abaa 2025 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

abaa EDUCATION

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.

abaa building enclosure conference

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.

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Learning Objectives

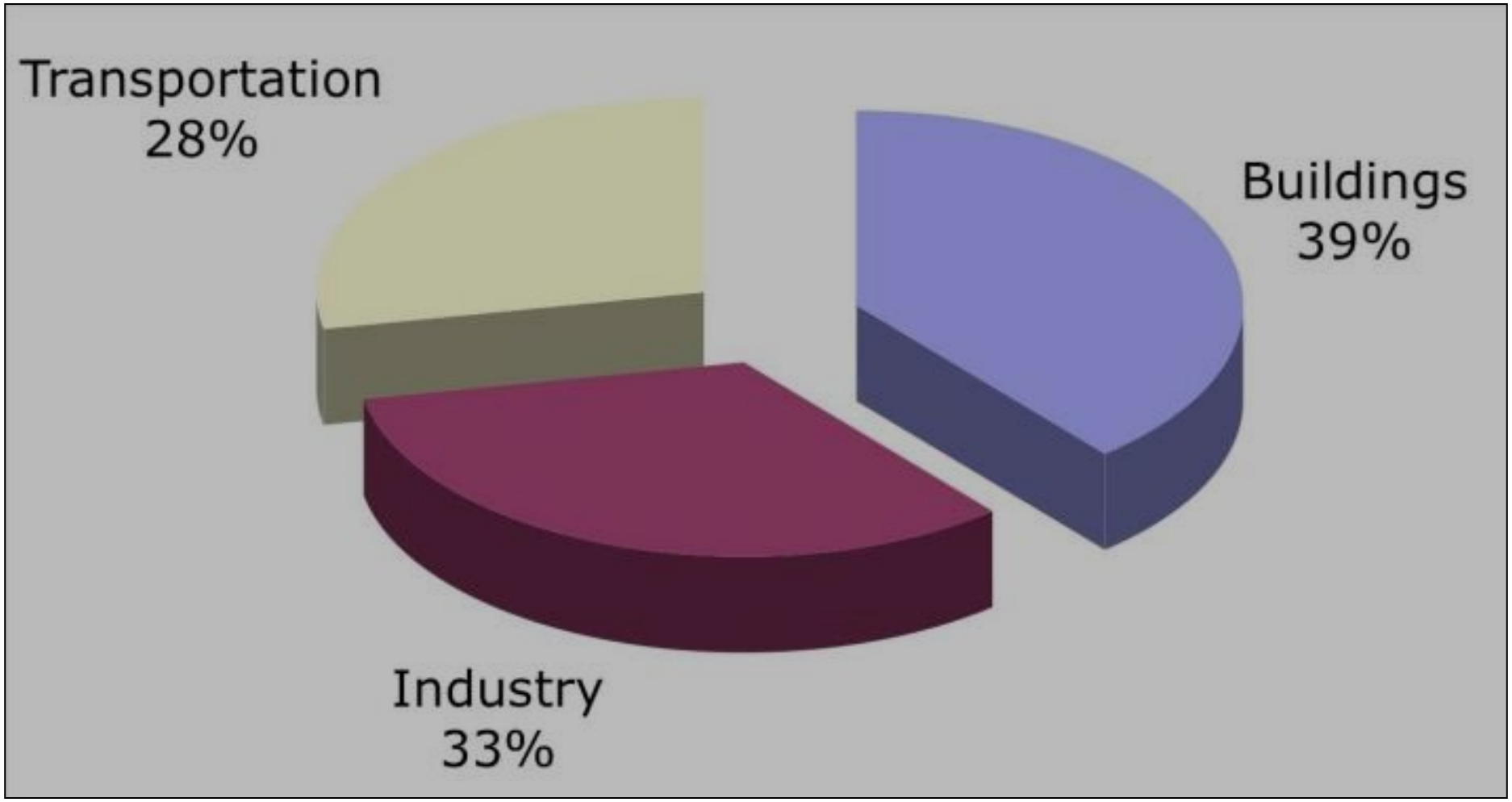
1. Review the theory and historical progression of air tightness requirements and understand the metrics that provide the baseline for levels of air tightness.
2. Understand what ASHRAE 90.1-2019 and IECC 2021 Air Leakage requirements are.
3. Understand the validity, impact, and relevance of the wide 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

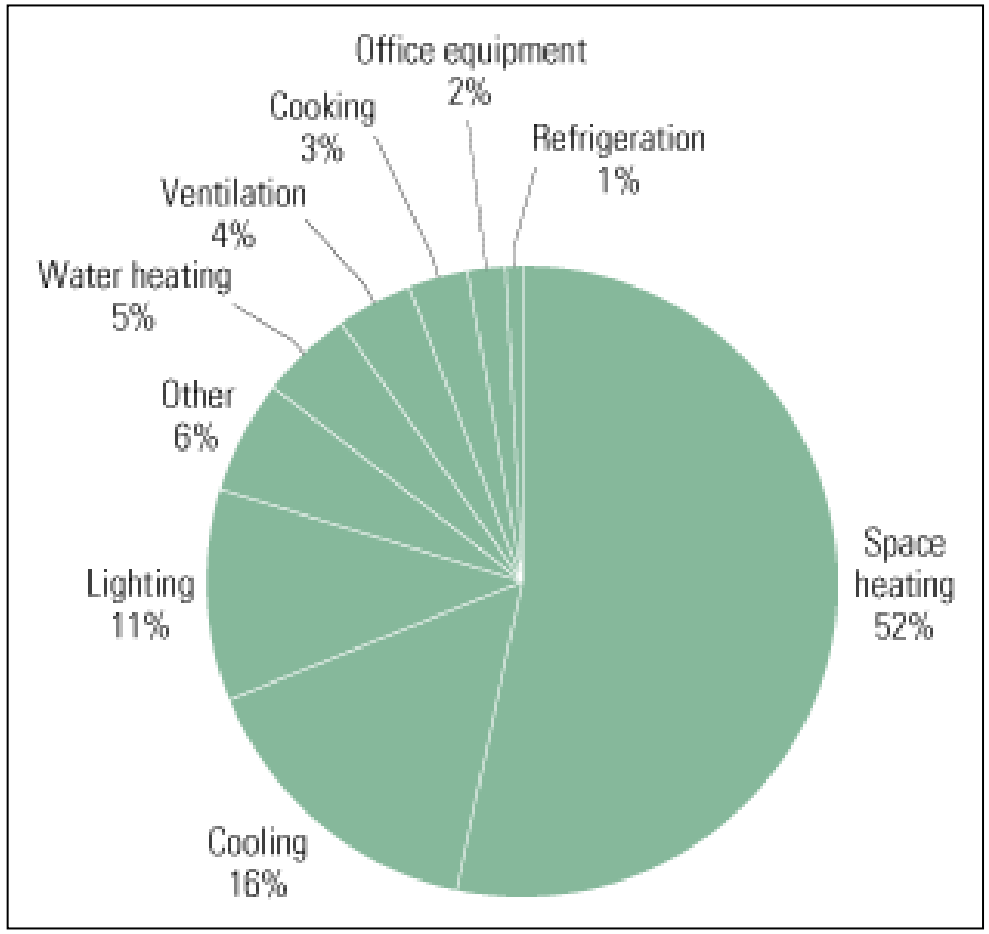
- Building Envelope Durability
  - H- Heat Barrier
  - A- Air Barrier
  - M_L- Moisture Liquid
  - M_V- Moisture Vapor

ENERGY



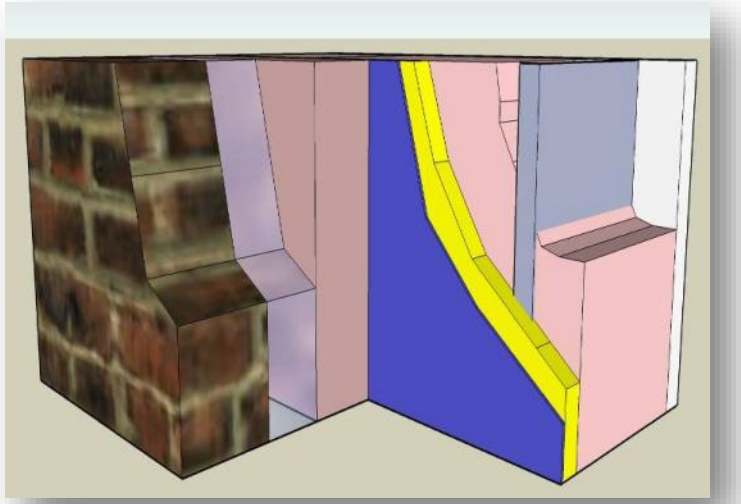
ENERGY

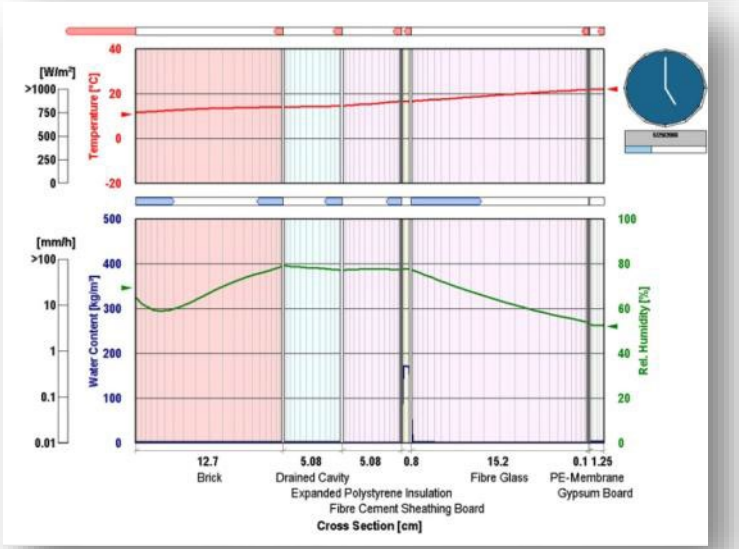
- Building Envelope (walls, roof, windows, and floors)
- Lighting
- Heating, Ventilating, and Air Conditioning (HVAC)
- Internal and Process Loads (cooking, hot water, manufacturing, etc.)

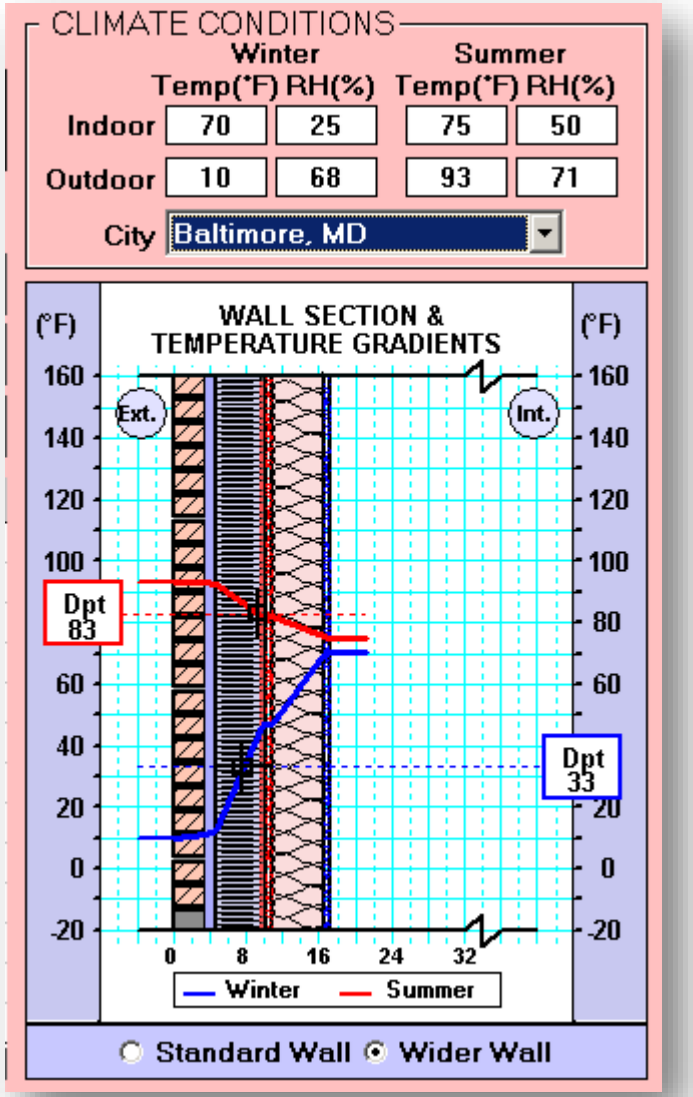


ENERGY

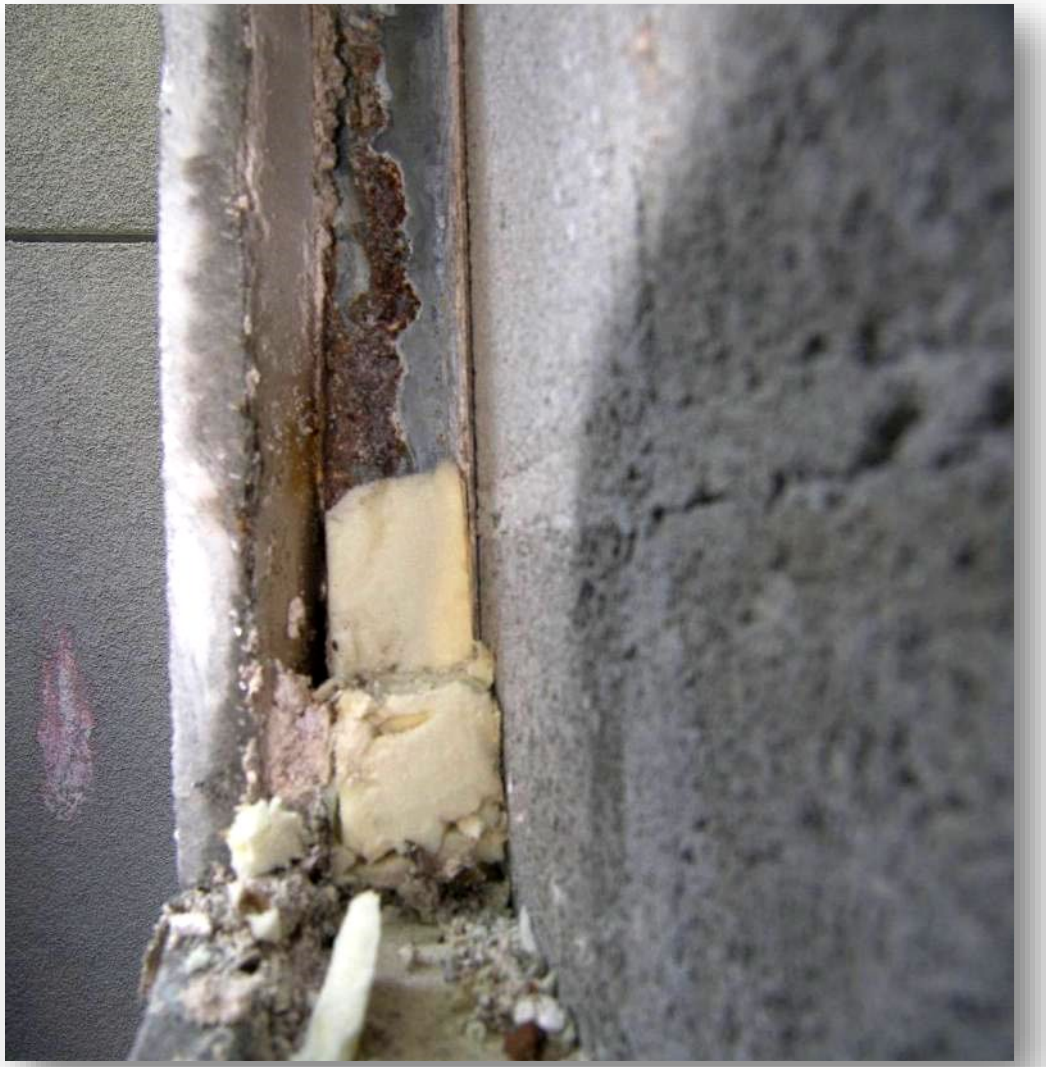
BUILDING ENCLOSURE DESIGN





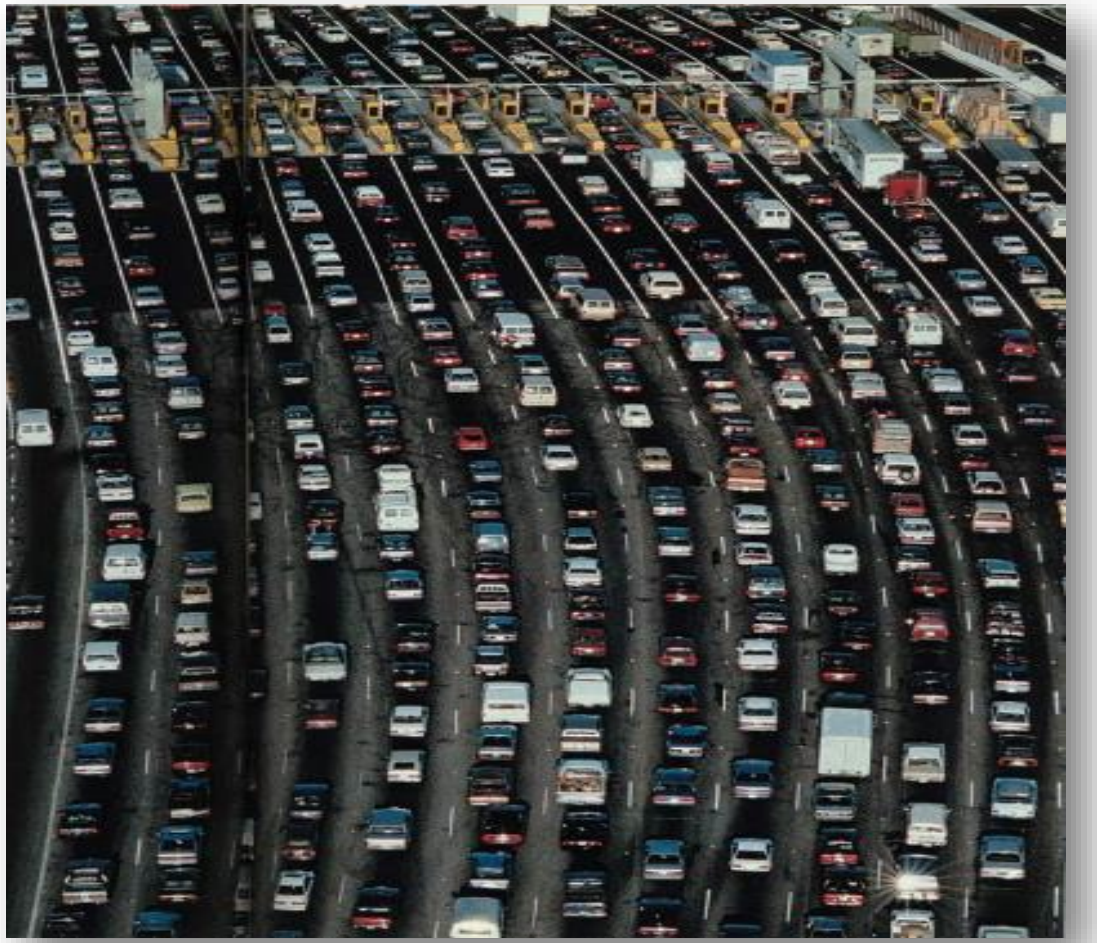


DURABILITY

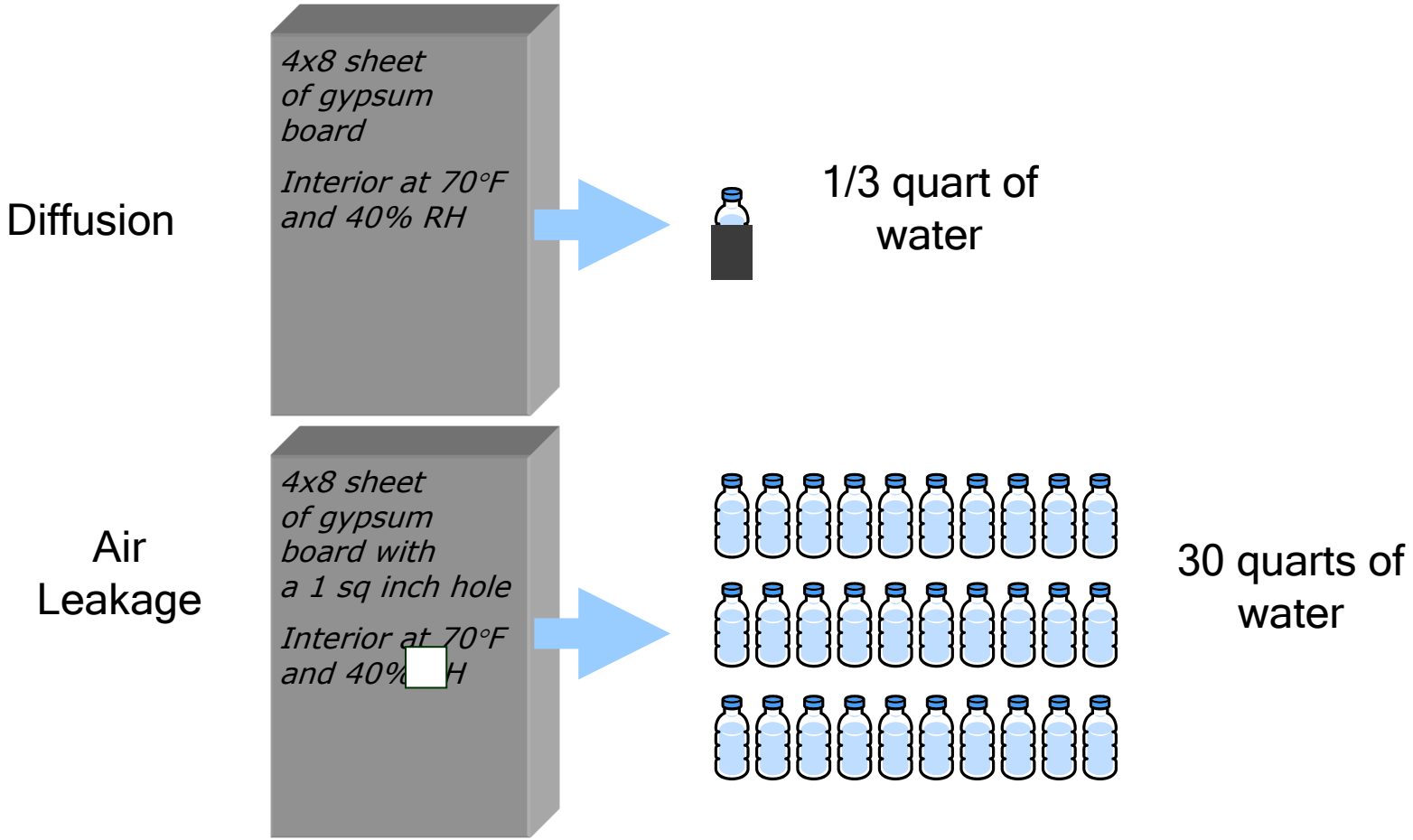


MOISTURE TRANSPORT- VAPOR DIFFUSION

MOISTURE TRANSPORT- AIR LEAKAGE

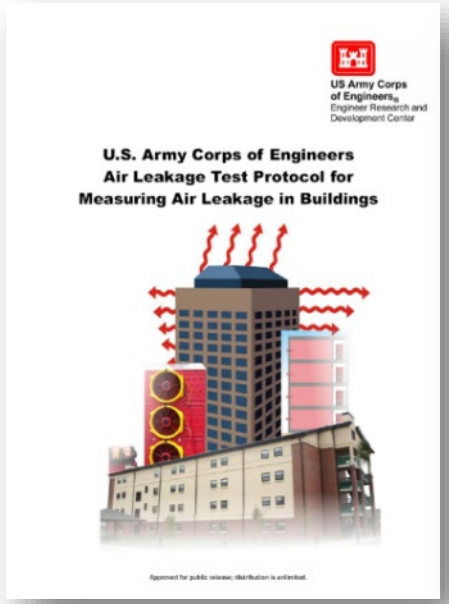


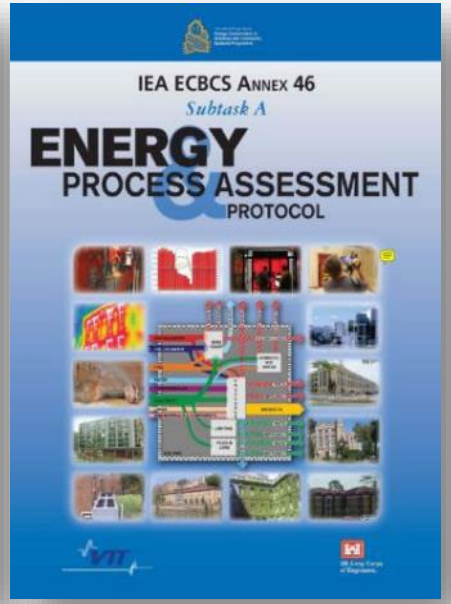
MOISTURE TRANSPORT

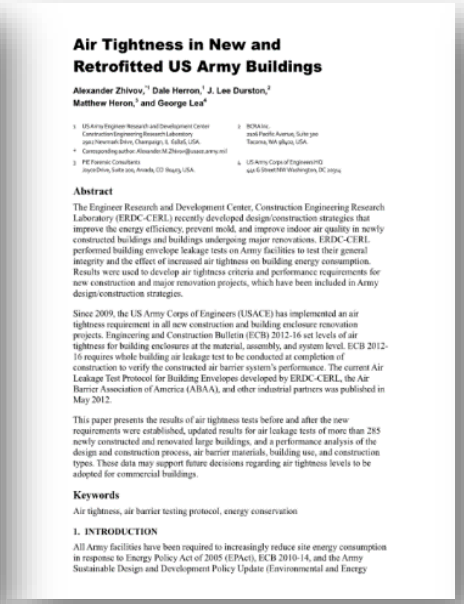


THE SILENT ISSUE

ENERGY TAKES THE FOREFRONT







Air Tightness in New and Retrofitted US Army Buildings

Alexander Zhivov,[1] Dale Herron,[1] J. Lee Durston,[2] Matthew Heron,[3] and George Lea[4]

Abstract

The Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) recently developed design/construction strategies that improve the energy efficiency, prevent mold, and improve indoor air quality in newly constructed buildings and buildings undergoing major renovations. ERDC-CERL performed building envelope leakage tests on Army facilities to test their general integrity and the effect of increased air tightness on building energy consumption. Results were used to develop air tightness criteria and performance requirements for new construction and major renovation projects, which have been included in Army design/construction strategies.

Since 2009, the US Army Corps of Engineers (USACE) has implemented an air tightness requirement in all new construction and building enclosure renovation projects. Engineering and Construction Bulletin (ECB) 2012-16 set levels of air tightness for building enclosures at the material, assembly, and system level. ECB 2012-16 requires whole building air leakage test to be conducted at completion of construction to verify the constructed air barrier system's performance. The current Air Leakage Test Protocol for Building Envelopes developed by ERDC-CERL, the Air Barrier Association of America (ABAA), and other industrial partners was published in May 2012.

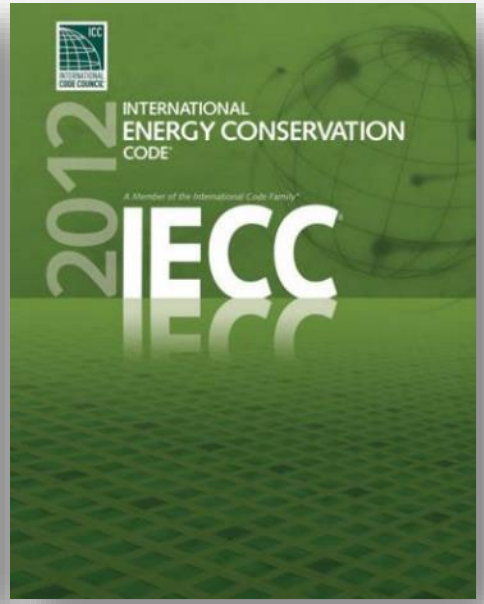
This paper presents the results of air tightness tests before and after the new requirements were established, updated results for air leakage tests of more than 285 newly constructed and renovated large buildings, and a performance analysis of the design and construction process, air barrier materials, building use, and construction types. These data may support future decisions regarding air tightness levels to be adopted for commercial buildings.

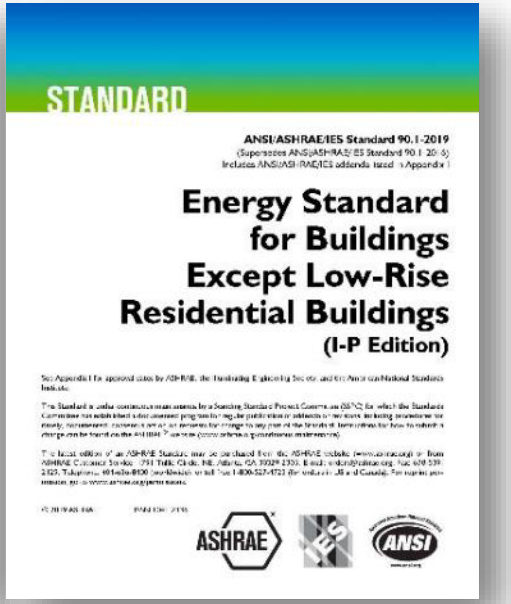
Keywords

Air tightness, air barrier testing protocol, energy conservation

1. INTRODUCTION

All Army facilities have been required to increasingly reduce site energy consumption in response to Energy Policy Act of 2005 (EPAct), ECB 2010-14, and the Army Sustainable Design and Development Policy Update (Environmental and Energy

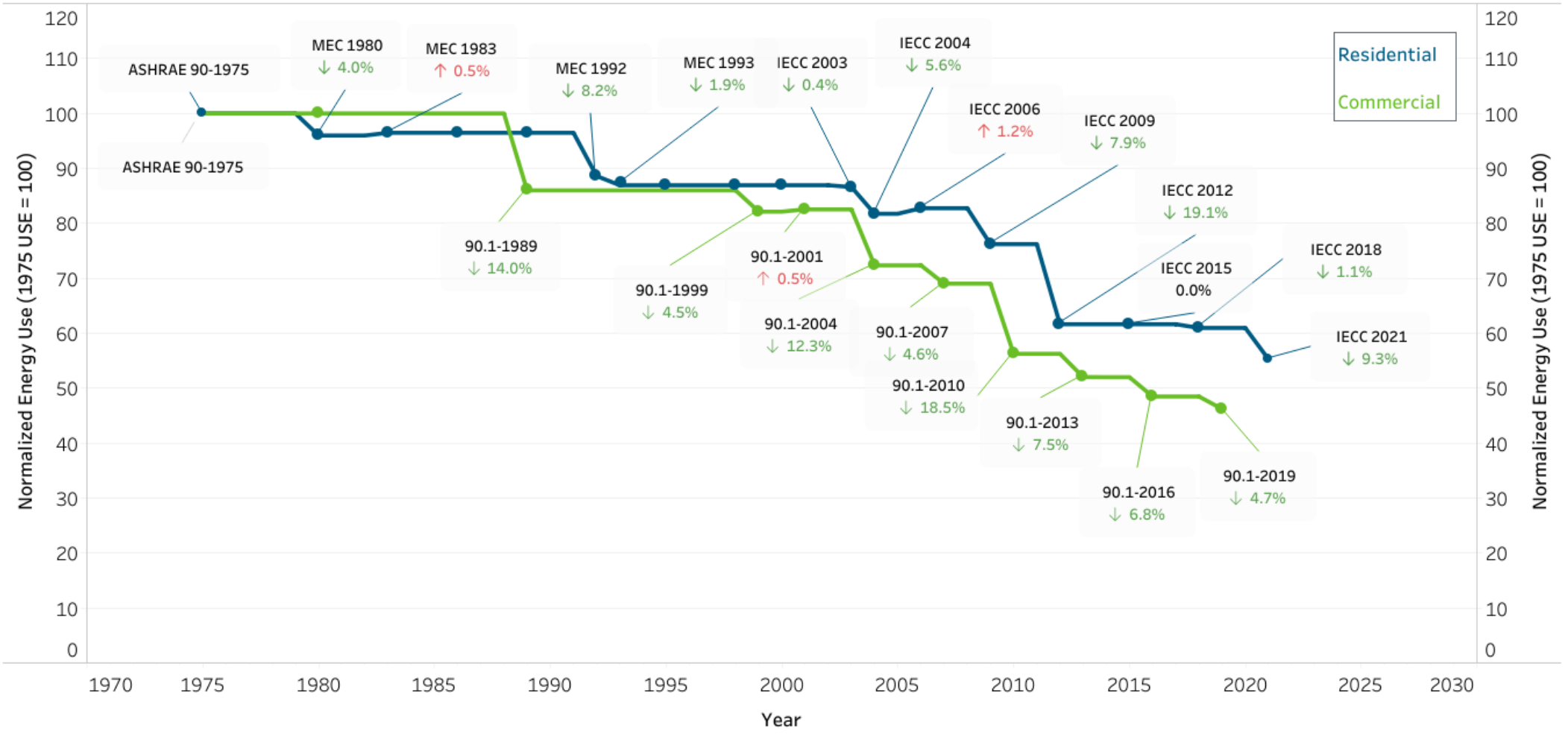




U.S. DEPARTMENT OF ENERGY

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

Pacific Northwest NATIONAL LABORATORY



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)

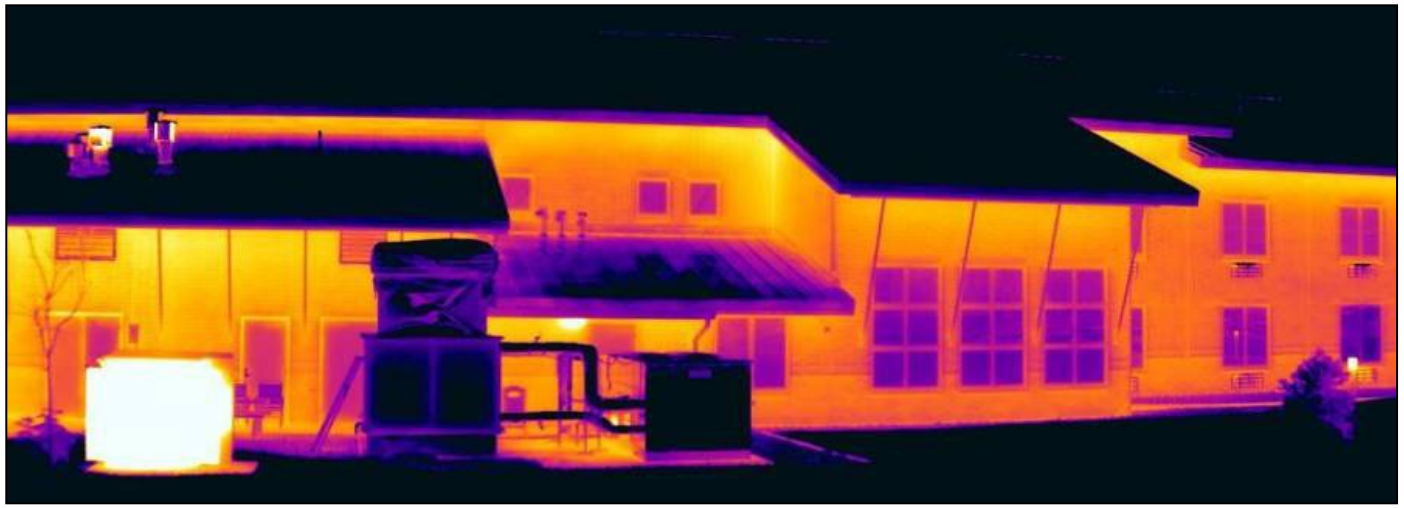
5.4.3.1.1 - EXCEPTIONS

1. For *buildings* having over 50,000 ft^2 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*:

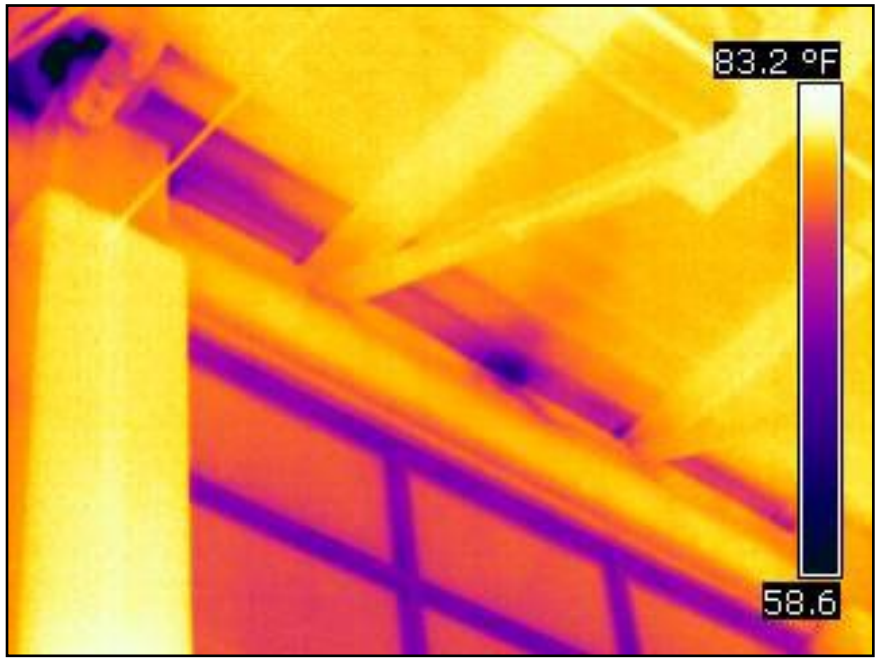
    a. The entire *floor* area of all *stories* that have any *spaces* directly under a *roof.*
    b. The entire *floor* area of all *stories* that have a *building entrance* or loading dock.
    c. Representative *above-grade wall* sections of the *building* totaling at least 25% of the *wall* area enclosing 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

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/ft^2 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*.

C402.5.1.3.1 Building thermal envelope corrective measures. Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s · m^2) 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

/ˈgrēnˌwôSH,ˈgrēnˌwäSH/

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"

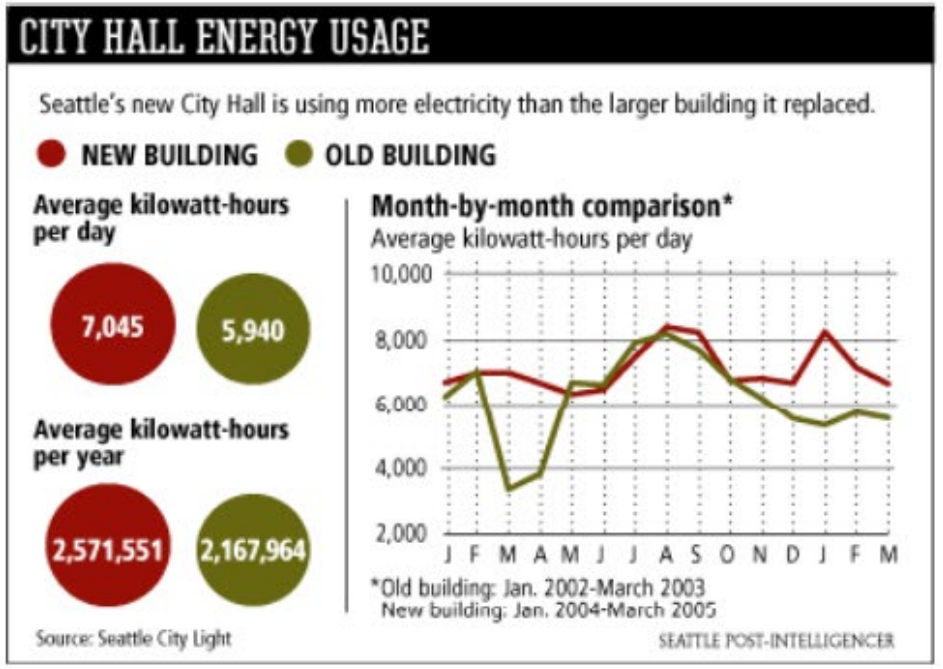
STOP THE GREENWASH!

Mail Online

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!



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 *average* handbook of fundamentals	0.30 cfm/ft² at 75Pa	**0.30/1.52**
→	**U.S. DoD Standard**	**0.25 cfm/ ft² at 75Pa**	**0.25/1.27**
UK	TS-1Commercial 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**
US	ASHRAE HOF *tight* 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

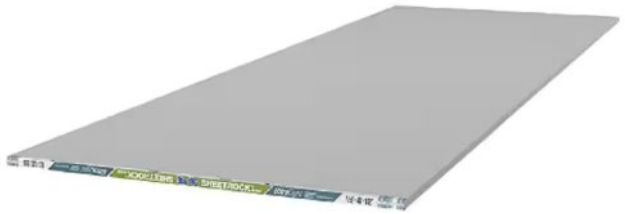
Leakier

Tighter

→ Passive House 0.06 cfm/ft² at 75Pa

AIR LEAKAGE BY THE NUMBERS

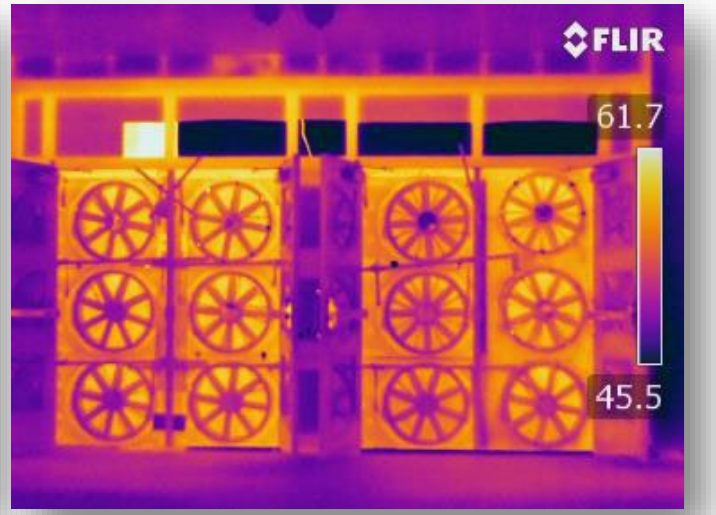
	ASHRAE 90.1 Append. Z (cfm/ft^2 @ .3" w.c.)	US Army Corps Engineers	Canada NBC (L/(s*m^2 @75Pa)
Material	0.004	0.004	0.02
Assembly	0.04	0.04	0.2
Building	0.4	0.25	2.0



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:

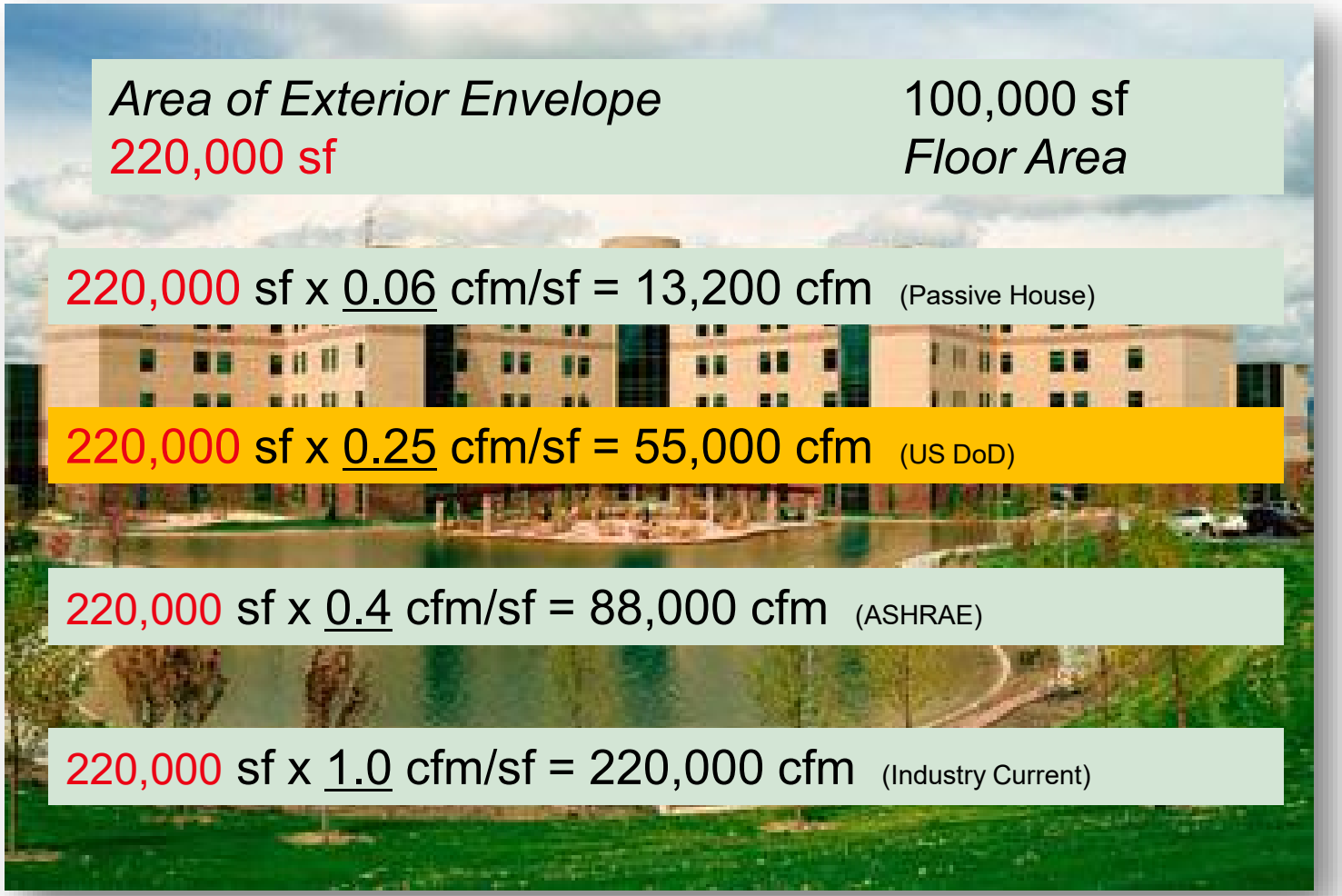
0.40 to 1.60 cfm/sf @ 0.3” wg

100,000sf of envelope =

40,000cfm to 160,000cfm

HOW LEAKY ARE BUILDINGS…?

Example #2



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 *average* handbook of fundamentals	0.30 cfm/ft² at 75Pa	**0.30/1.52**
→	**U.S. DoD Standard**	**0.25 cfm/ ft² at 75Pa**	**0.25/1.27**
UK	TS-1Commercial 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**
US	ASHRAE HOF *tight* 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

Leakier

Tighter

→ Passive House 0.06 cfm/ft² at 75Pa

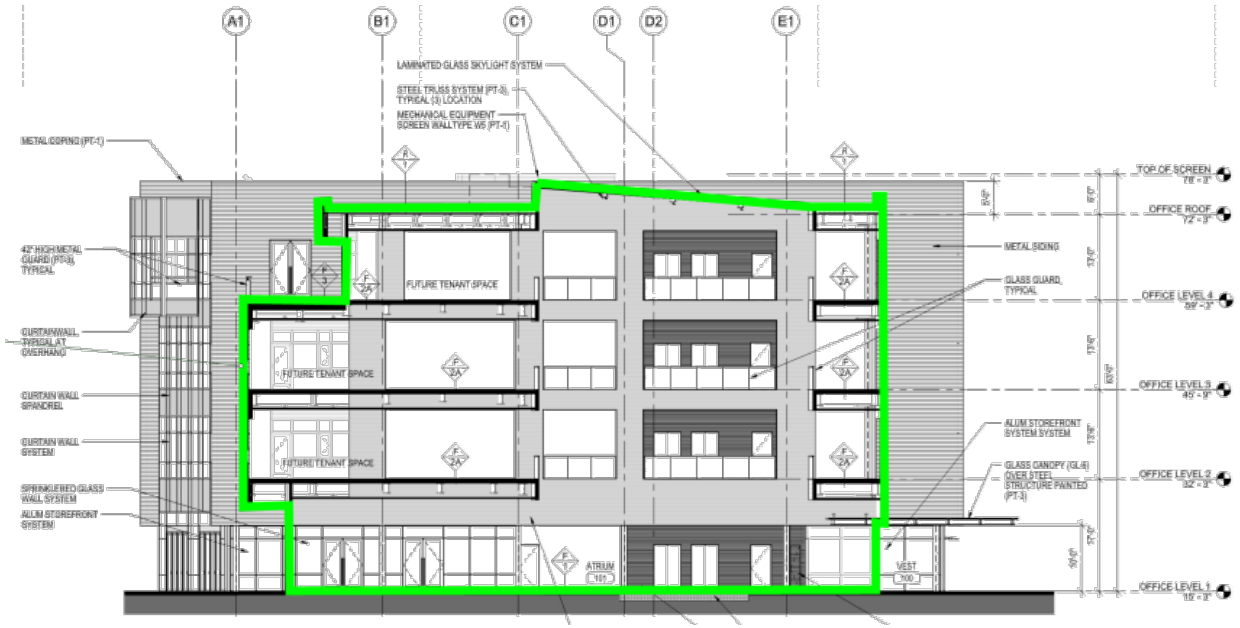
6 STEPS TO QUALITY AIR BARRIER SYSTEMS

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

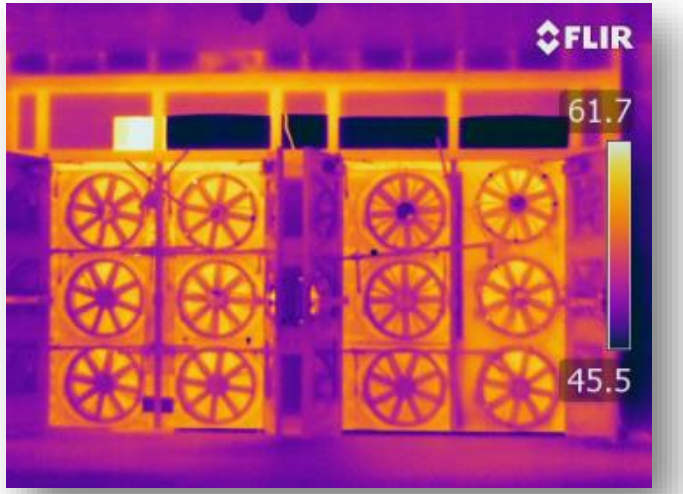
- ABAA quality assurance program
- Enclosure Consultant
- Pre-installation meeting
- Review mock-up
- Review installation in progress
- Testing

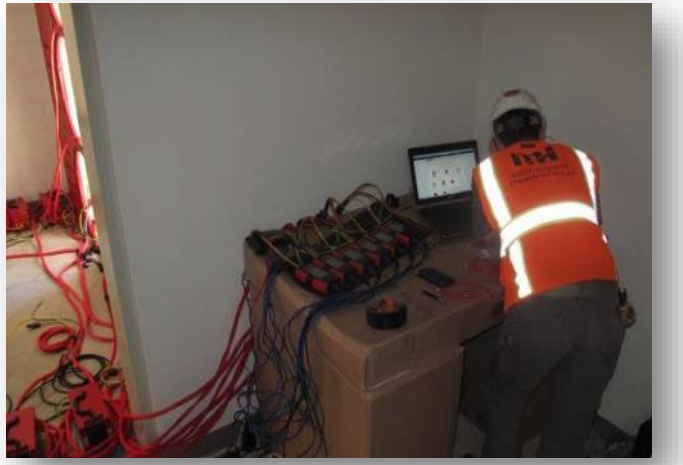
SPECIFYING TESTING

- 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



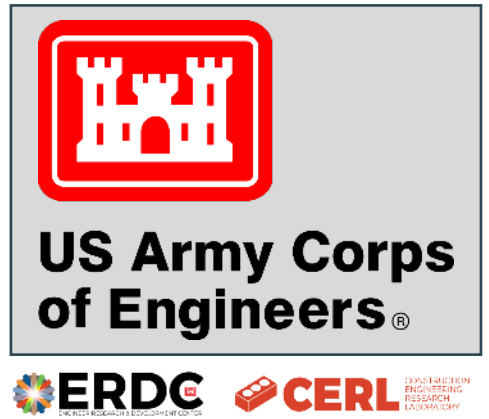


PERFORMANCE VERIFICATION

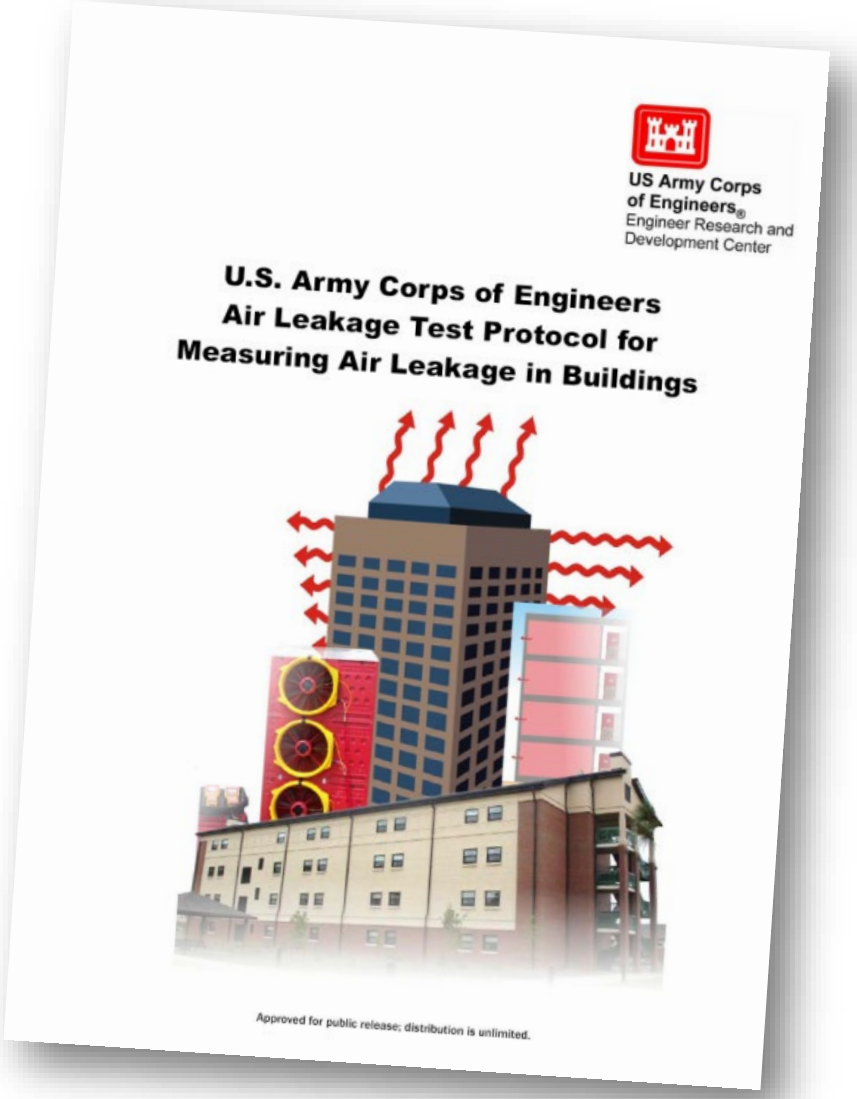
- ASHRAE 90.1 2019 = not to exceed 0.40 cfm/sf @ 75 Pa
- IECC 2019= not to exceed 0.40 cfm/sf @ 75 Pa
- IECC 2021= not to exceed 0.30 cfm/sf @ 75 Pa
- USACE = not to exceed 0.25 cfm/sf @ 75 Pa
- LEED-H= not to exceed
  0.35 ACH @ 50 Pa
- Washington State Energy Code
  0.30 cfm/sf @75Pa
- City of Fort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

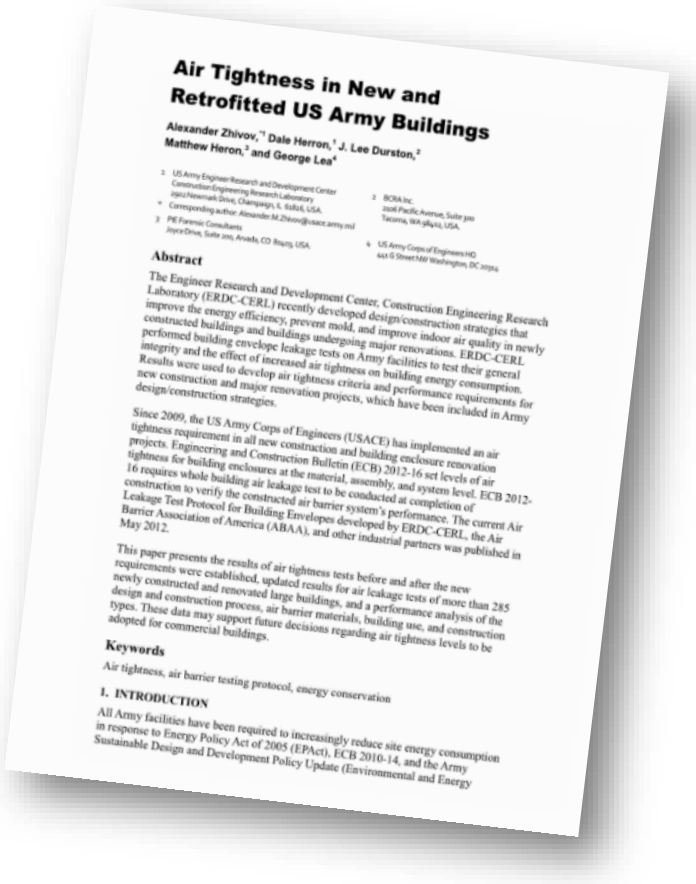


SEND IT!


US Army Corps
of Engineers®
Engineer Research and
Development Center
U.S. Army Corps of Engineers
Air Leakage Test Protocol for
Measuring Air Leakage in Buildings
Approved for public release; distribution is unlimited.

WBALT TESTING STUDY

- 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



Air Tightness in New and Retrofitted US Army Buildings

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Abstract

The Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) recently developed design/construction strategies that improve the energy efficiency, prevent mold, and improve indoor air quality in newly constructed buildings and buildings undergoing major renovations. ERDC-CERL performed building envelope leakage tests on Army facilities to test their general integrity and the effect of increased air tightness on building energy consumption. Results were used to develop air tightness criteria and performance requirements for new construction and major renovation projects, which have been included in Army design/construction strategies.

Since 2009, the US Army Corps of Engineers (USACE) has implemented an air tightness requirement in all new construction and building enclosure renovation projects. Engineering and Construction Bulletin (ECB) 2012-16 set levels of air tightness for building enclosures at the material, assembly, and system level. ECB 2012-16 requires whole building air leakage test to be conducted at completion of construction to verify the constructed air barrier system's performance. The current Air Leakage Test Protocol for Building Envelopes developed by ERDC-CERL, the Air Barrier Association of America (ABAA), and other industrial partners was published in May 2012.

This paper presents the results of air tightness tests before and after the new requirements were established, updated results for air leakage tests of more than 285 newly constructed and renovated large buildings, and a performance analysis of the design and construction process, air barrier materials, building use, and construction types. These data may support future decisions regarding air tightness levels to be adopted for commercial buildings.

Keywords

Air tightness, air barrier testing protocol, energy conservation

1. INTRODUCTION

All Army facilities have been required to increasingly reduce site energy consumption in response to Energy Policy Act of 2005 (EPAct), ECB 2010-14, and the Army Sustainable Design and Development Policy Update (Environmental and Energy

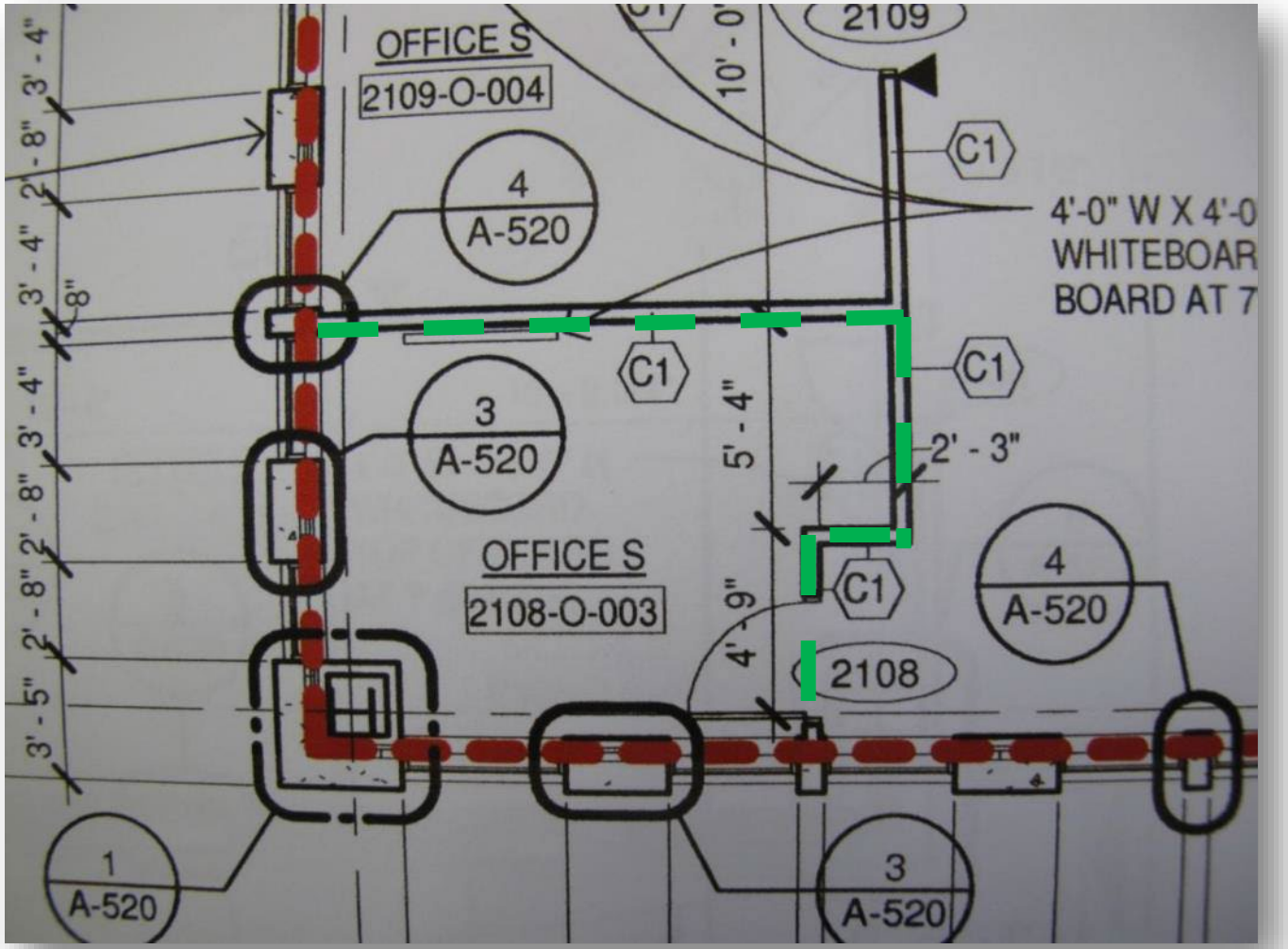
CASE STUDY – DETROIT ARSENAL BUILDING 270

DETROIT ARSENAL BLDG. 270

DETROIT ARSENAL BLDG. 270

DETROIT ARSENAL BLDG. 270

CONFIDENCE TEST/MOCK-UP



BUILDING PREP

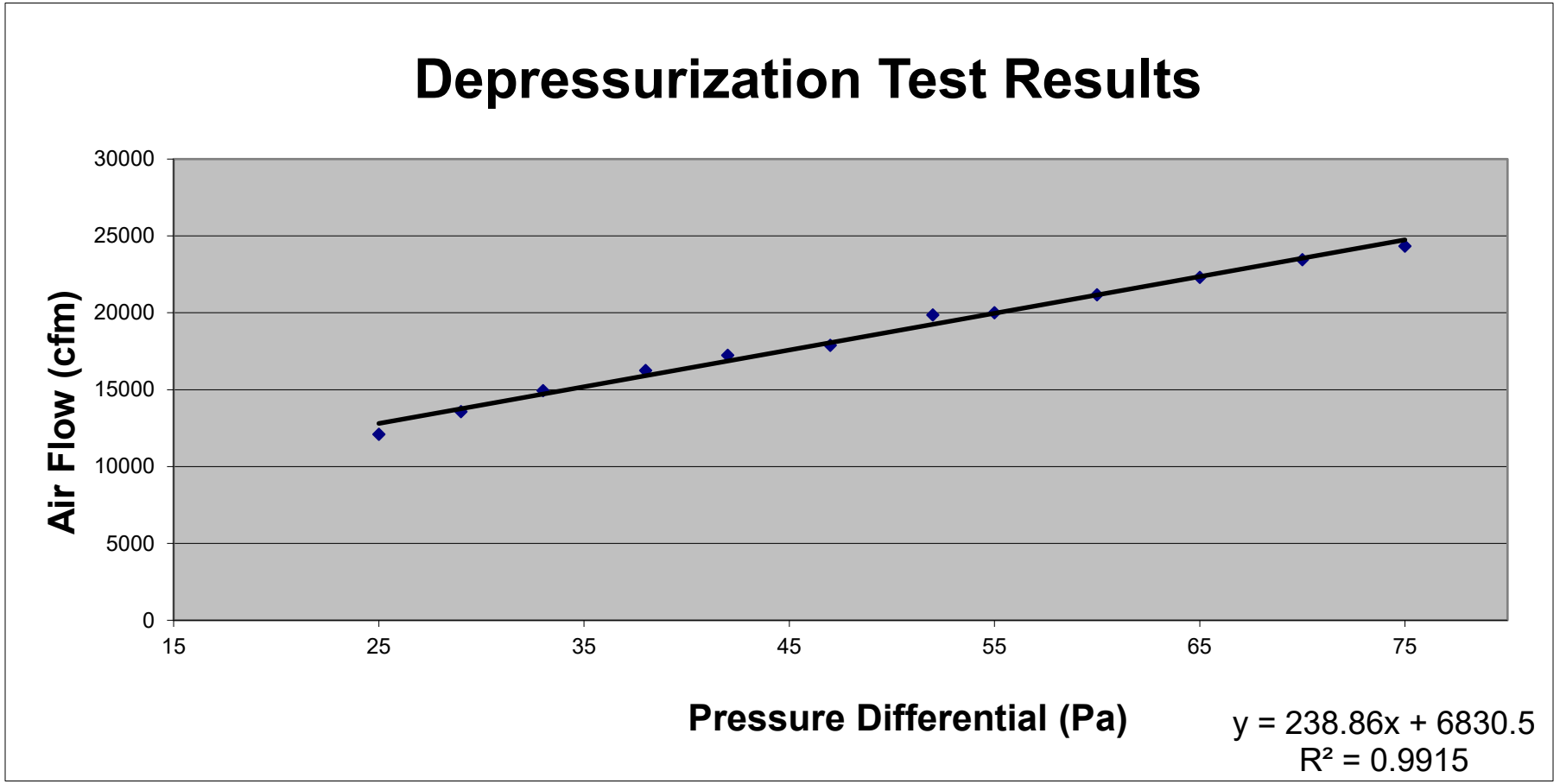
TEST SET-UP

TEST SET-UP

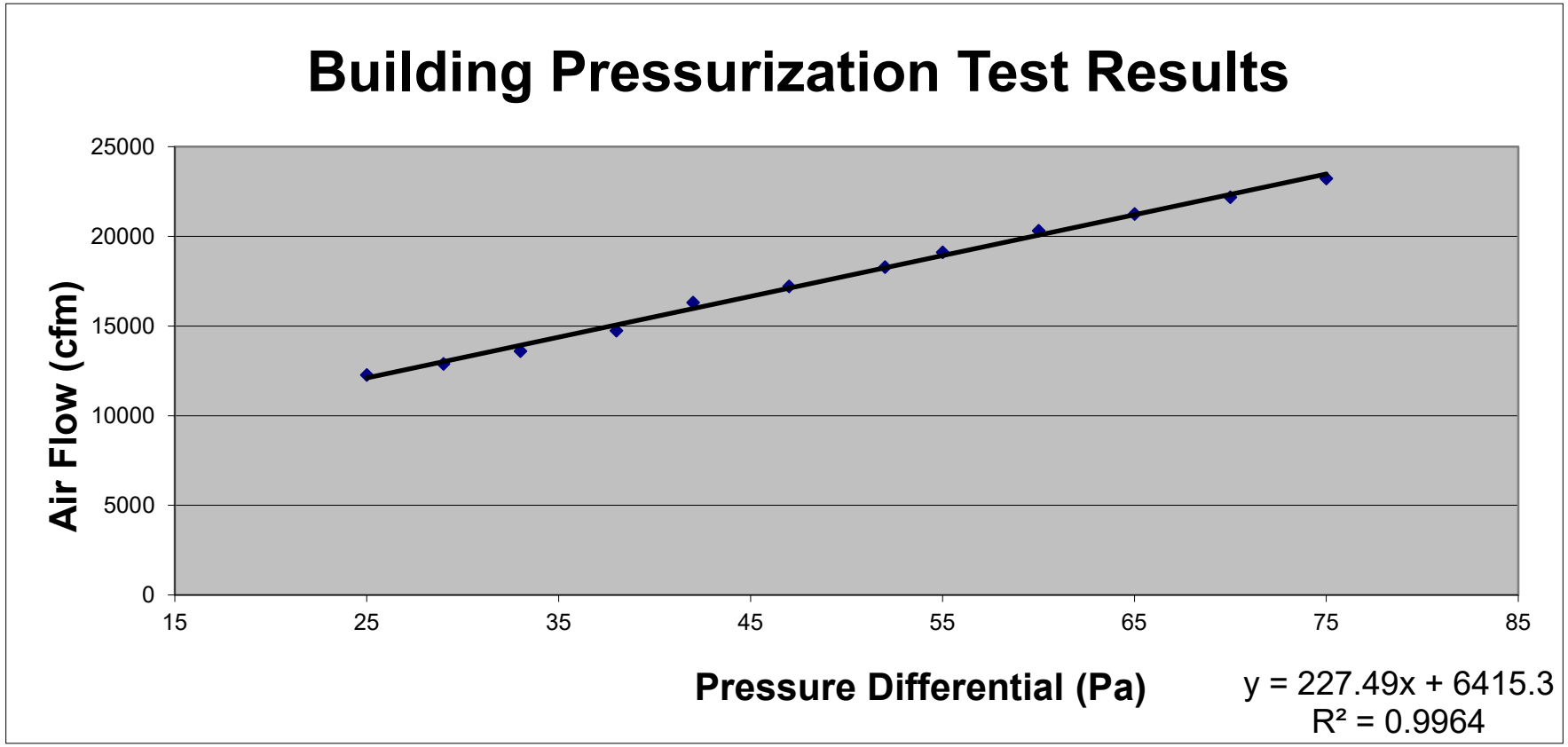
TARGET AIR LEAKAGE

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

DATA


Depressurization Test Results
Air Flow (cfm)
30000
25000
20000
15000
10000
5000
0
15
25
35
45
55
65
75
Pressure Differential (Pa)
y = 238.86x + 6830.5
R² = 0.9915

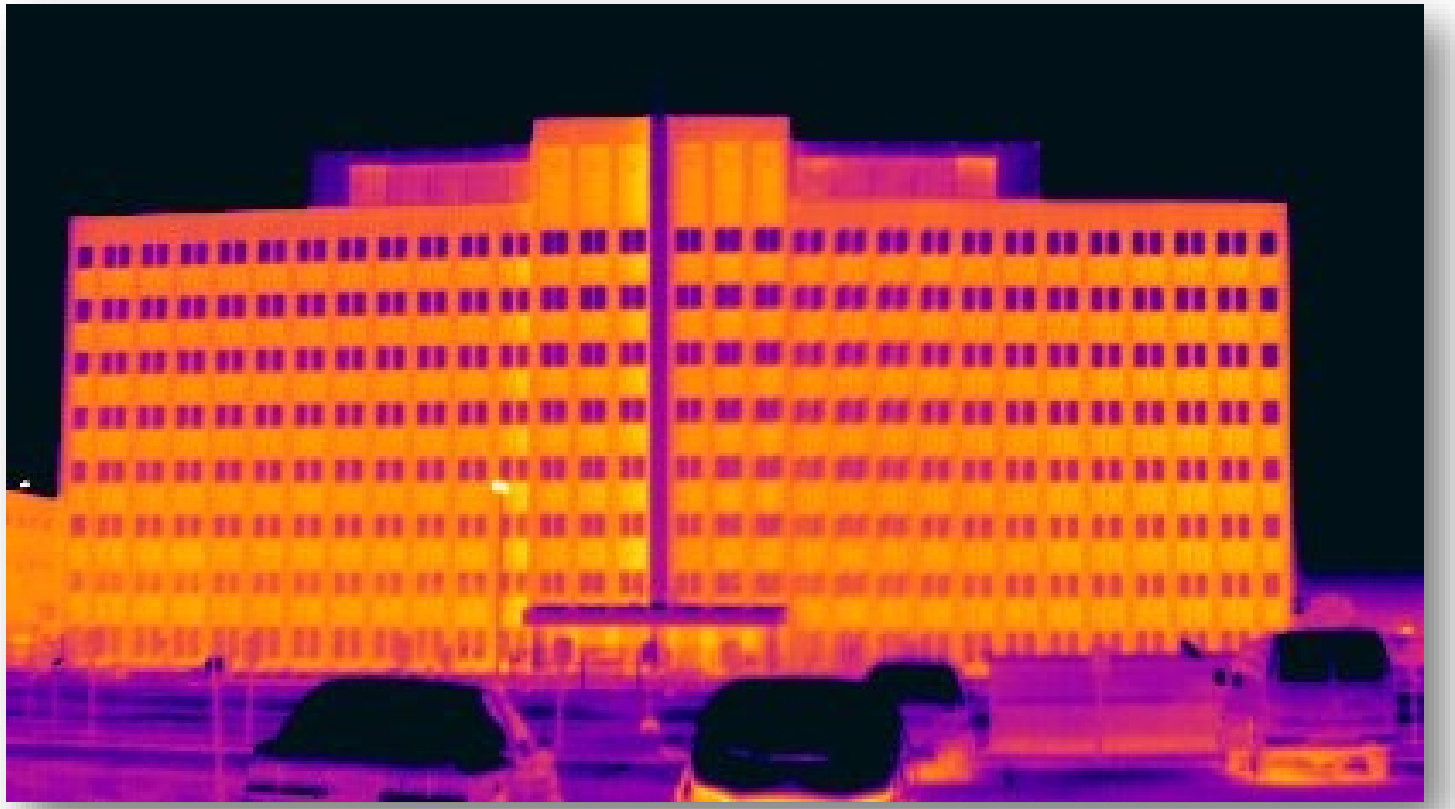
DATA


Building Pressurization Test Results
25000
20000
15000
10000
5000
0
Air Flow (cfm)
15
25
35
45
55
65
75
85
Pressure Differential (Pa)
y = 227.49x + 6415.3
R² = 0.9964

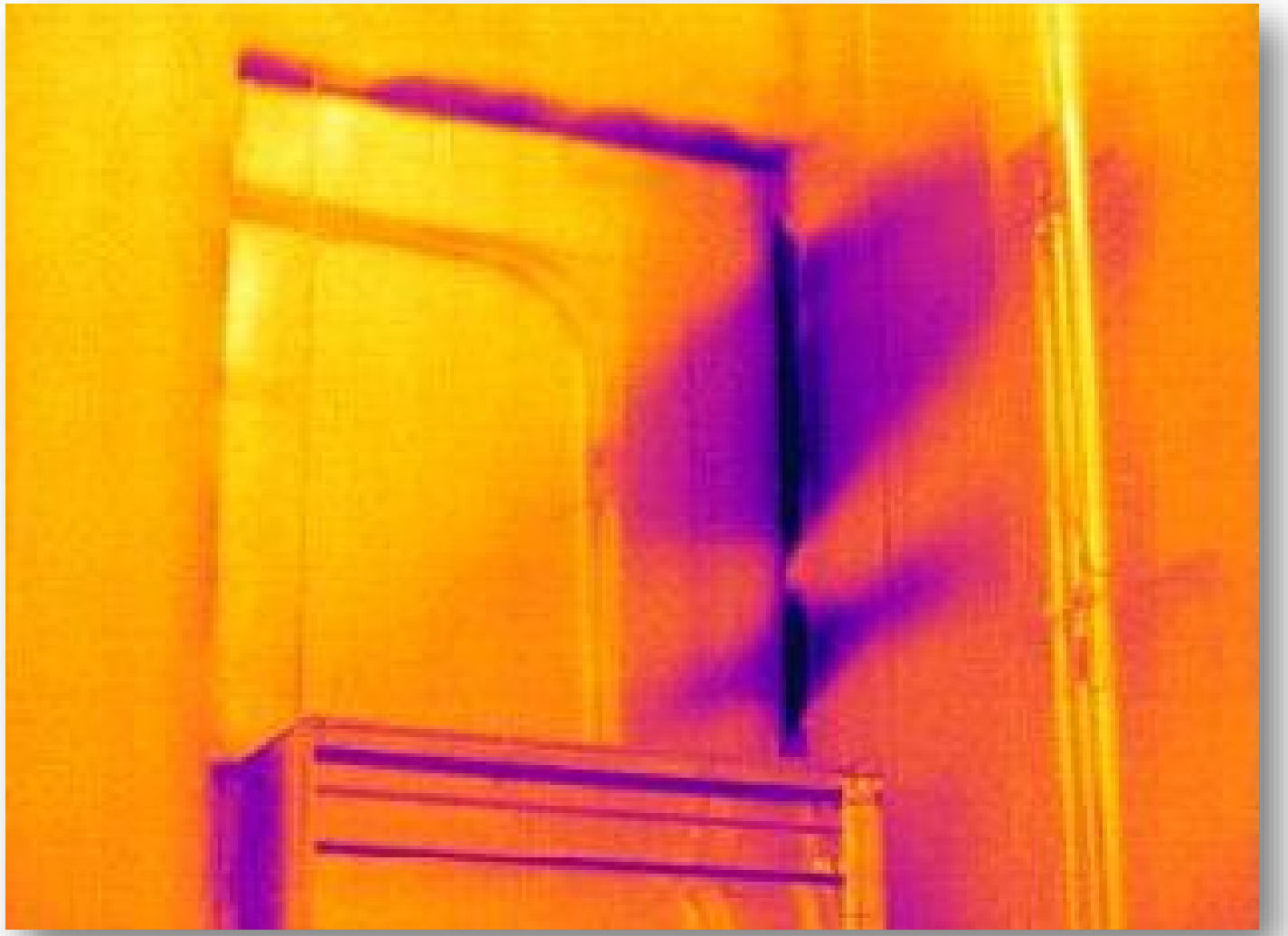
RESULTS

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

WHOLE BUILDING TEST

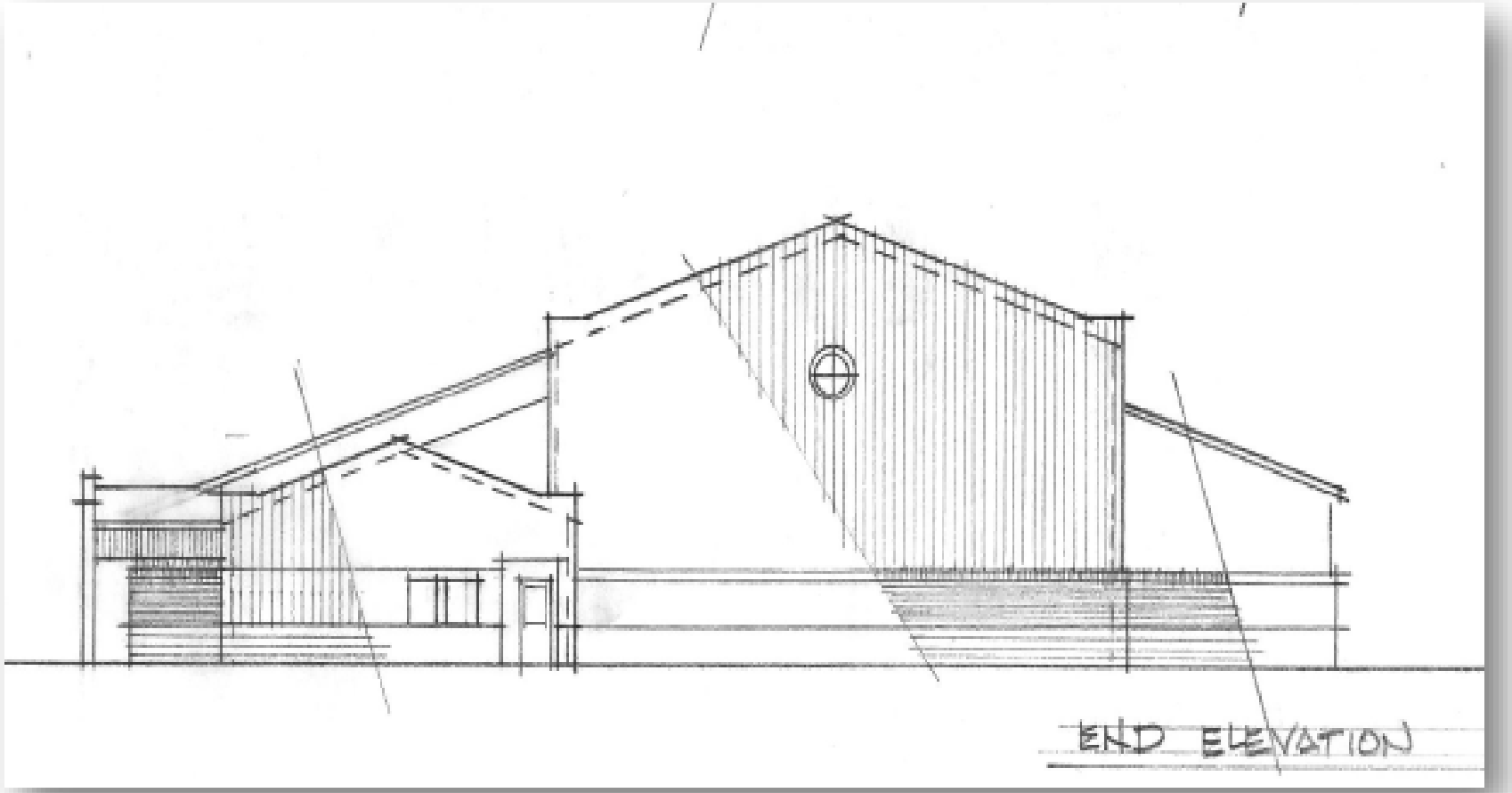


WHOLE BUILDING TEST

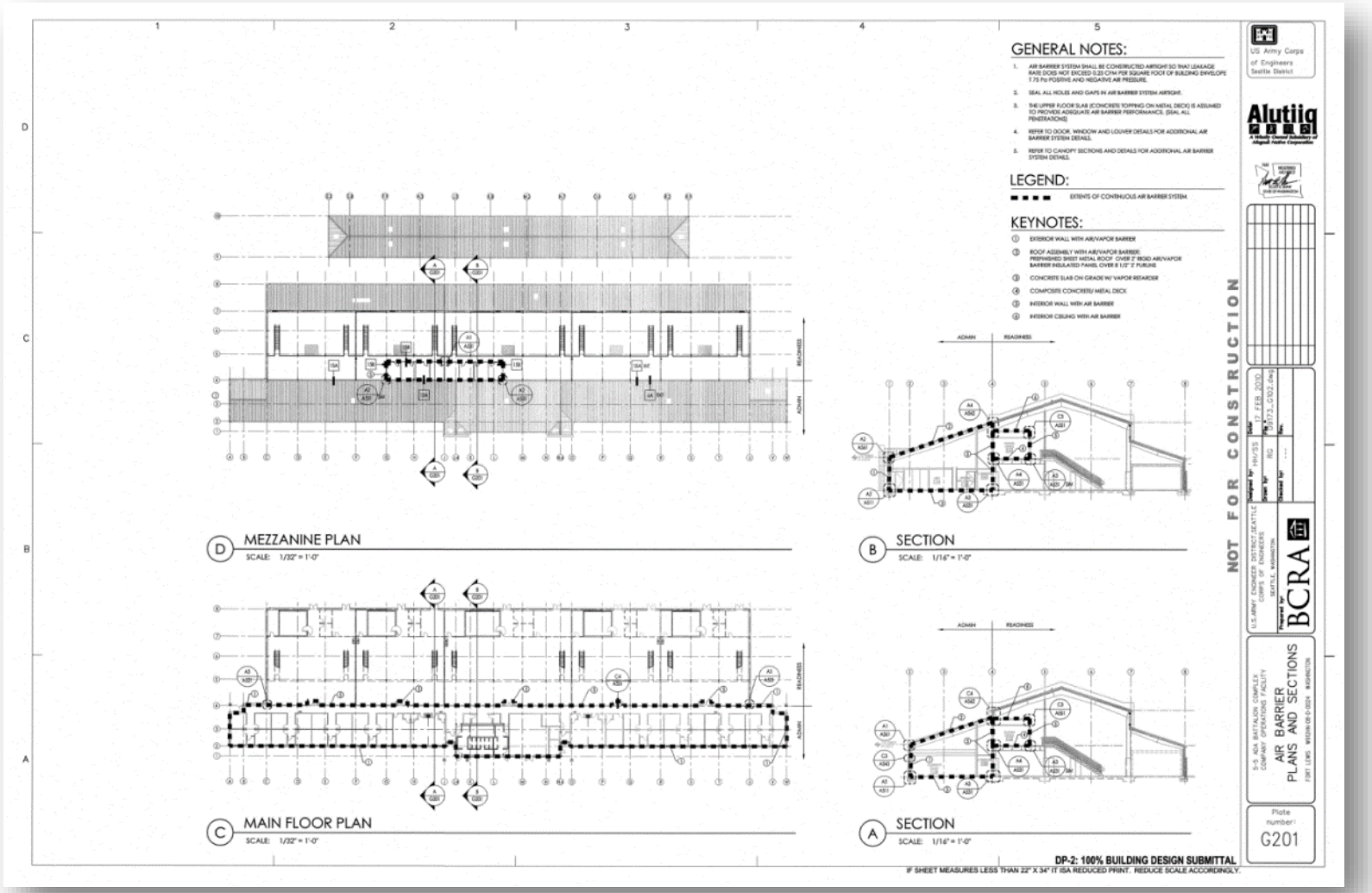


DEFINING PATHWAYS

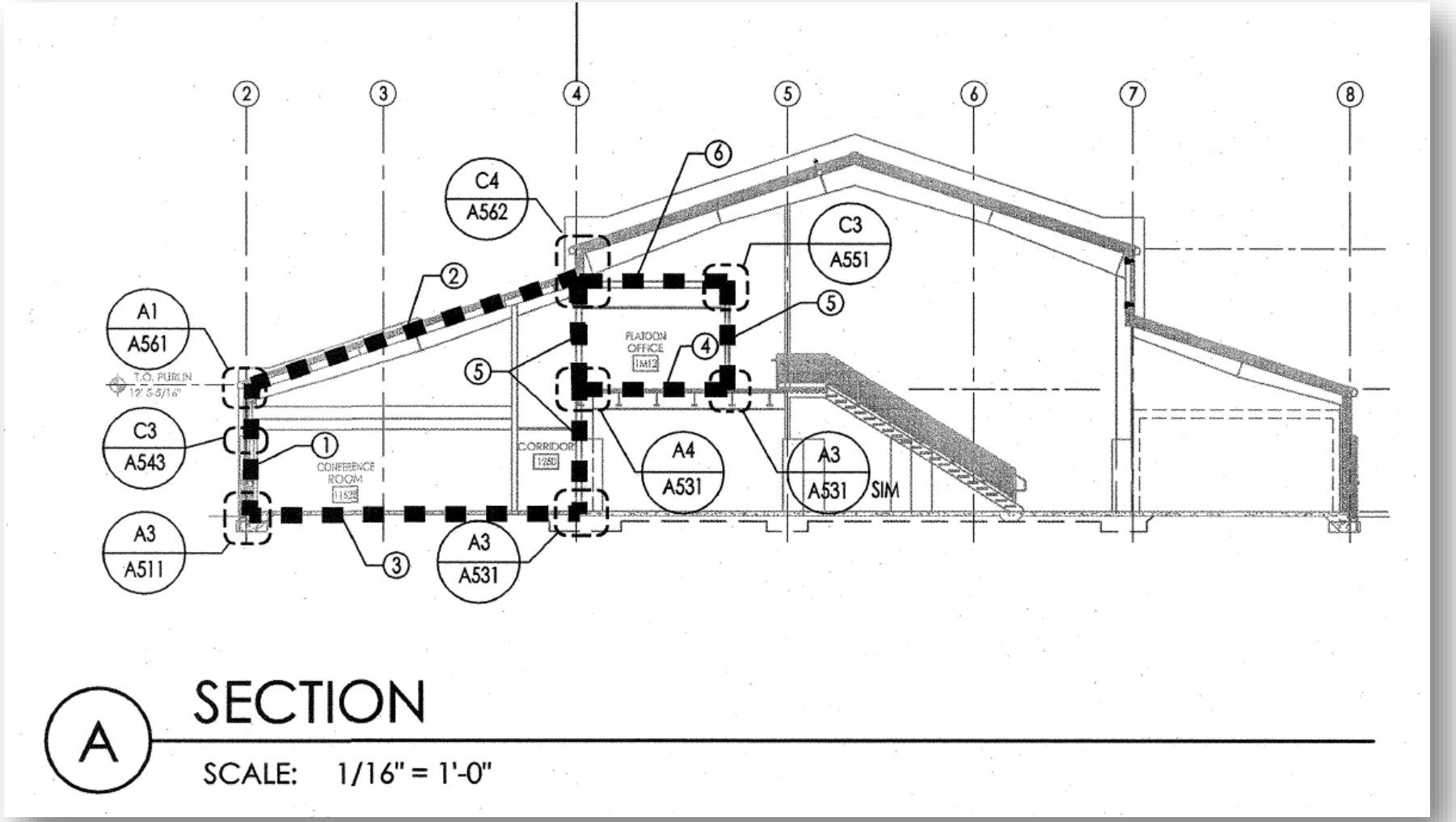
CASE STUDY –
5-5 ADA COF - JOINT BASE LEWIS-MCCHORD,WA



EXTENTS OF AIR BARRIER



EXTENTS OF AIR BARRIER



CONSTRUCTION

CONSTRUCTION

CONSTRUCTION

TARGET AIR LEAKAGE

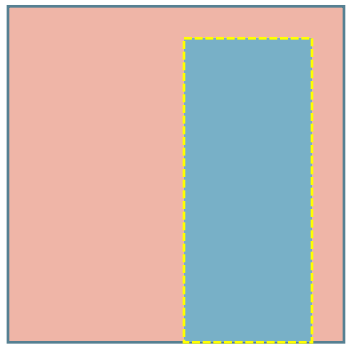
USACE	cfm/sf@75Pa
RFP Requirement	.25cfm/sf @75PA
5-5 COF Admin Office Area	Envelope SF 51,352
Allowable leakage rate	12,838 cfm
5-5 ADA COF Mezzanine Office	Envelope SF 4,887
Allowable leakage rate	1222 cfm

RESULTS

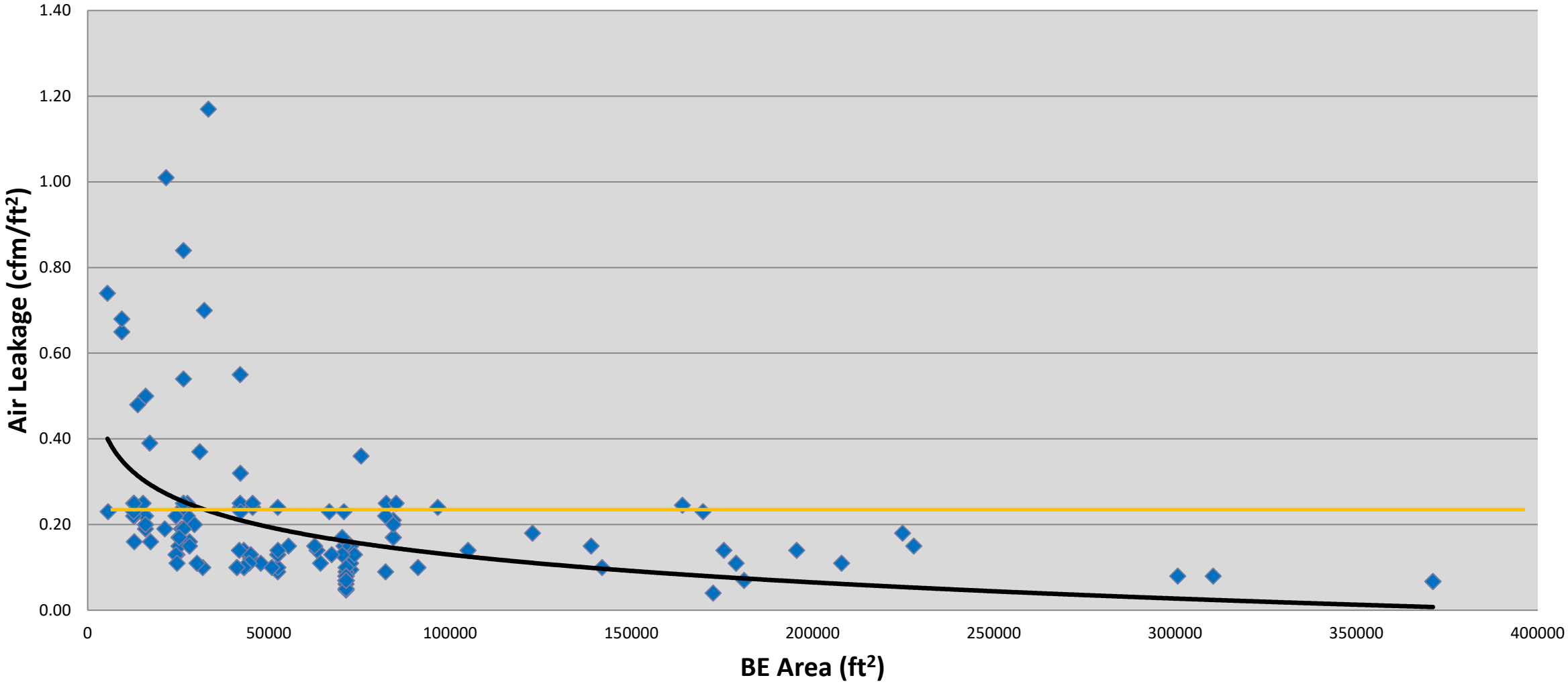
Admin Area	Mezzanine Offices
0.063	0.209
3,260 cfm/75	1,020 cfm/75

PROPORTION OF OPERATIONAL LEAKS

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



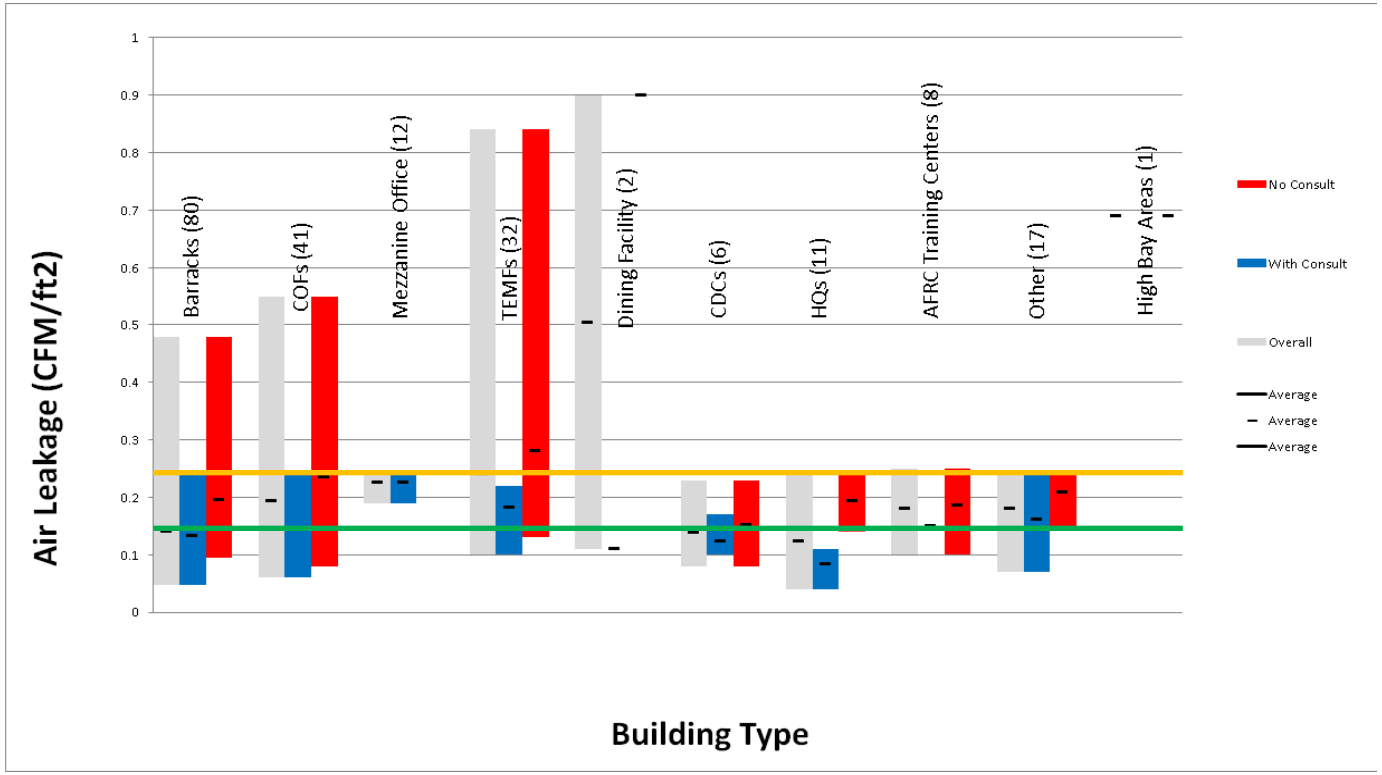
LEAKAGE RATE VS. BUILDING SIZE



LEAKAGE RATE VS. BUILDING SIZE

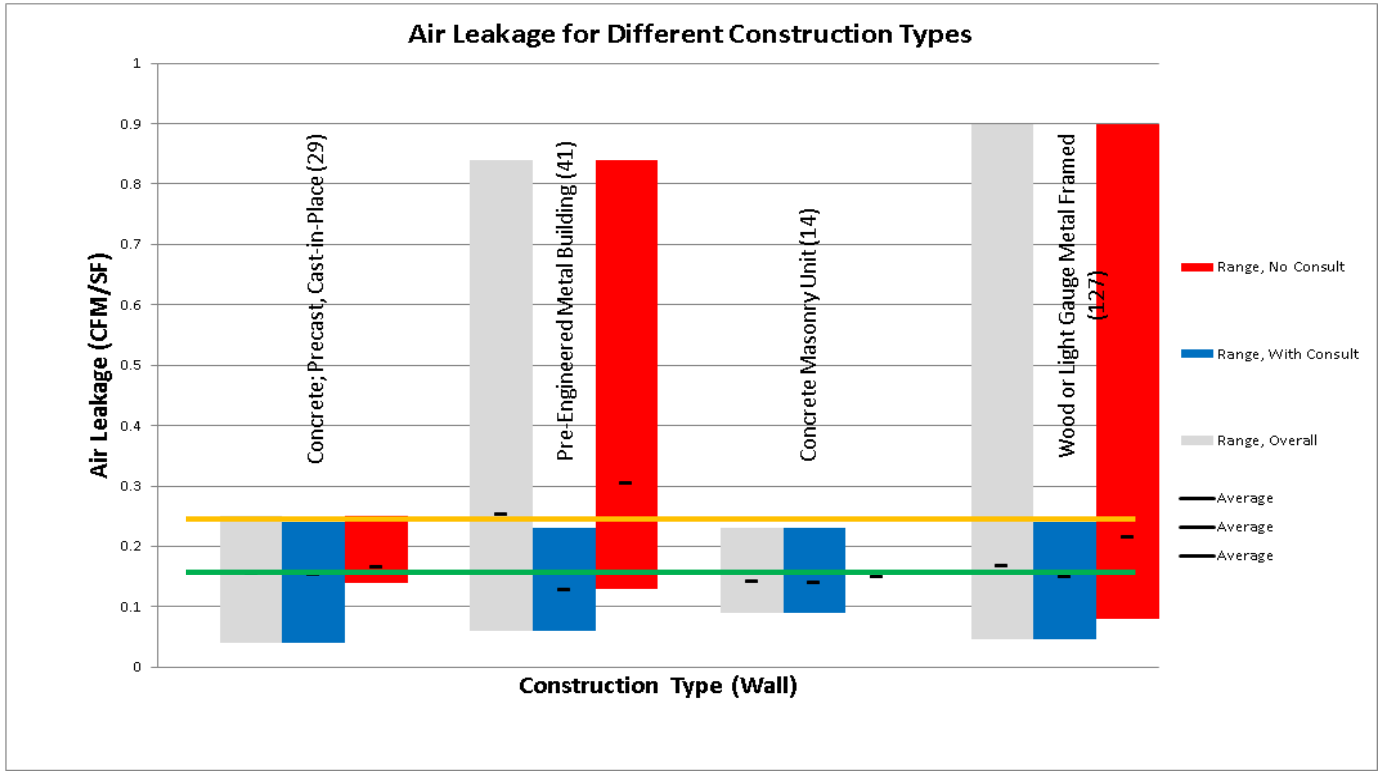
LT

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



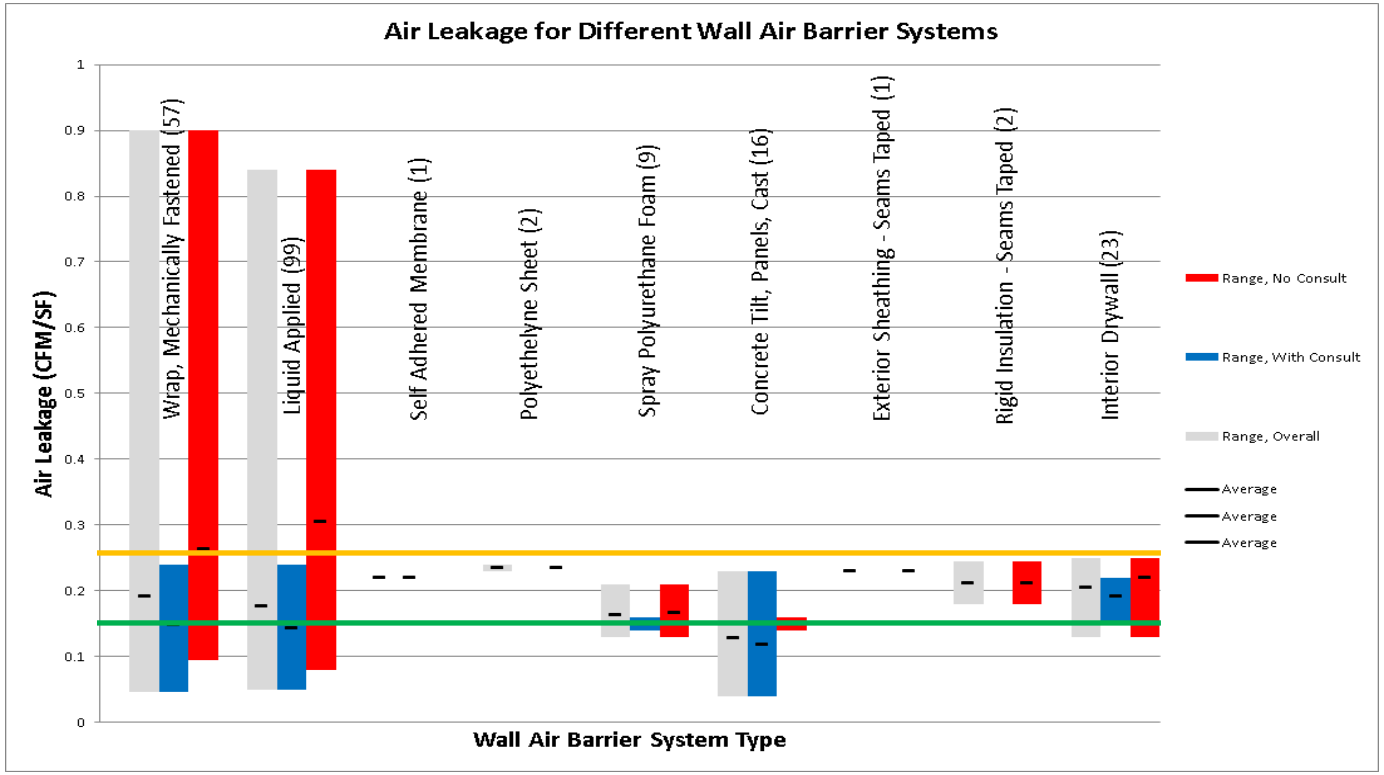
LT

- 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



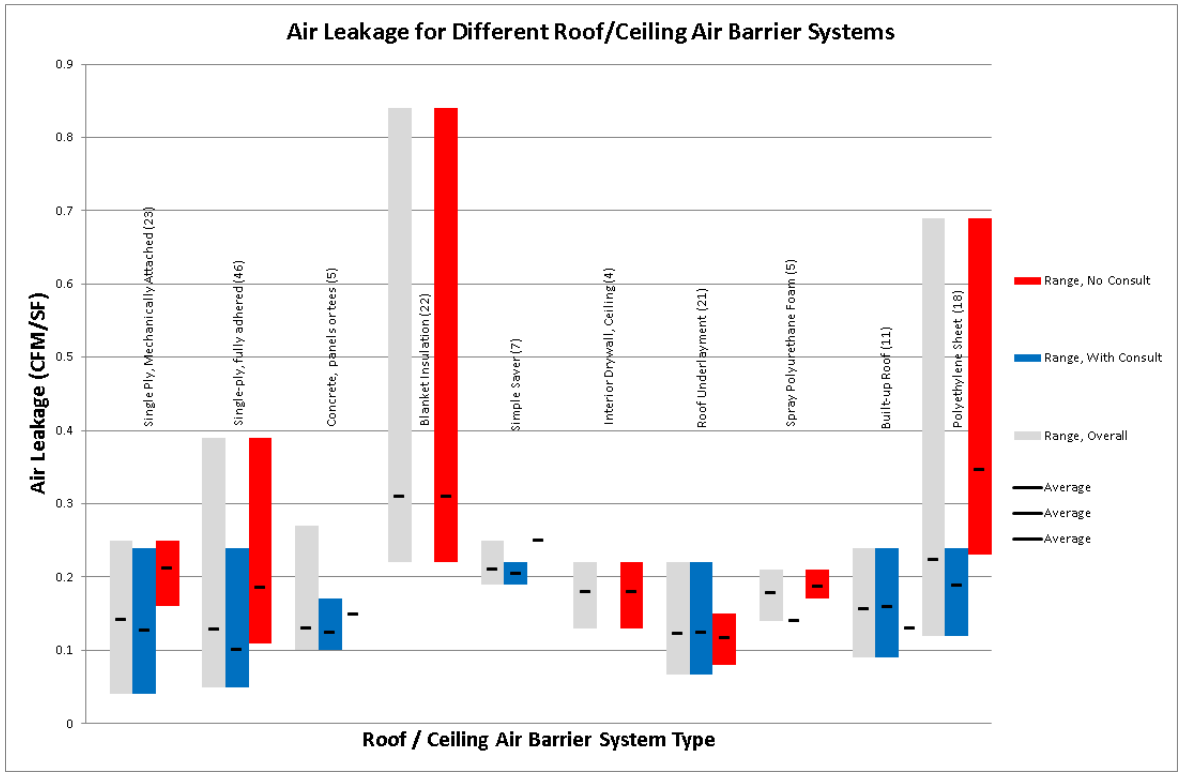
LT

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



LT

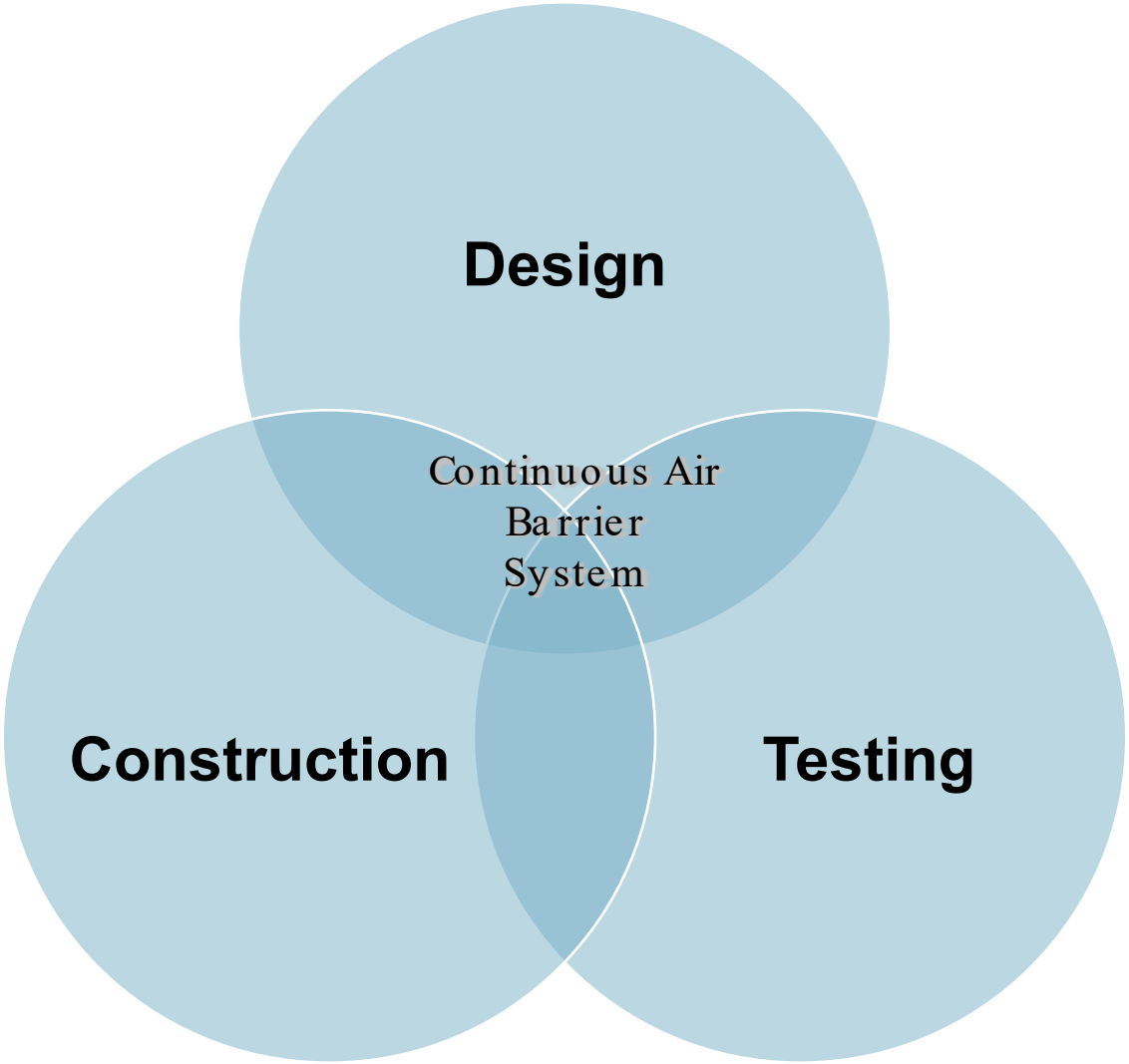
- Blanket Insulation Doesn’t Work
- Average & range, w/ no consultation
- 0.25 CFM/SF & 0.15 CFM/SF



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!

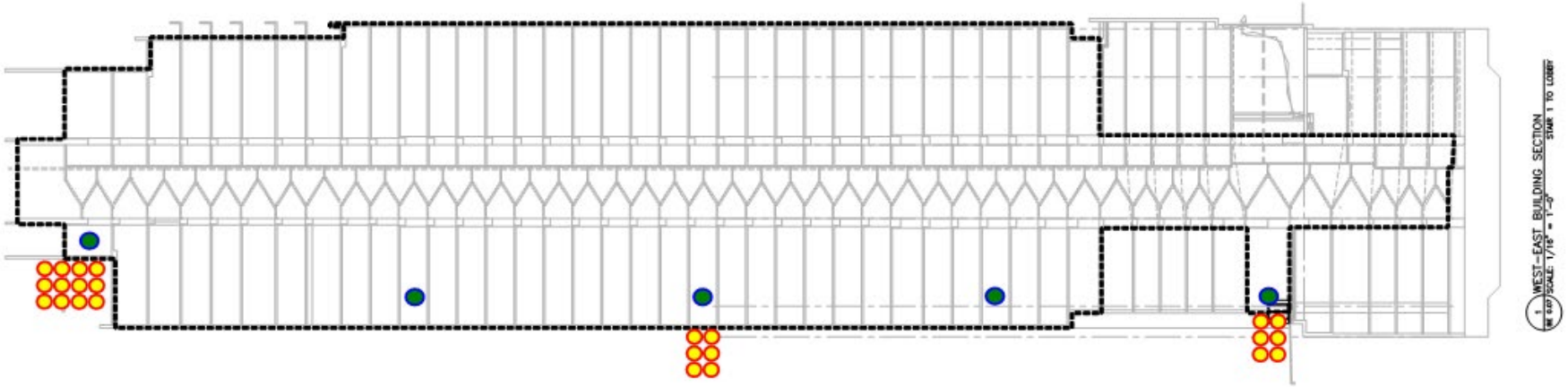
MULTI-PHASED HOLISTIC APPROACH



WBALT FOR ALL BUILDINGS

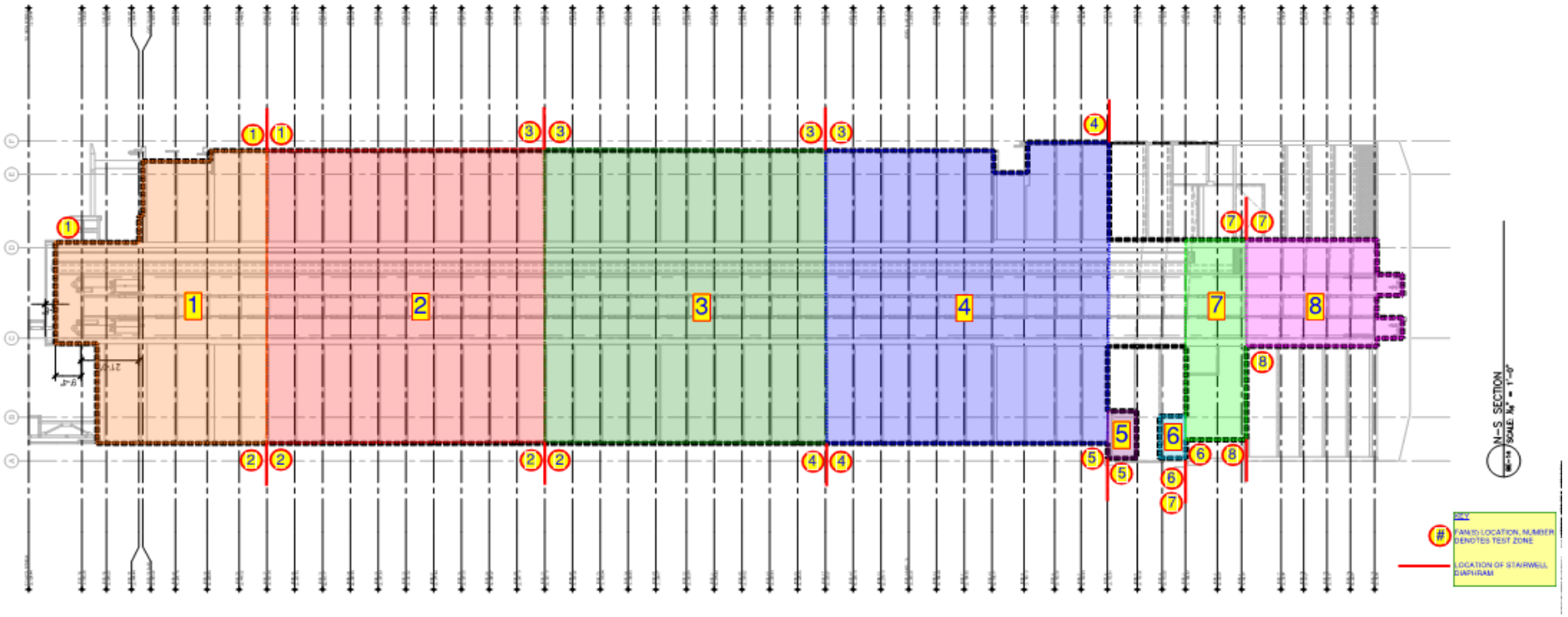
COMPARTMENTALIZE OR WHOLE BUILDING?

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



COMPARTMENTALIZE OR WHOLE BUILDING?

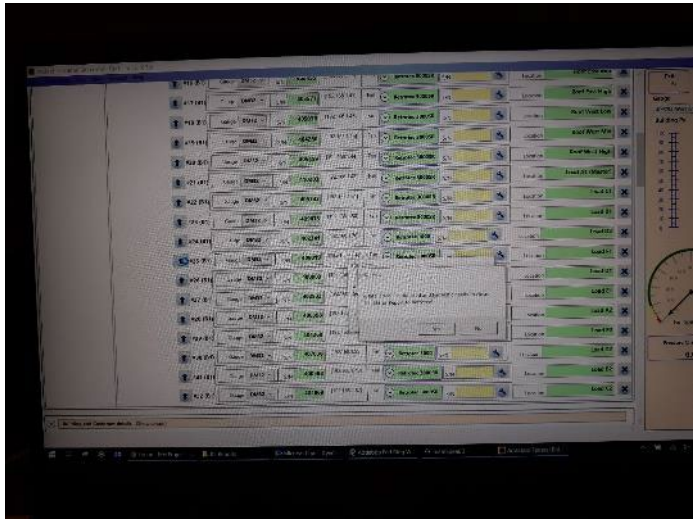
- Tall tower broken up for phased move-in
  - Extensive preparation and testing effort
  - Diaphragms in Stairwells
  - Pressure-equalize above and below test zones



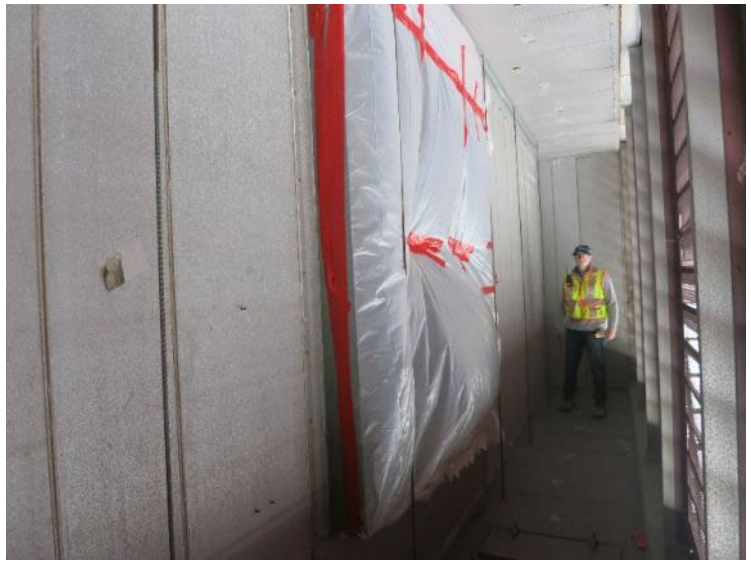
TESTING THE BEHEMOTHS- ASTM 3158

ASTM 3158

ASTM 3158



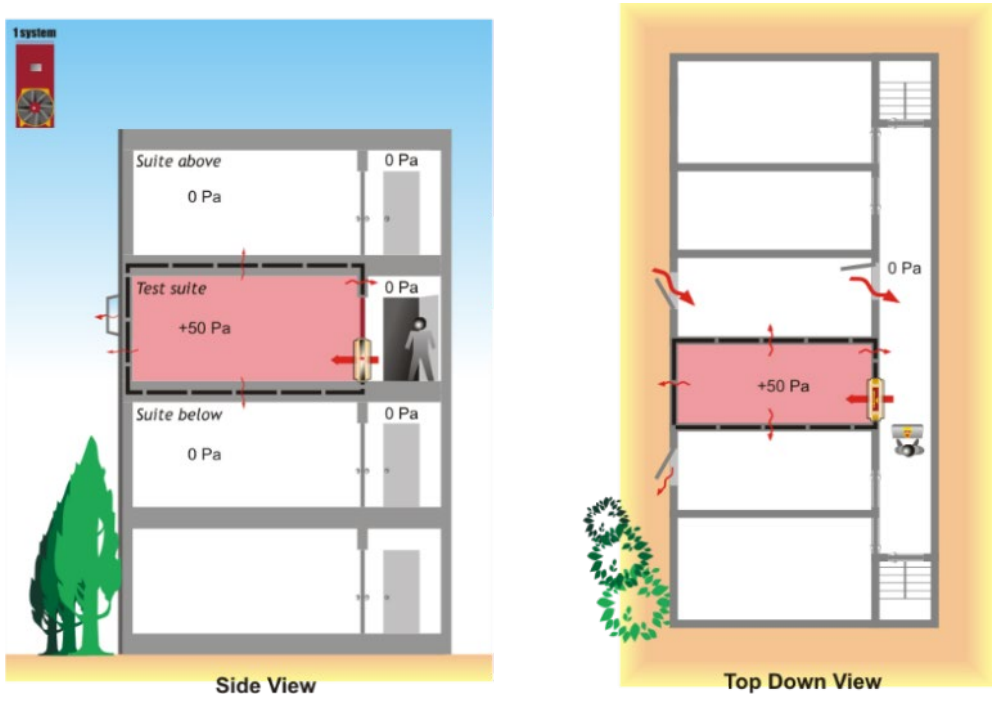
ASTM 3158



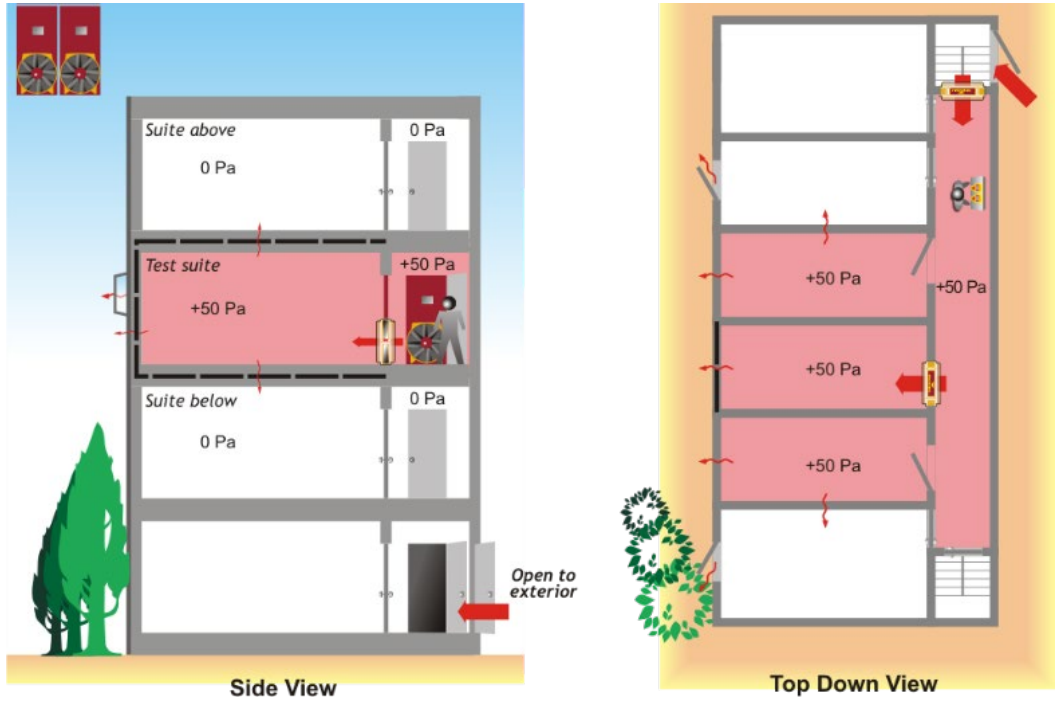
THE MONSTERS

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?!

air barrier abaa association of america

Whole Building Airtightness Program™

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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www.bpl-enclosure.com

abaa building enclosure conference

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