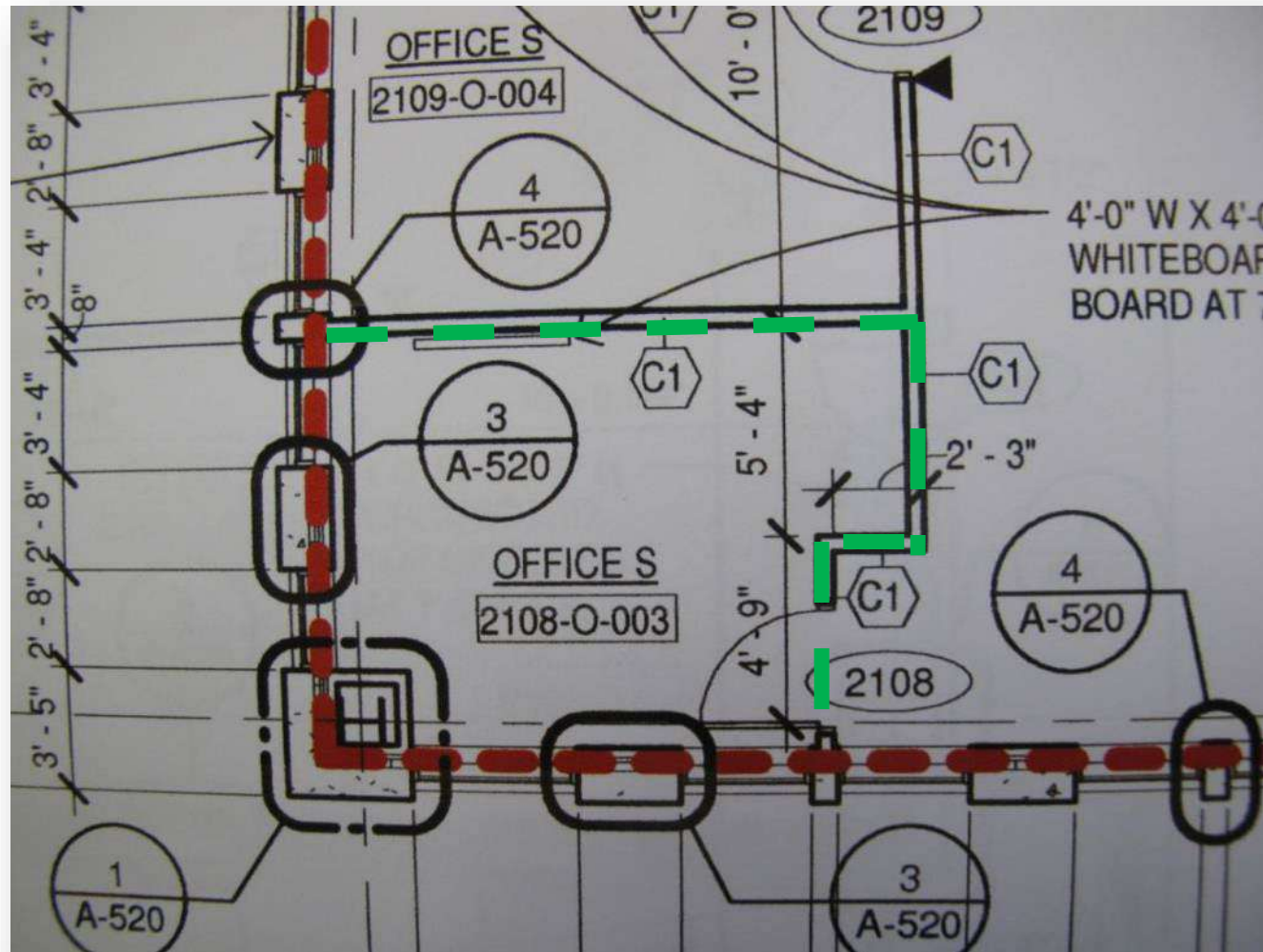
DETROIT ARSENAL BLDG. 270



DETROIT ARSENAL BLDG. 270



CONFIDENCE TEST/MOCK-UP



BUILDING PREP



TEST SET-UP



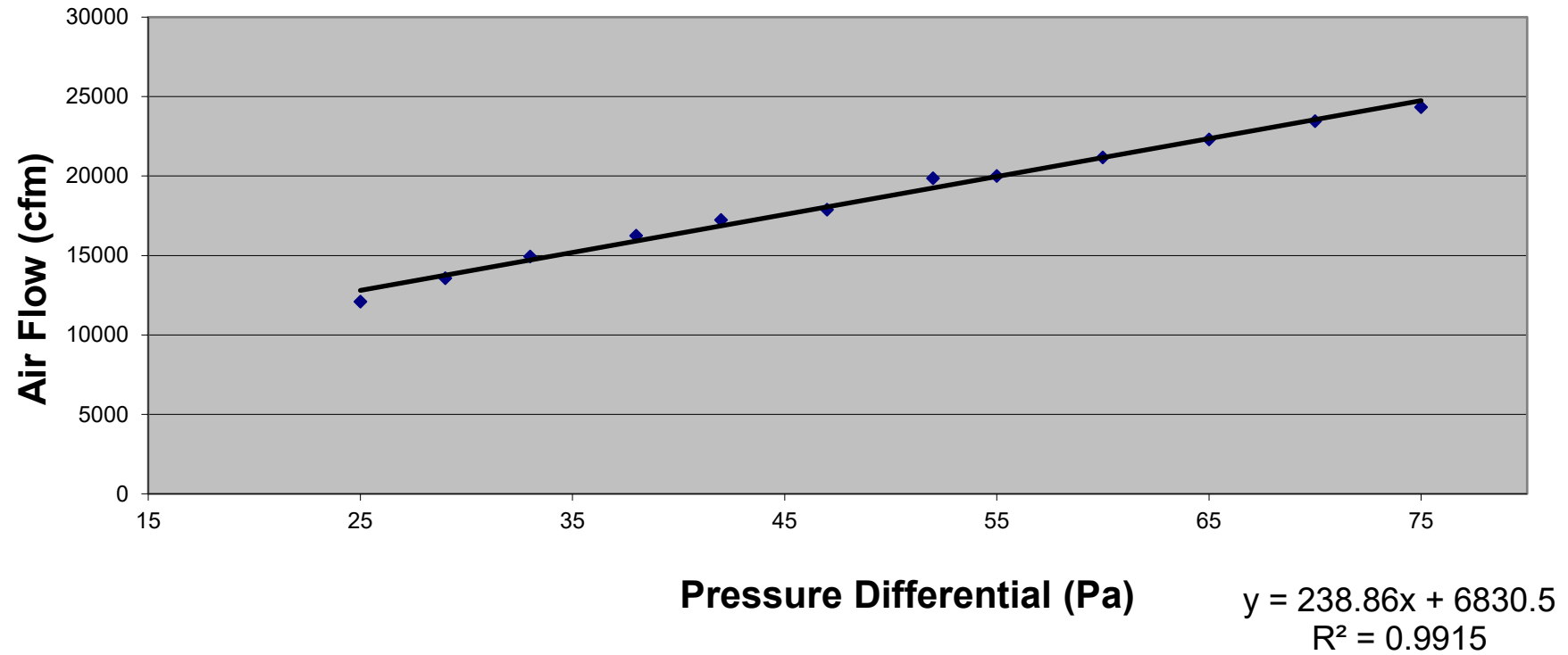
TEST SET-UP

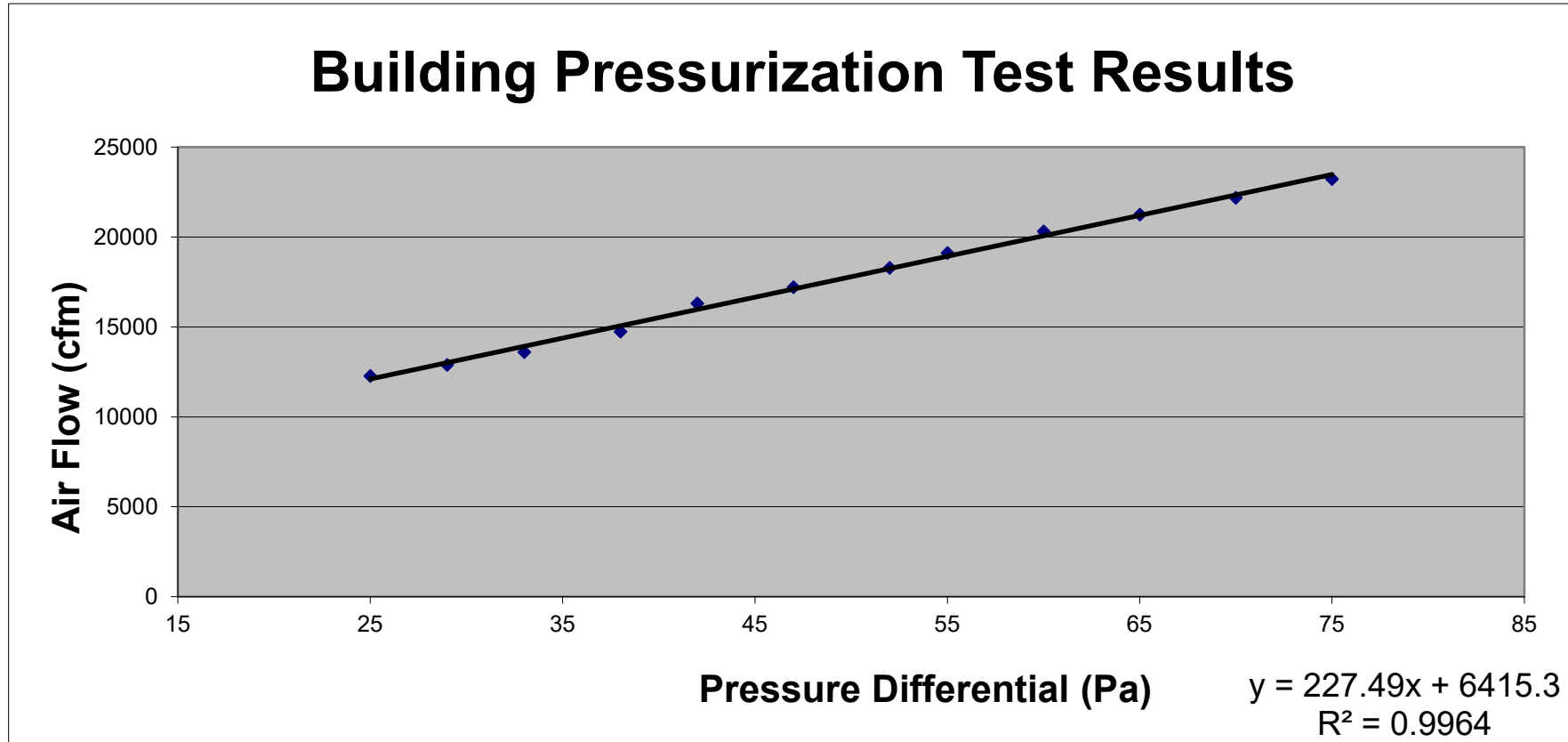


TARGET AIR LEAKAGE

USACE	cfm/sf@75Pa
<i>RFP Requirement</i>	<i>.25cfm/sf @75PA</i>
<i>Detroit Arsenal Bldg. 270</i>	<i>Envelope SF: 144,622</i>
<i>Allowable leakage rate</i>	<i>36155.5 cfm</i>

Depressurization Test Results

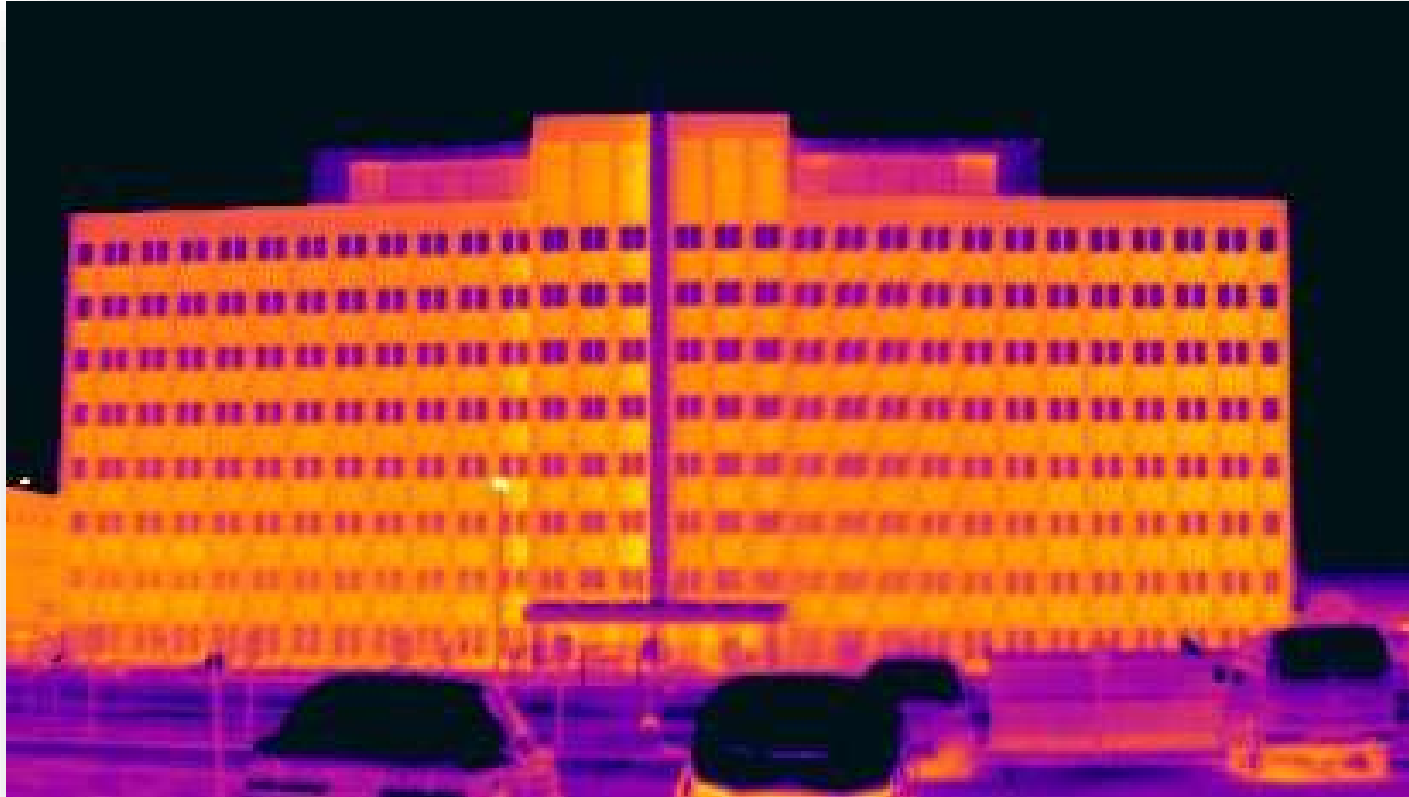




RESULTS

Depressurize	Pressurize
0.168	0.161
24,330 cfm/75	23,235 cfm/75
Average = 0.16	
- Data correlation > 99%	

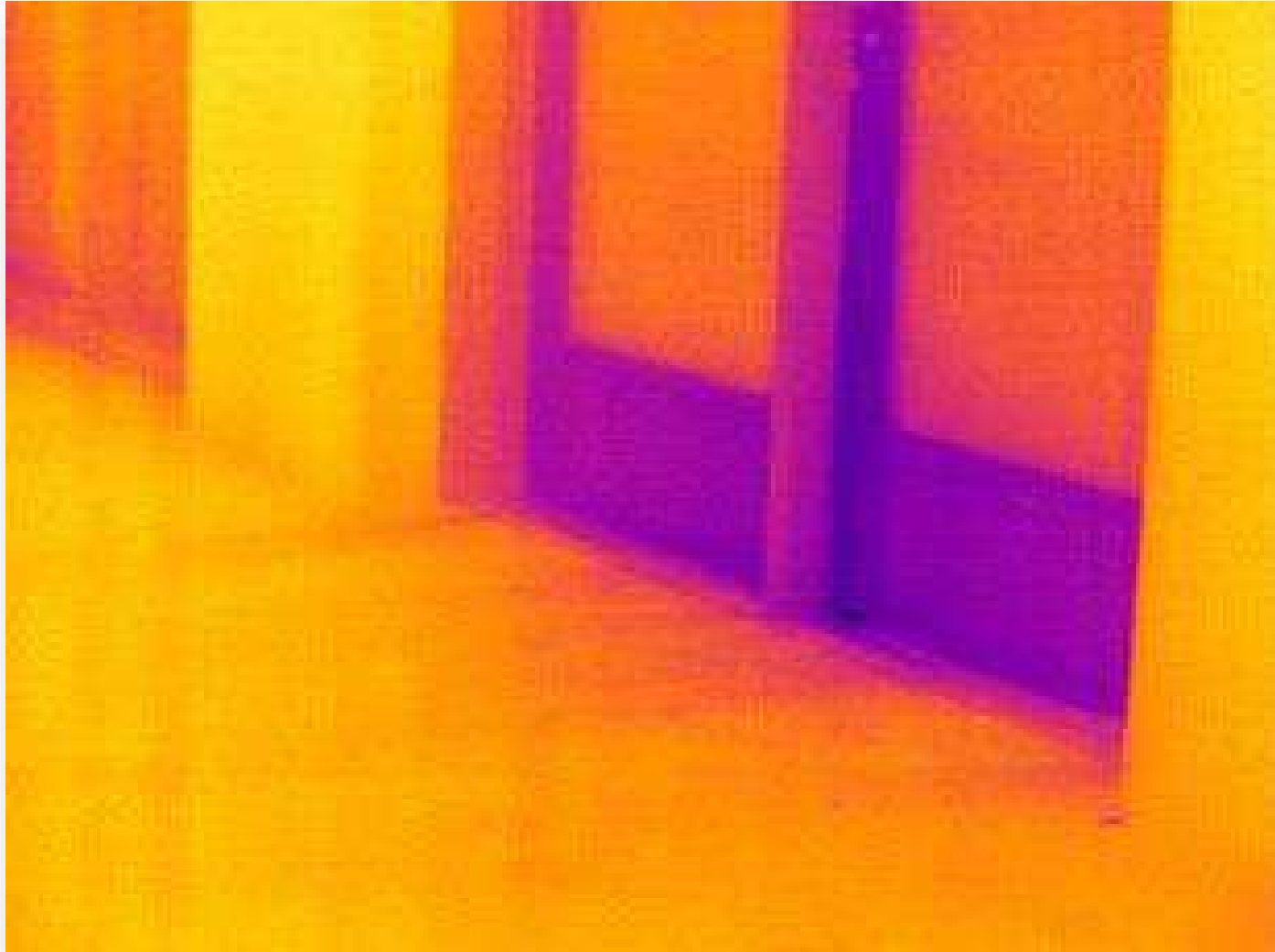
WHOLE BUILDING TEST



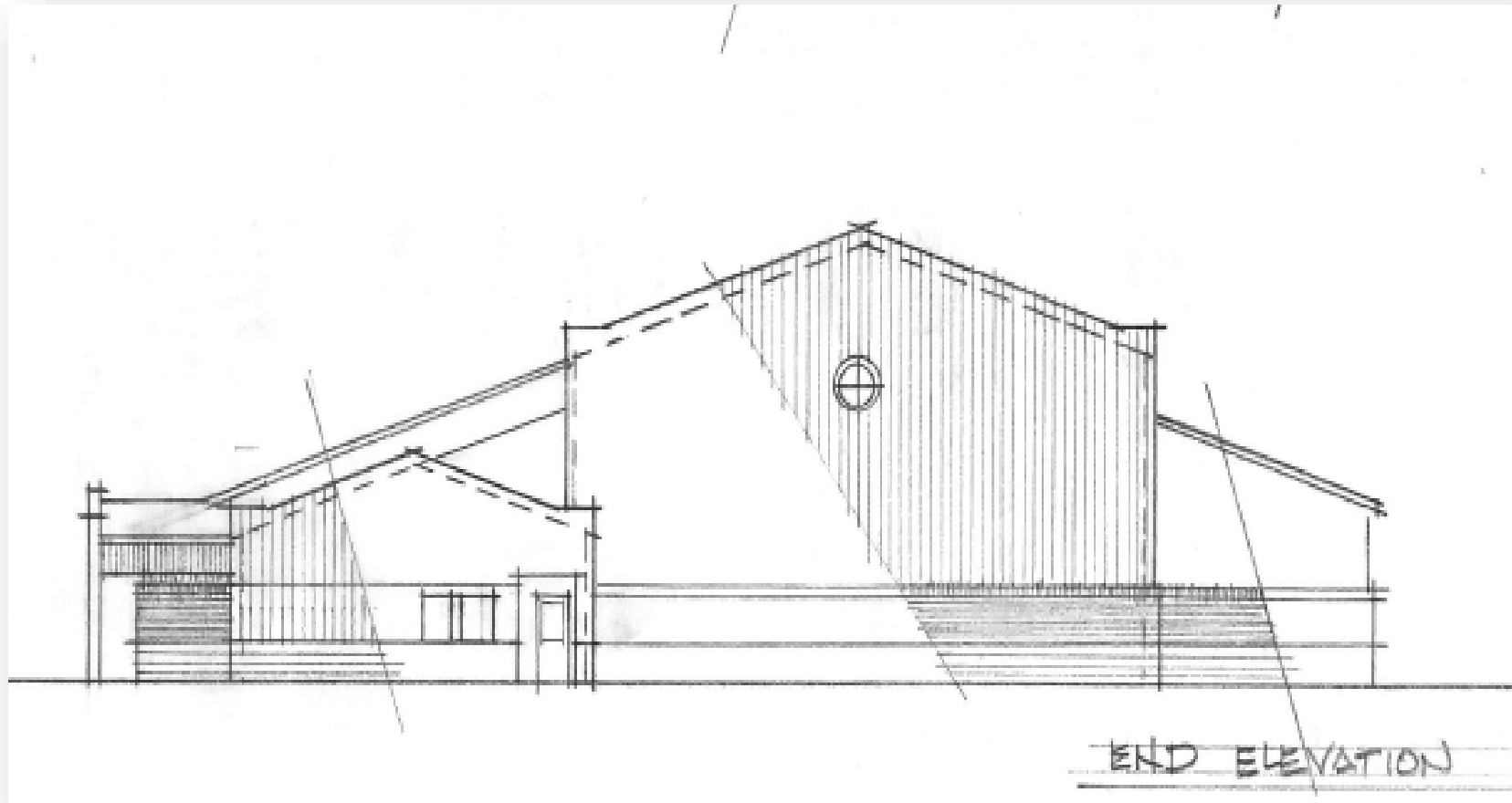
WHOLE BUILDING TEST



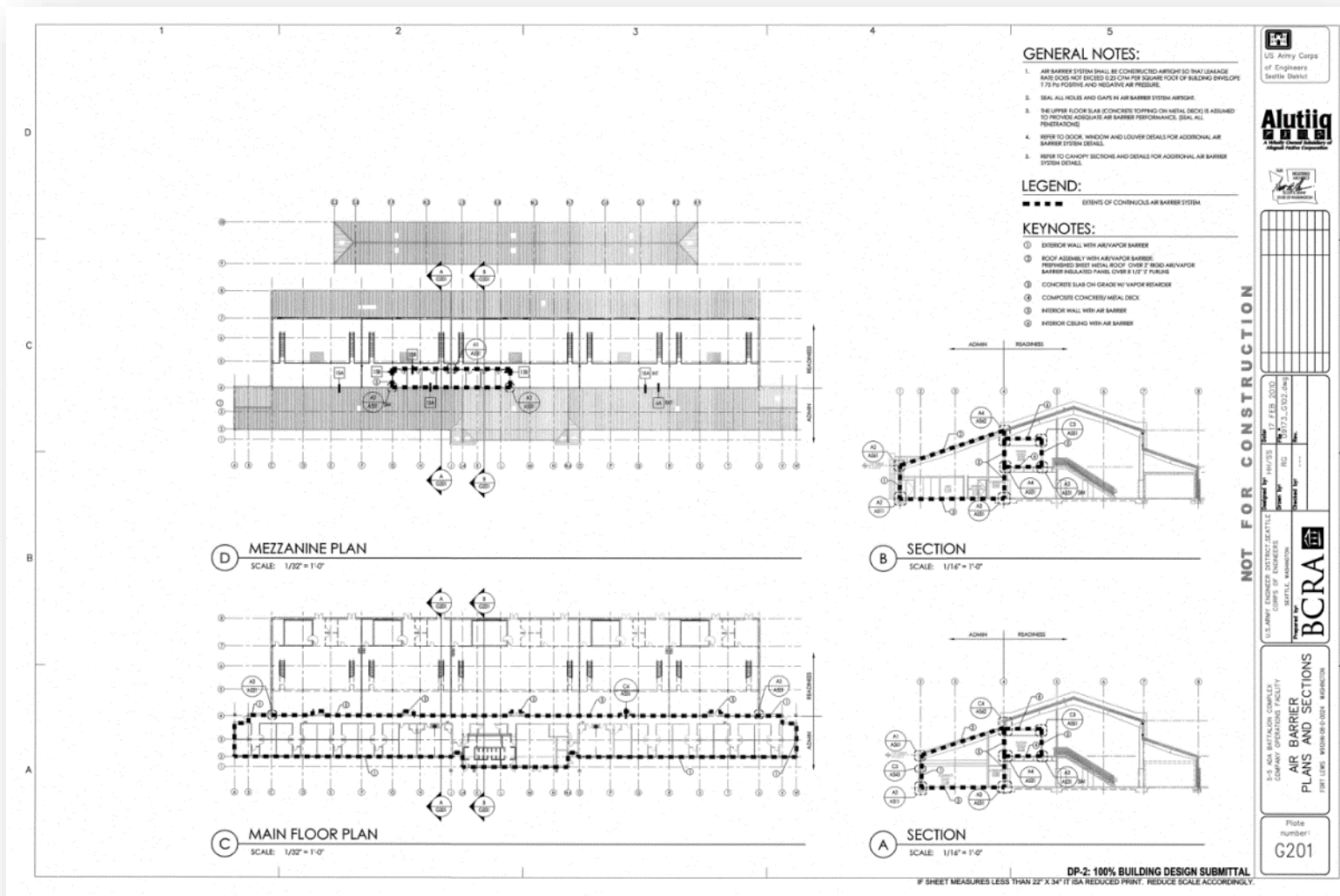
DEFINING PATHWAYS



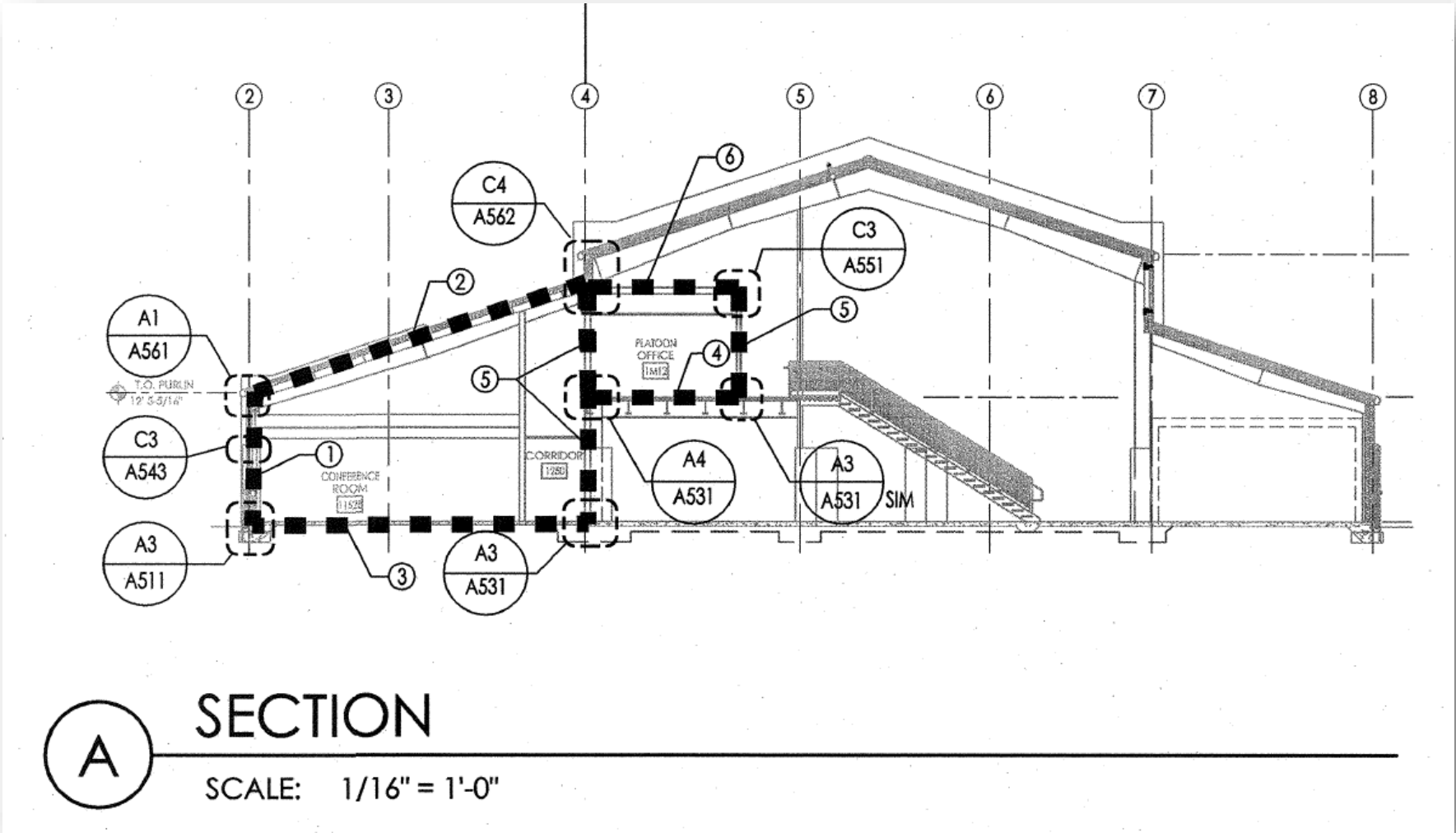
CASE STUDY – 5-5 ADA COF - JOINT BASE LEWIS-MCCHORD,WA



EXTENTS OF AIR BARRIER



EXTENTS OF AIR BARRIER



CONSTRUCTION



CONSTRUCTION



CONSTRUCTION



TARGET AIR LEAKAGE

USACE	cfm/sf@75Pa
RFP Requirement	.25cfm/sf @75PA
5-5 COF Admin Office Area	Envelope SF 51,352
Allowable leakage rate	12,838 cfm
5-5 ADA COF Mezzanine Office	Envelope SF 4,887
Allowable leakage rate	1222 cfm

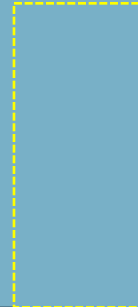
RESULTS

Admin Area	Mezzanine Offices
0.063	0.209
3,260 cfm/75	1,020 cfm/75

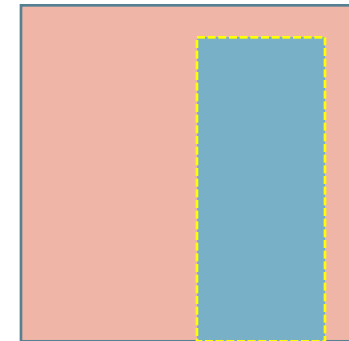
PROPORTION OF OPERATIONAL LEAKS

10,000 sf of envelope area
Allowable leakage = 2,500cfm
@75Pa

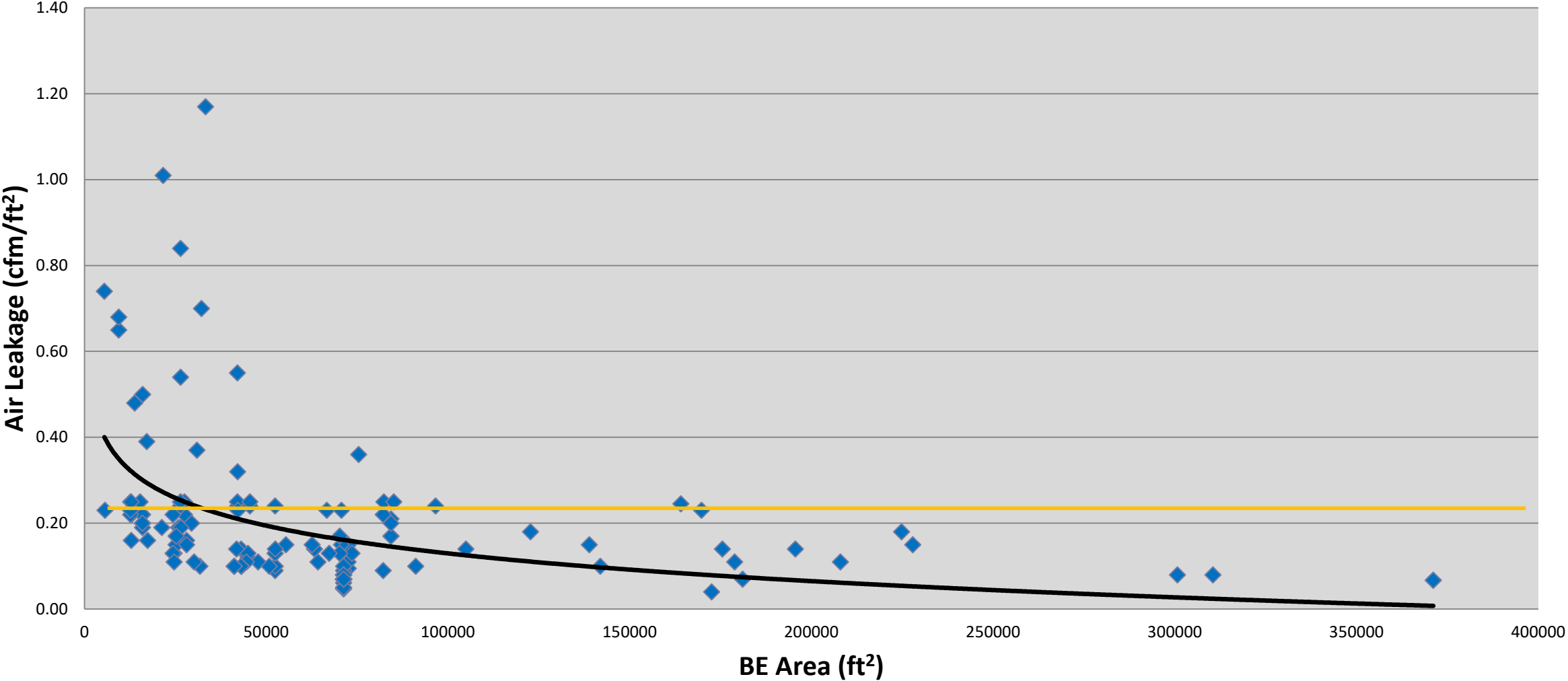
150cfm @ 75Pa



1,000 sf of envelope area
Allowable leakage =
250cfm @75Pa



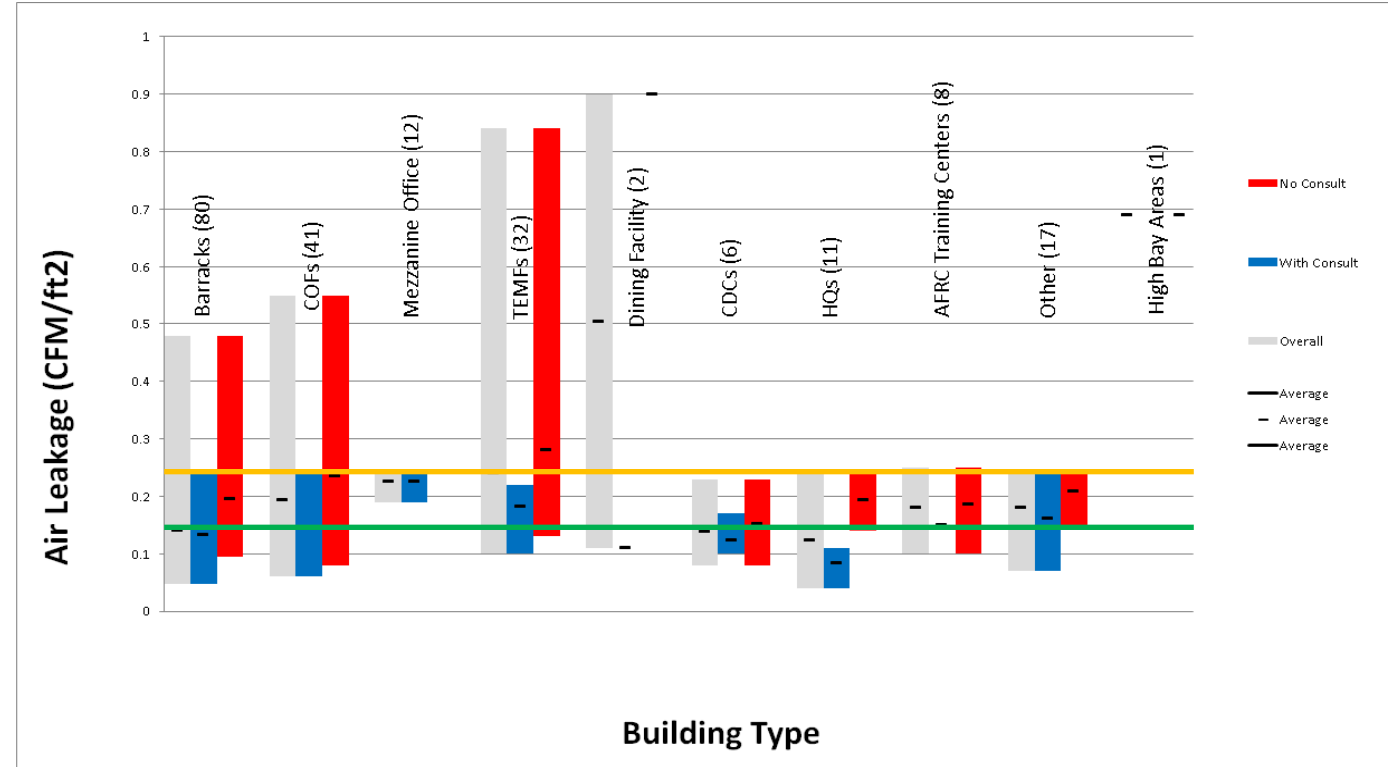
LEAKAGE RATE VS. BUILDING SIZE



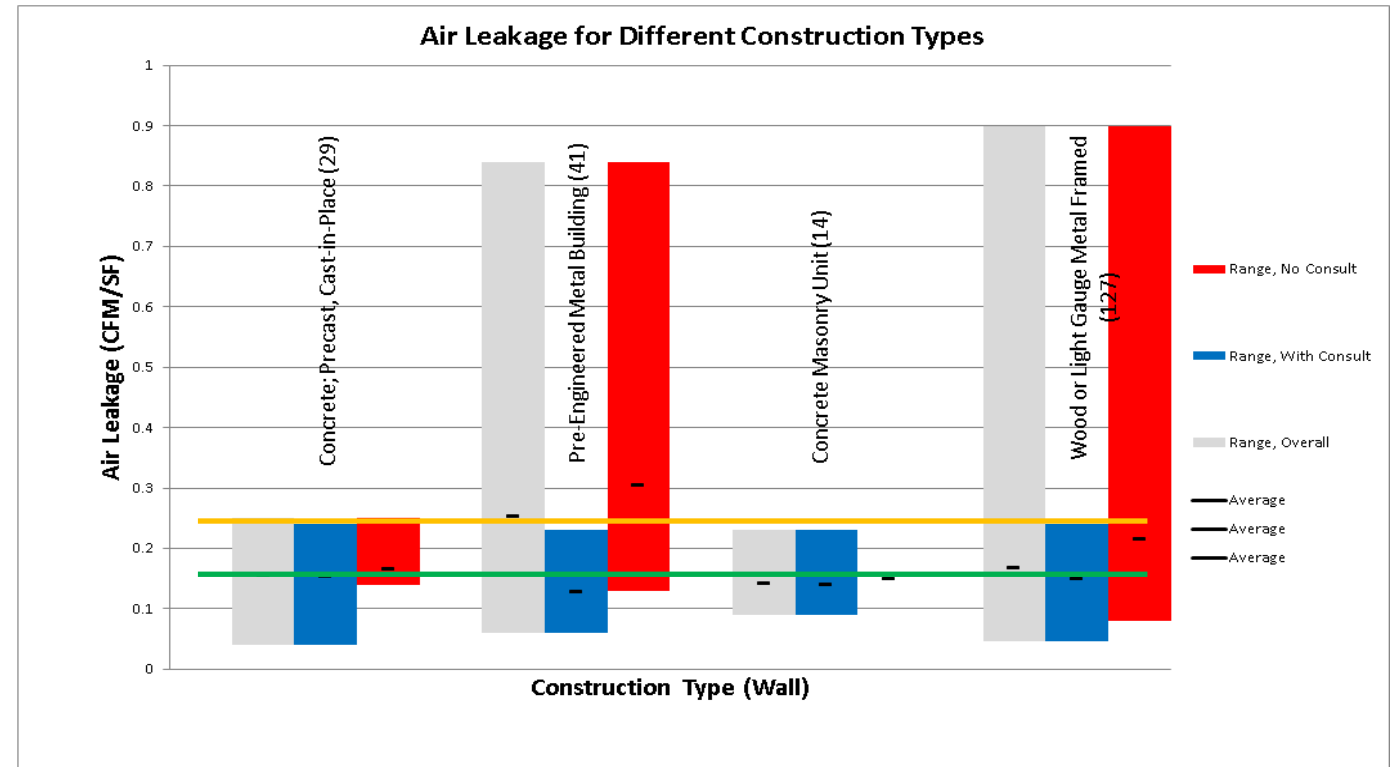
LEAKAGE RATE VS. BUILDING SIZE



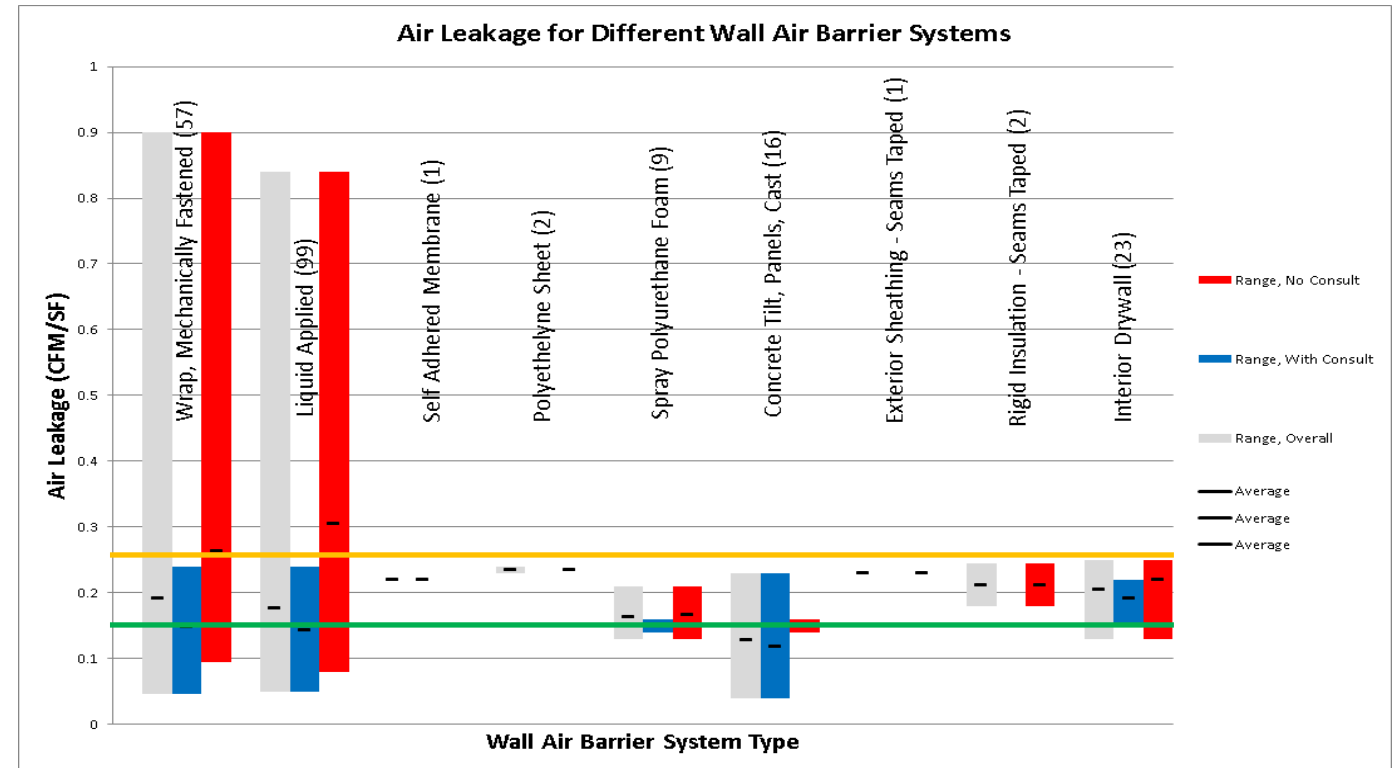
- Range (standard deviation) w/ no expert consultation
- TEMFs are challenging
- 0.25 CFM/SF & 0.15 CFM/SF



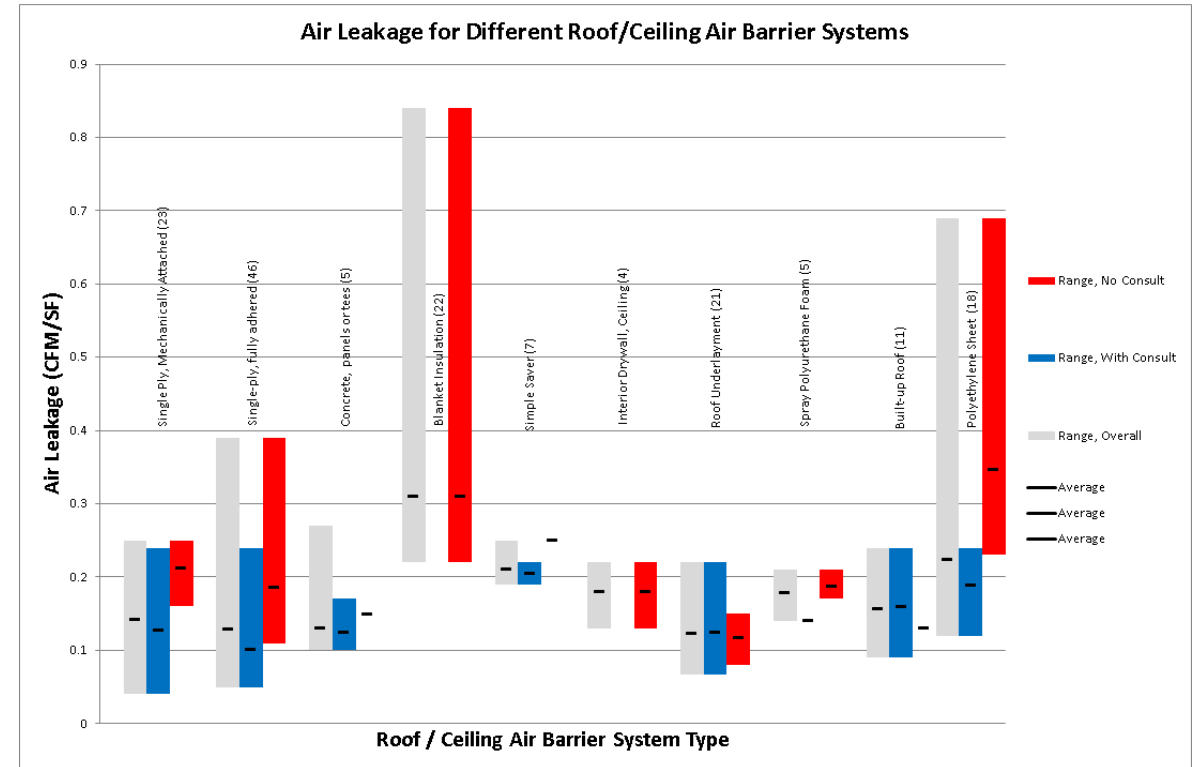
- Averages, expert consultation vs. no consultation
- Range (standard deviation) w/ no consultation
- Concrete is an excellent air barrier
- 0.25 CFM/SF & 0.15 CFM/SF



- Averages & range, w/ no consultation
- 0.25 CFM/SF & 0.15 CFM/SF



- Blanket Insulation Doesn't Work
- Average & range, w/ no consultation
- 0.25 CFM/SF & 0.15 CFM/SF

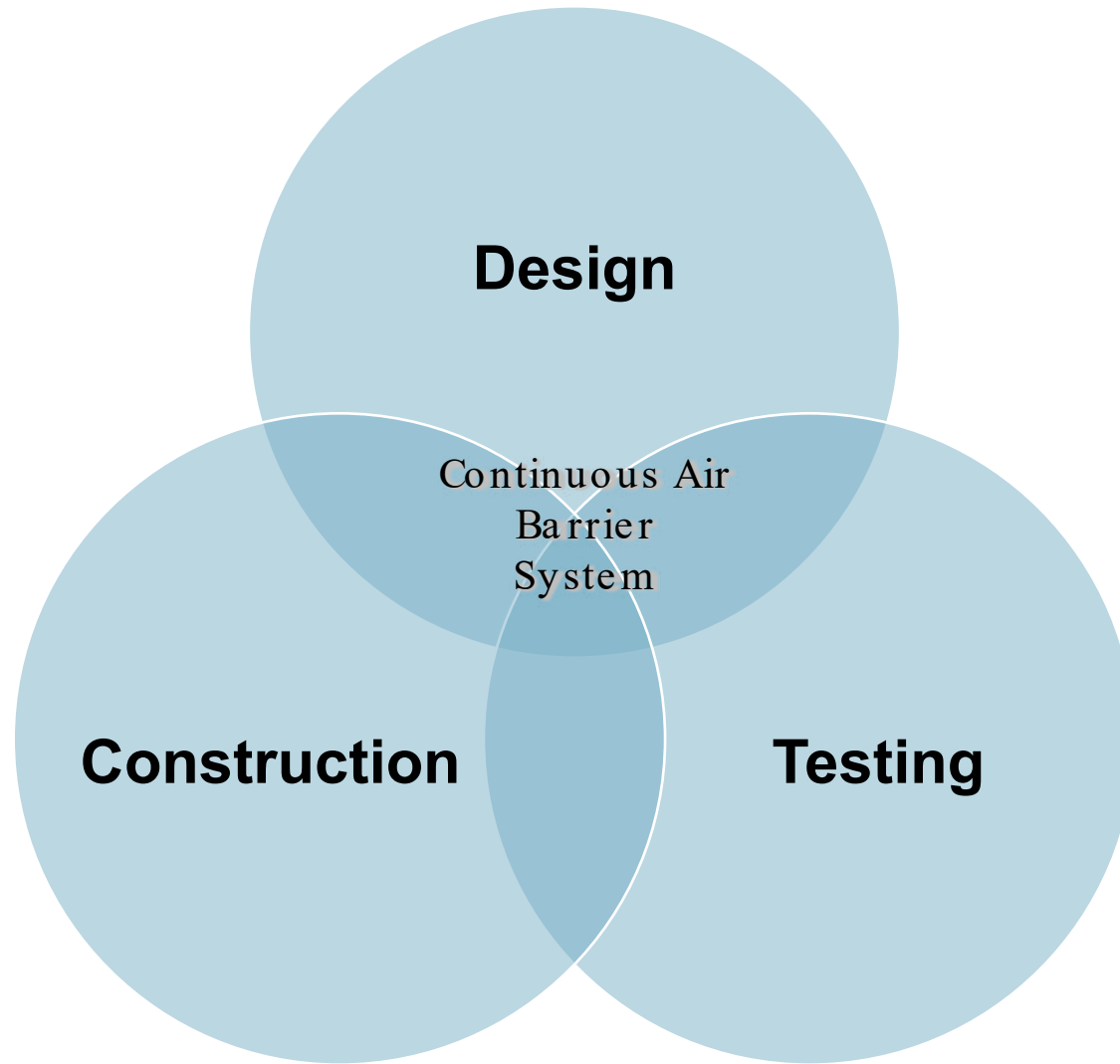


SUCCESS OF THE AIR TIGHTNESS REQUIREMENT

- Achievable
- Applicable
- Does not limit construction type
- Does not limit construction materials
- Building envelope discipline
- ENERGY SAVINGS WERE MEASURED!



MULTI-PHASED HOLISTIC APPROACH

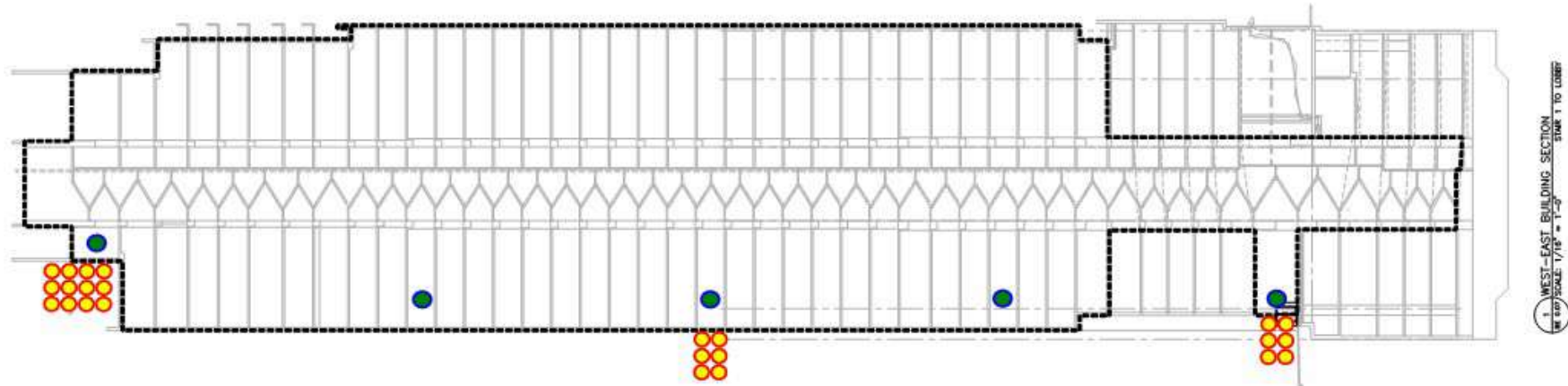


WBALT FOR ALL BUILDINGS



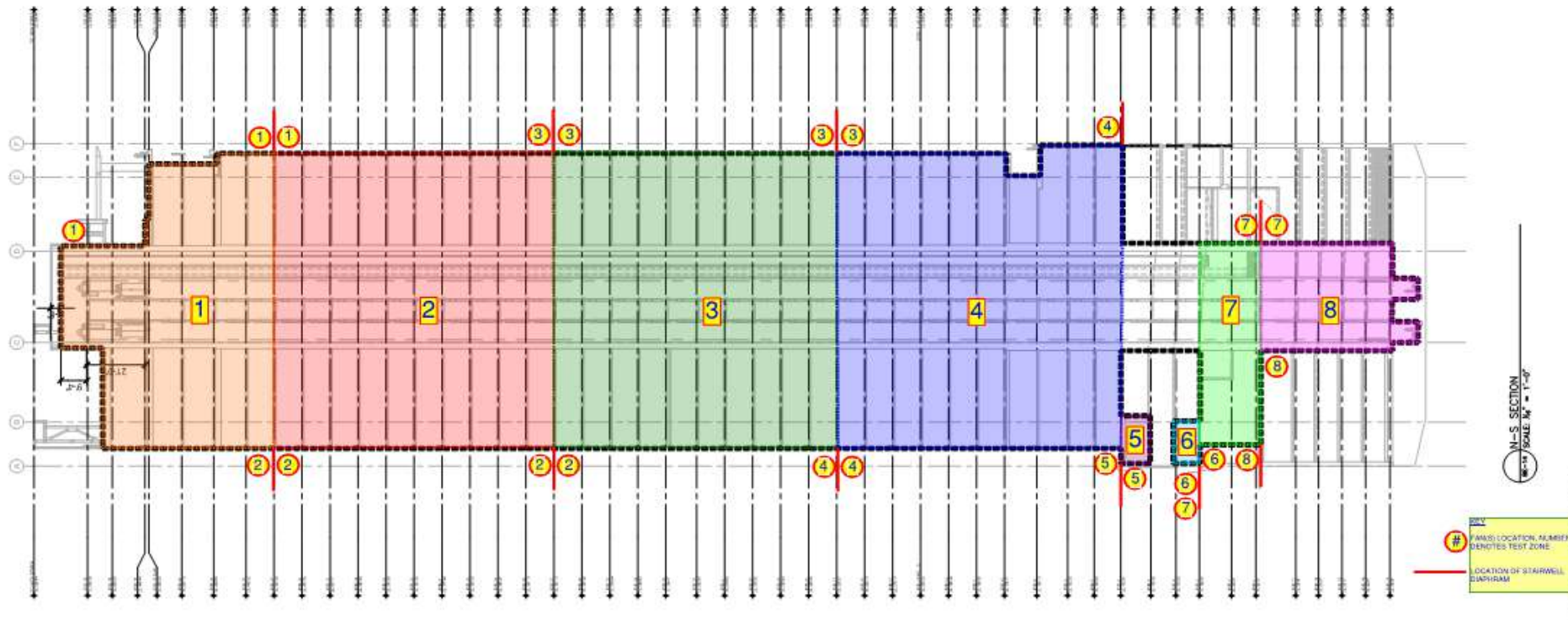
COMPARTMENTALIZE OR WHOLE BUILDING?

- Tall tower tested as one zone
 - Preparation is less complicated
 - Distributed equipment



COMPARTMENTALIZE OR WHOLE BUILDING?

- Tall tower broken up for phased move-in
 - Extensive preparation and testing effort
 - Diaphragms in Stairwells
 - Pressure-equalize above and below test zones



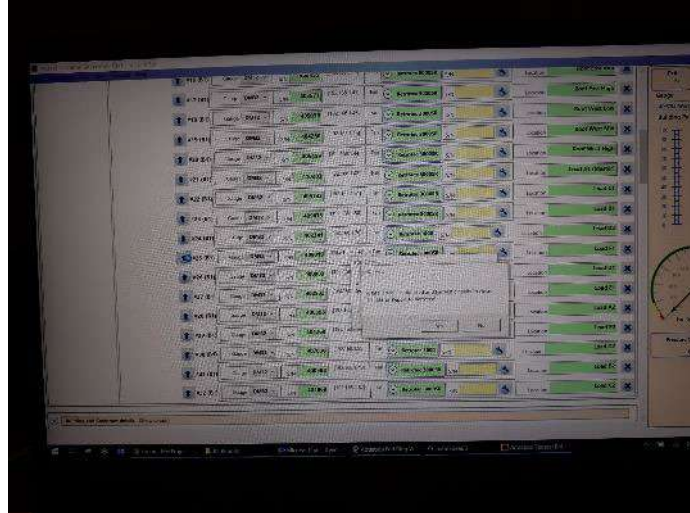
TESTING THE BEHEMOTHS- ASTM 3158



ASTM 3158



ASTM 3158



ASTM 3158

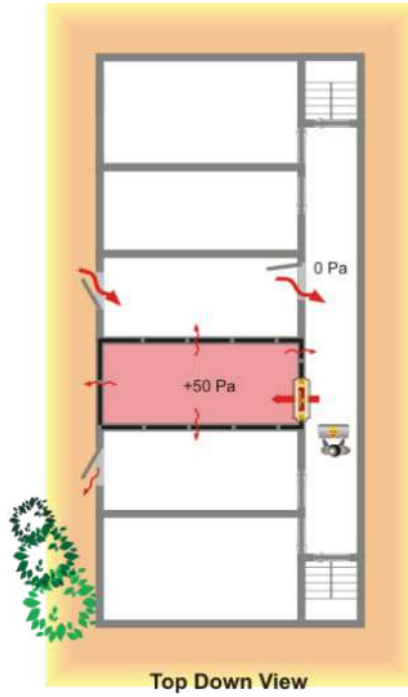
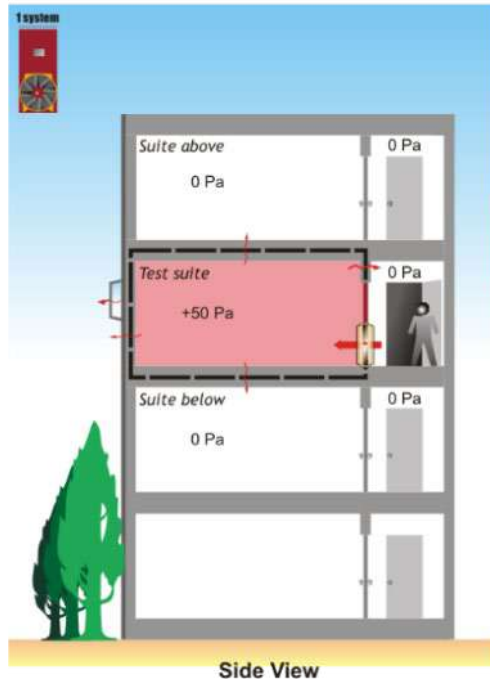


THE MONSTERS

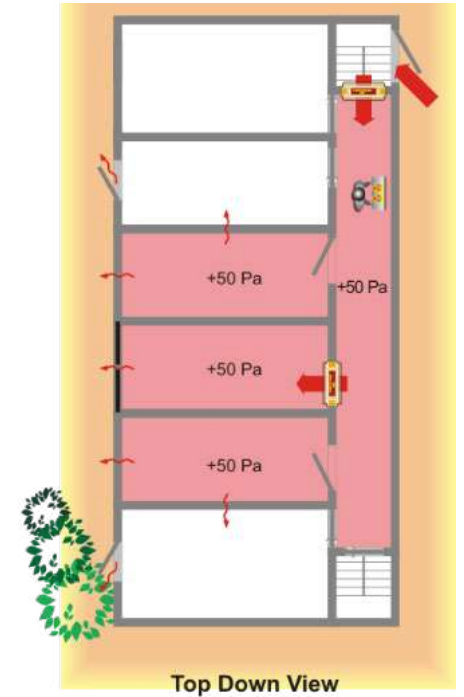
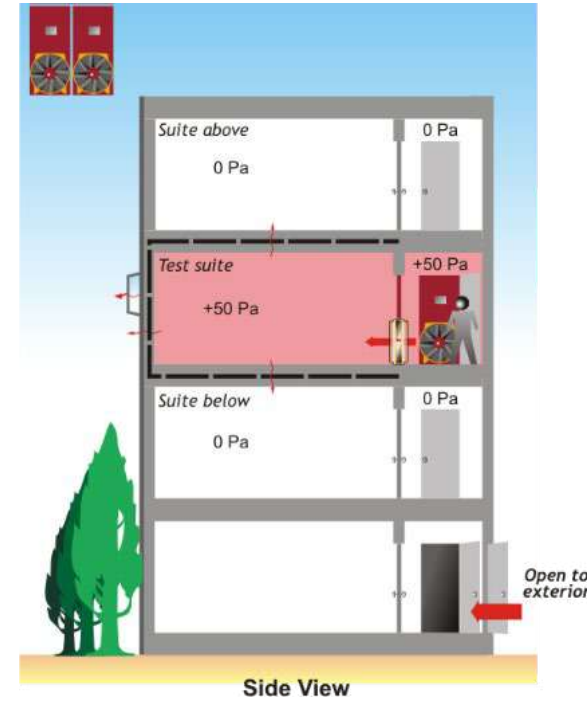


THE MONSTERS

- Total Air Leakage



- Isolating the Sample



THE MONSTERS



QUESTIONS STILL REMAIN...

- What is the right number for air leakage?
- Who is qualified to test?
- What Standard Governs Testing?
- Can you test with the building's HVAC System?
- Pressurization/Depressurization Both?
- Multi-point Test? Single Point Test?
- Appropriateness of all buildings? Sample Testing?
- What happens when it fails?
- Exemptions?!



CONCLUSIONS

Air barrier testing of all buildings is coming.
However, a lot of questions and grey areas still exist.

An effective air barrier starts in design. A quality assurance program is required at every stage of construction to assure an air-tight envelope

Coordination between all team members is key

Design and construction issues all effect the planning, execution, and cost of the test

Testing Agents and Consultants need Certification

QUESTIONS & DISCUSSION



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