

# New Energy Code Impacts on Whole Building Air Leakage Testing

Lee Durston  
Morrison Hershfield

# New Energy Code Impacts on Whole Building Air Leakage Testing

Over the past decade, energy codes have brought a number of changes with respect to improving the performance of the building envelope both in design and construction. Most notable is the increasing importance placed on air-leakage through the enclosure and how this often unknown value affects many of the energy efficiency metrics that define the performance of the building. In North America, there are currently multiple codes and standards requiring varying levels of air tightness as well as varying performance levels and methods of verification. As the requirements and performance implications become understood, common design and construction practices will experience shifts toward better performance, as was experienced in the early years of the USACE requirements on which the private sector codes are based. Through a review of multiple case studies of current enclosure consulting and whole building air leakage testing, including high-rise, multi-family, and other commercial new and renovation construction, this presentation will provide a critical review of these codes and standards for validity, impact, and relevance.



## Lee Durston

Lee Durston is a Principal, Sr. Building Science Consultant with the Building Specialty Services division of Morrison Hershfield. Lee has over 19 years of building science experience over a variety of project types including military, mid-rise, high-rise, natatoriums, government, multi-family residential, and sporting venues. Lee performs holistic building envelope consulting and commissioning as well as forensic investigations using his skills in science and engineering to define, analyze, and remediate problems or failures in the building enclosure. Lee provides training for industry professionals, contractors, architects, developers, Navy Facilities Command (NAVFAC) and the US Army Corps of Engineers (USACE) on topics including Buildings Science, Infrared Thermography, and Air Barrier Design, Construction & Testing. He has served as a contributing editor for the USACE Air Leakage Testing Protocol.



## 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 the basic phases of holistic enclosure consulting related to air barriers and performance verification of air barriers.
3. Familiarize participants with specific building envelope requirements related to air leakage testing in the most recent and upcoming energy codes and how those codes and standards are being enforced.
4. Understand validity, impact, and relevance of the wide range of air tightness codes and standards.

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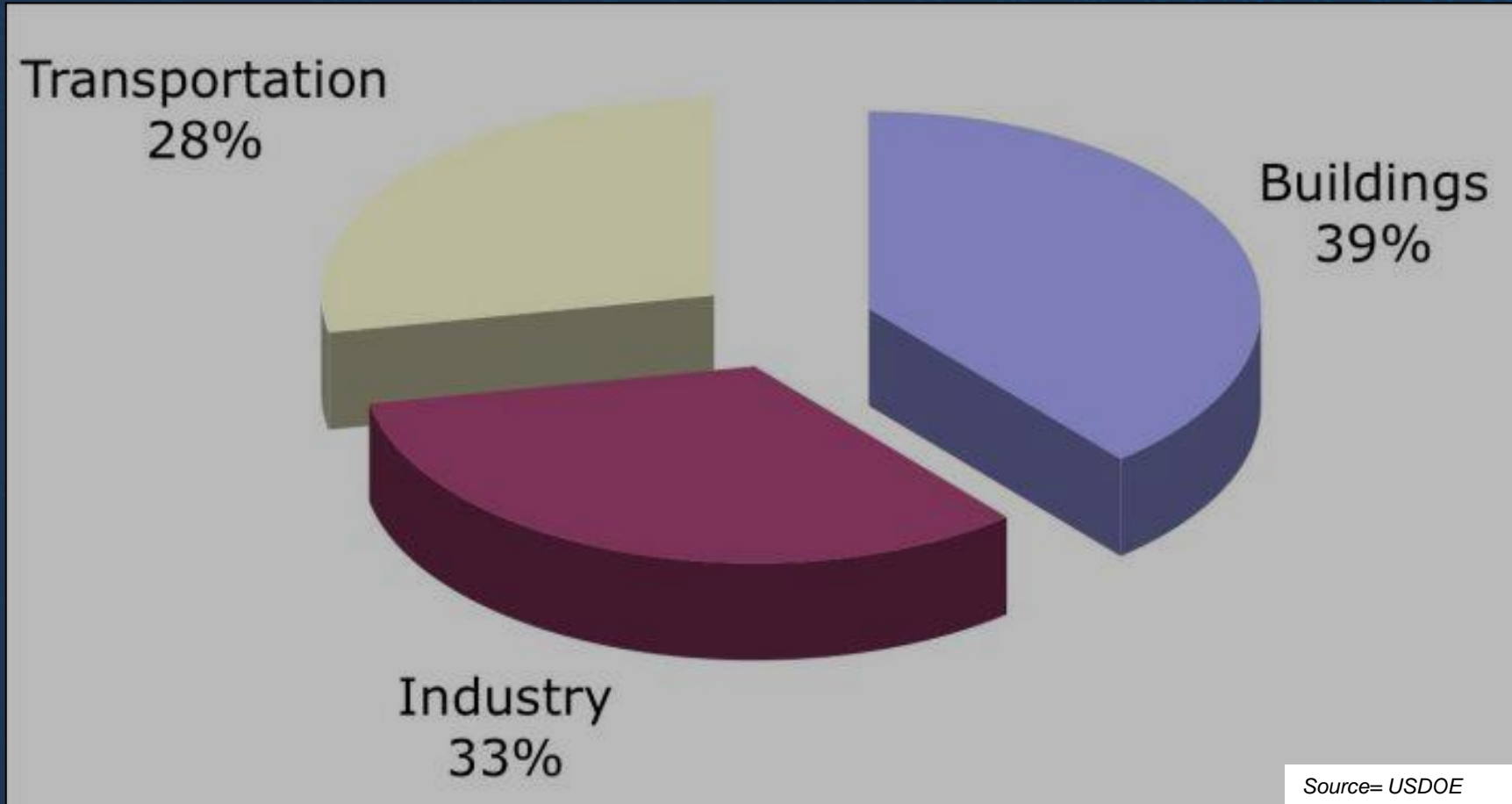


# Why Air Barriers and Why Now?

- Energy Conservation Measure
  - First Costs/Construction
  - Operational Costs
- Building Envelope Durability
  - H- Heat Barrier
  - A- Air Barrier
  - M<sub>L</sub>- Moisture Liquid
  - M<sub>V</sub>- Moisture Vapor

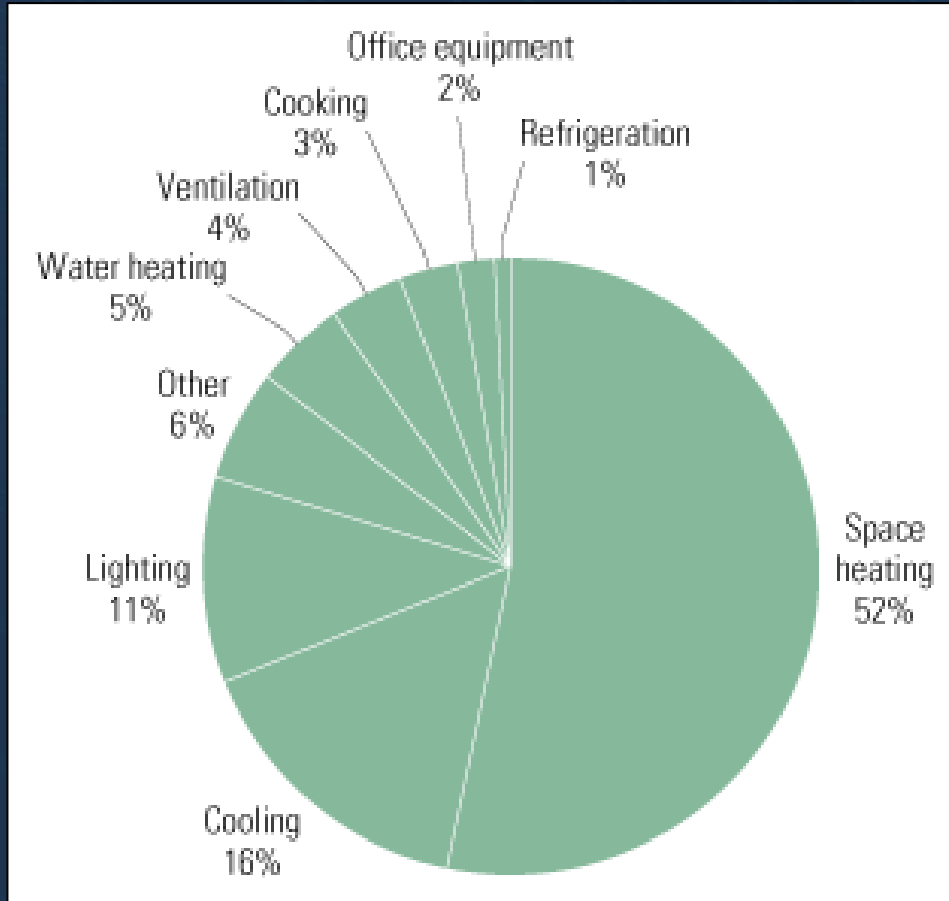


# Where is Energy Used?





# How Buildings Use Energy



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



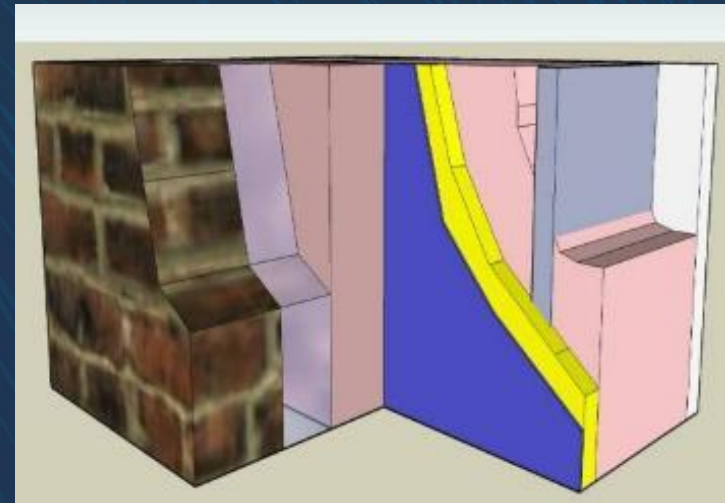
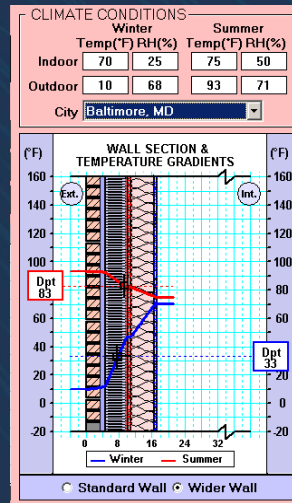
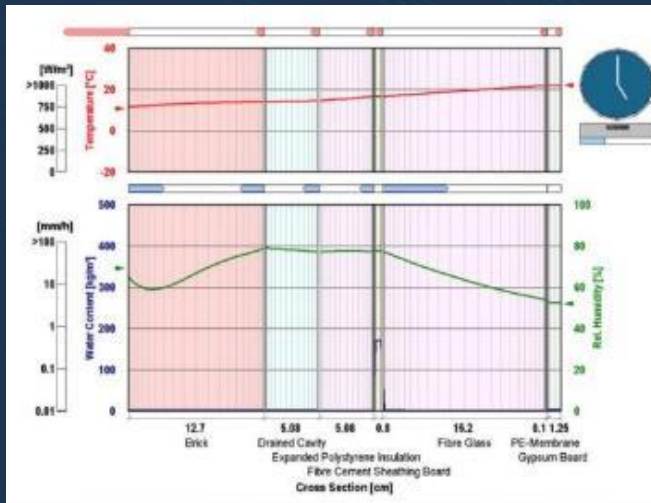
# Energy





# Durability

## HAMM- Building Enclosure Design



# Moisture Transport - Vapor Diffusion



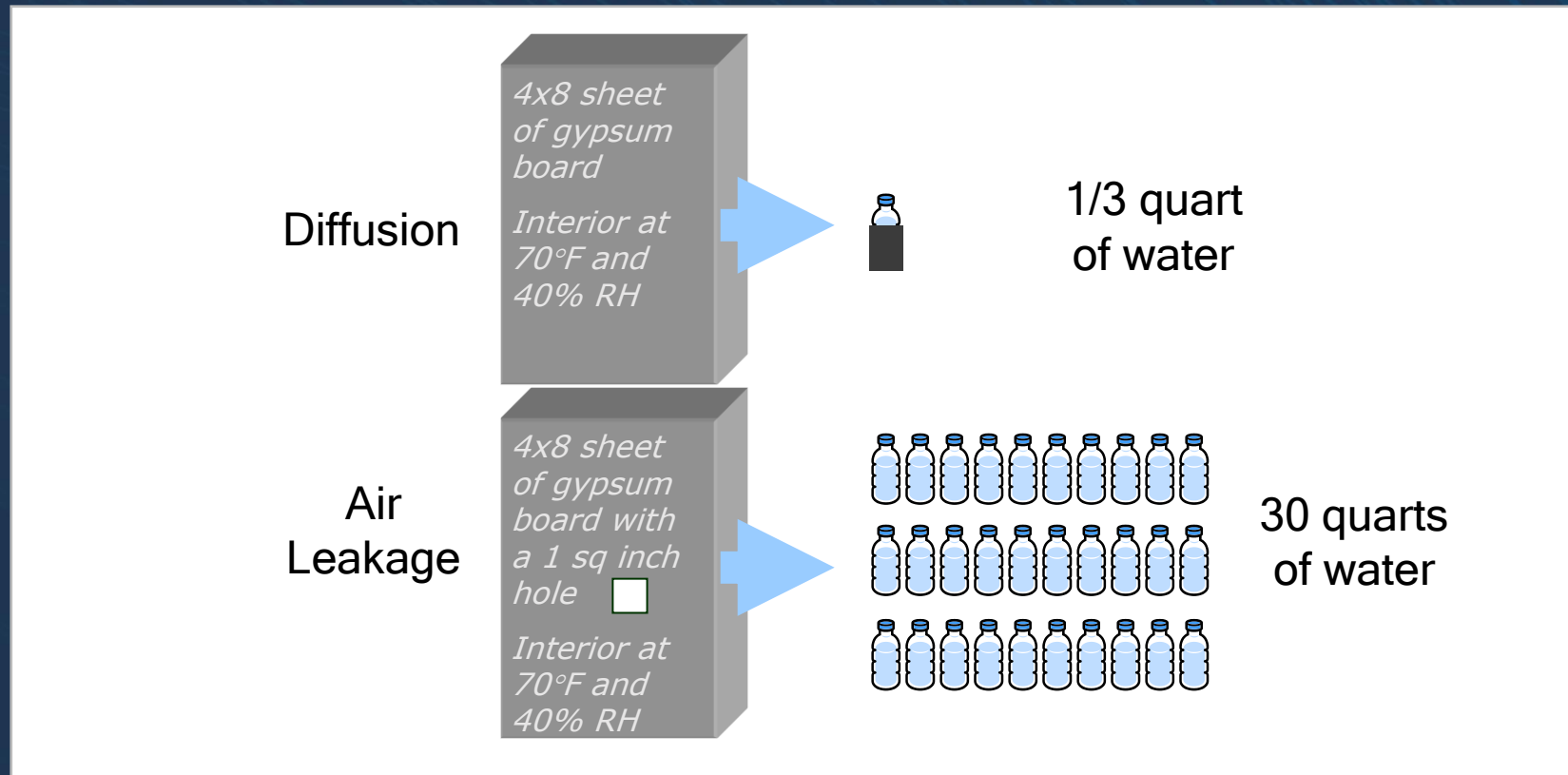


# Moisture Transport – Air Leakage





# Airborne Moisture



# Vapor Diffusion or Vapor Laden Air?





# Air Leakage Issues





# Air Leakage Issues





It haunts me.....





# Is it all just Hot Air?

NISTIR 7238

## Investigation of the Impact of Commercial Building Envelope Airtightness on HVAC Energy Use

Steven J. Emmerich  
Tim McDowell  
Wagdy Anis

 **NIST**  
National Institute of Standards and Technology  
Technology Administration, U.S. Department of Commerce

# green·wash

/ˈgrēnwôSH,ˈgrēnwäSH/

*noun*

disinformation 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"



Translations, word origin, and more definitions



# Stop the 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!



## CITY HALL ENERGY USAGE

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

● NEW BUILDING ● OLD BUILDING

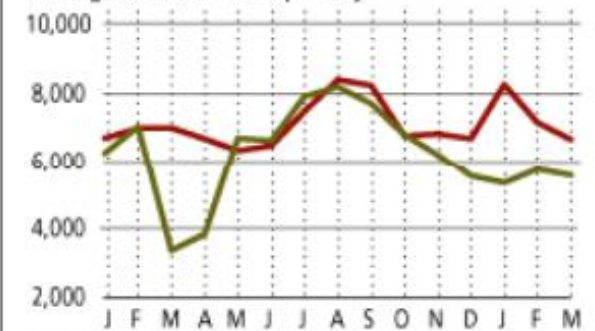
Average kilowatt-hours per day



Average kilowatt-hours per year



Month-by-month comparison\*  
Average kilowatt-hours per day



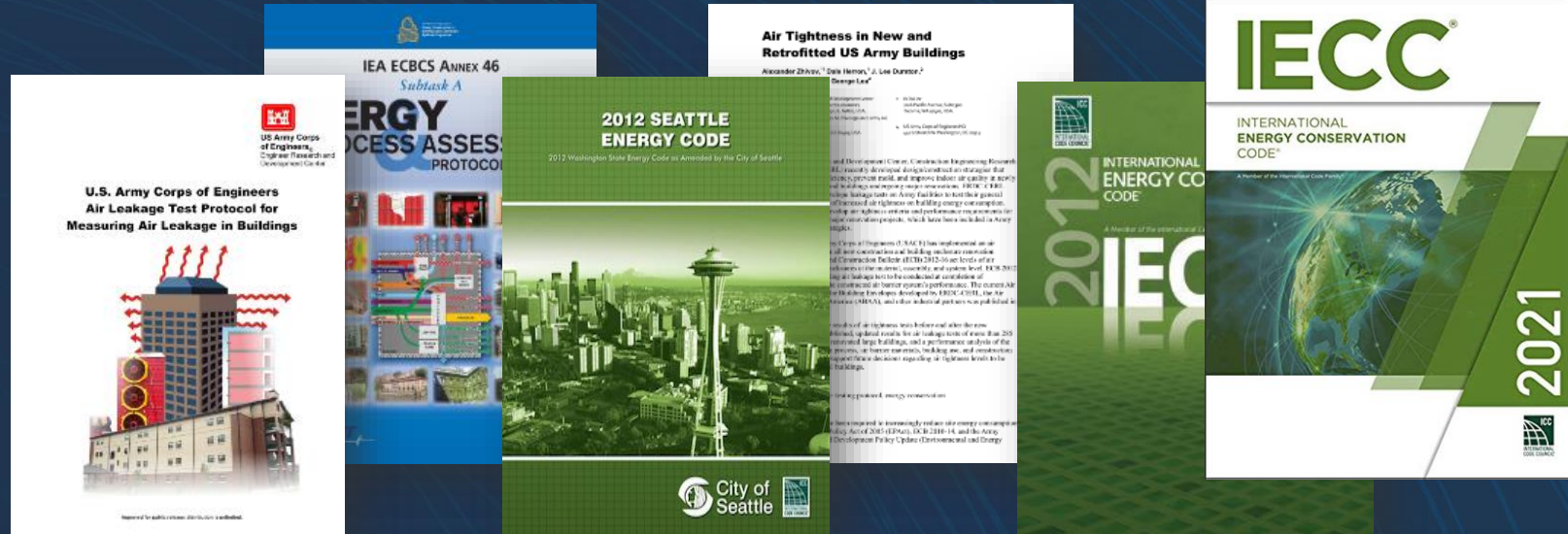
\*Old building: Jan. 2002-March 2003  
New building: Jan. 2004-March 2005

Source: Seattle City Light

SEATTLE POST-INTELLIGENCER



# From Then to Now





# A Look At Requirements Globally

			<small>cfm/ ft<sup>2</sup>[L/s*m<sup>2</sup>]at 75Pa</small>	
US	ASHRAE / IECC		0.40 cfm/ft <sup>2</sup> at 75Pa	<b>0.40/2.02</b>
US	LEED		1.25 in <sup>2</sup> EfLA @ 4 Pa / 100 ft <sup>2</sup>	<b>0.30/1.52</b>
US	ASHRAE Average fundamentals	handbook of	0.30 cfm/ft <sup>2</sup> at 75Pa	<b>0.30/1.52</b>
	<b>USACE / FEDERAL</b>		<b>0.25 cfm/ ft<sup>2</sup> at 75Pa</b>	<b>0.25/1.27</b>
UK	TS-1Commercial Tight		2 m <sup>3</sup> /h/m <sup>2</sup> at 50 Pa	<b>0.14/0.71</b>
CAN	R-2000		1 in <sup>2</sup> EqLA @10 Pa /100 ft <sup>2</sup>	<b>0.13/0.66</b>
US	ASHRAE 90.1 Tight fundamentals	handbook of	0.10 cfm/ft <sup>2</sup> at 75Pa	<b>0.10/0.51</b>

*For a 4 story building, 120 x 110 ft, n=0.65*



Leakier

Tighter



Passive House 0.06 cfm/ft<sup>2</sup> at 75Pa

# 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

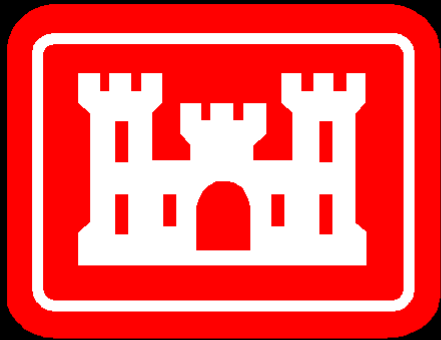
**220,000** sf x 0.06 cfm/sf = 13,200 cfm (Passive House)

**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)

# Early Push Back to an Air Tightness Requirement

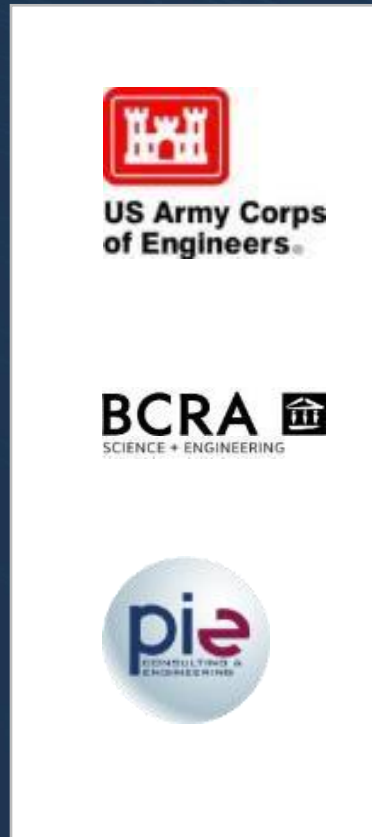


**US Army Corps  
of Engineers®**

- 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



# Test Study



- 285 DoD buildings
- Time range of 29 months
- 34+ DoD installations
- All climate zones in the United States *with some additional off shore*
- One to nine stories
- Building envelope areas ranging from 1,000 ft<sup>2</sup> to 370,000 ft<sup>2</sup>
- All building types/uses



# Lessons Learned





Poly Vapor Barrier = Air Barrier









# Size Matters- Detroit Arsenal Building 270





# Detroit Arsenal Bldg. 270



# Detroit Arsenal Bldg. 270





# WBALT



# Test Set-Up

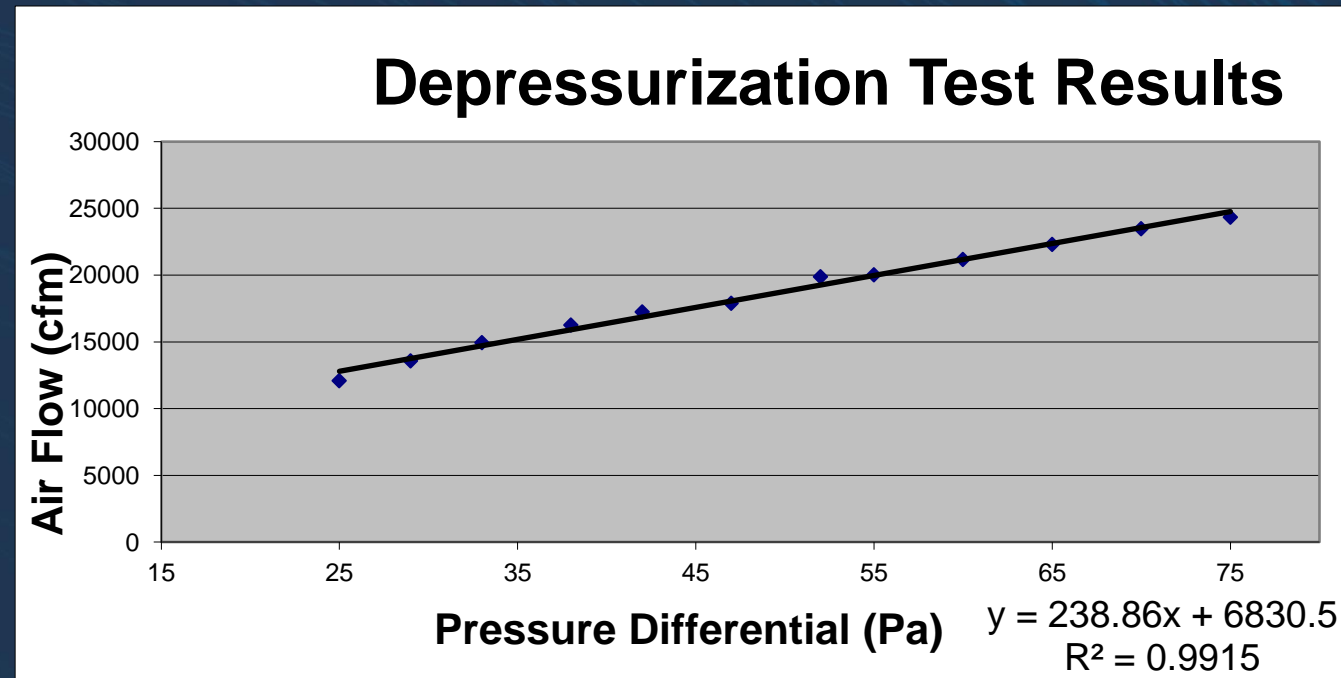




# Target Air Leakage

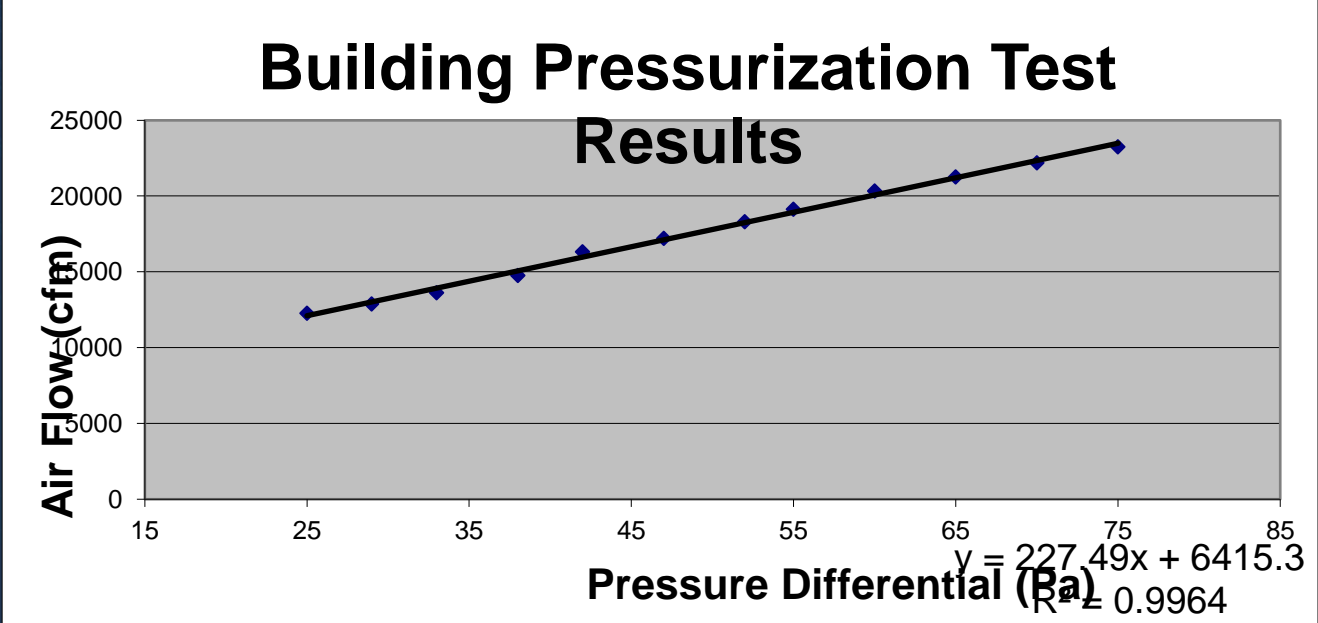
USACE	cfm/sf@75Pa
<i>RFP Requirement</i>	<i>.25cfm/sf @75PA</i>
<i>Detroit Arsenal Bldg. 270</i>	<i>Envelope SF: 144,622</i>
<i>Allowable leakage rate</i>	<i>36155.5 cfm</i>

# Data





# Data

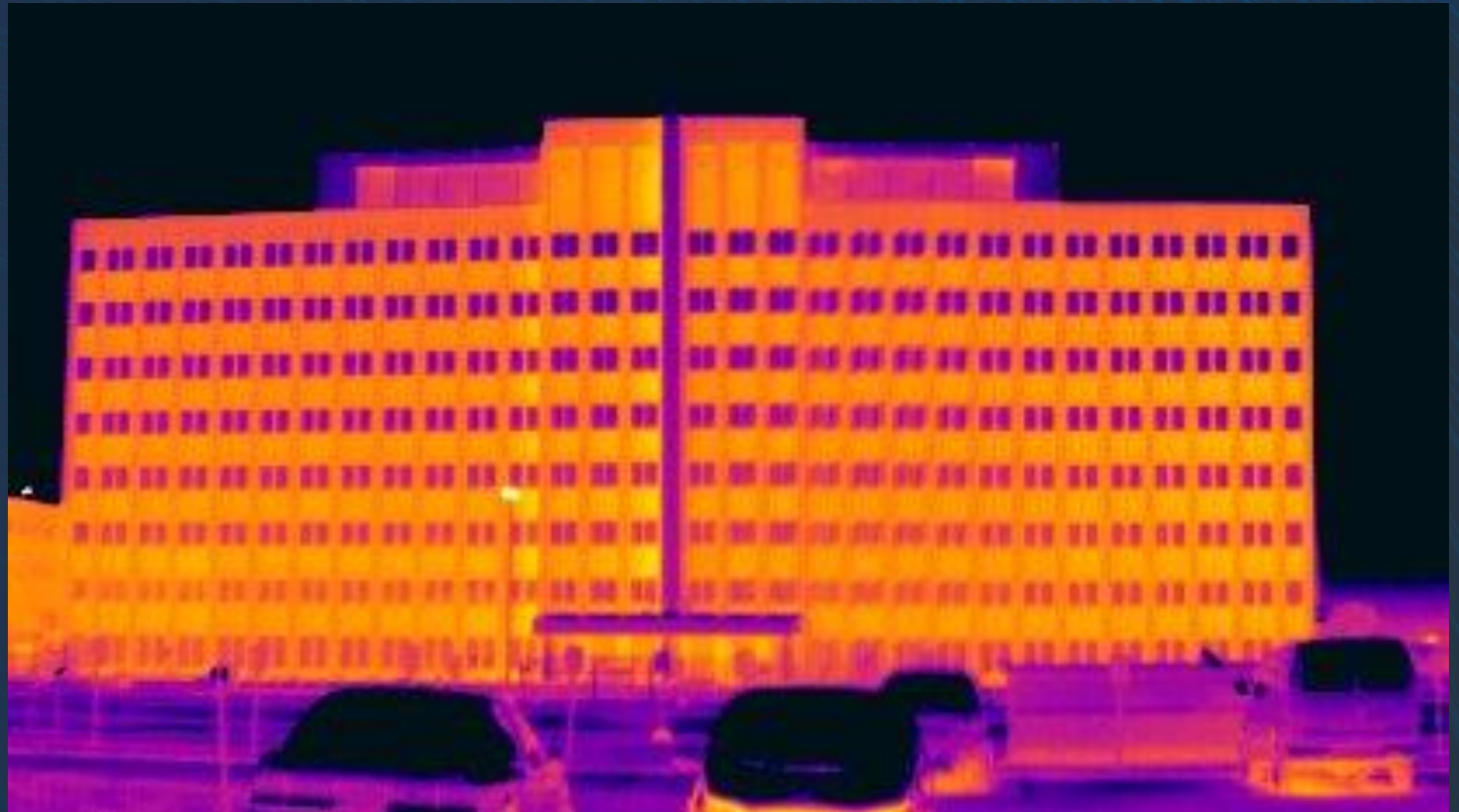


# Results

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



# Infrared Survey



# Infrared Survey

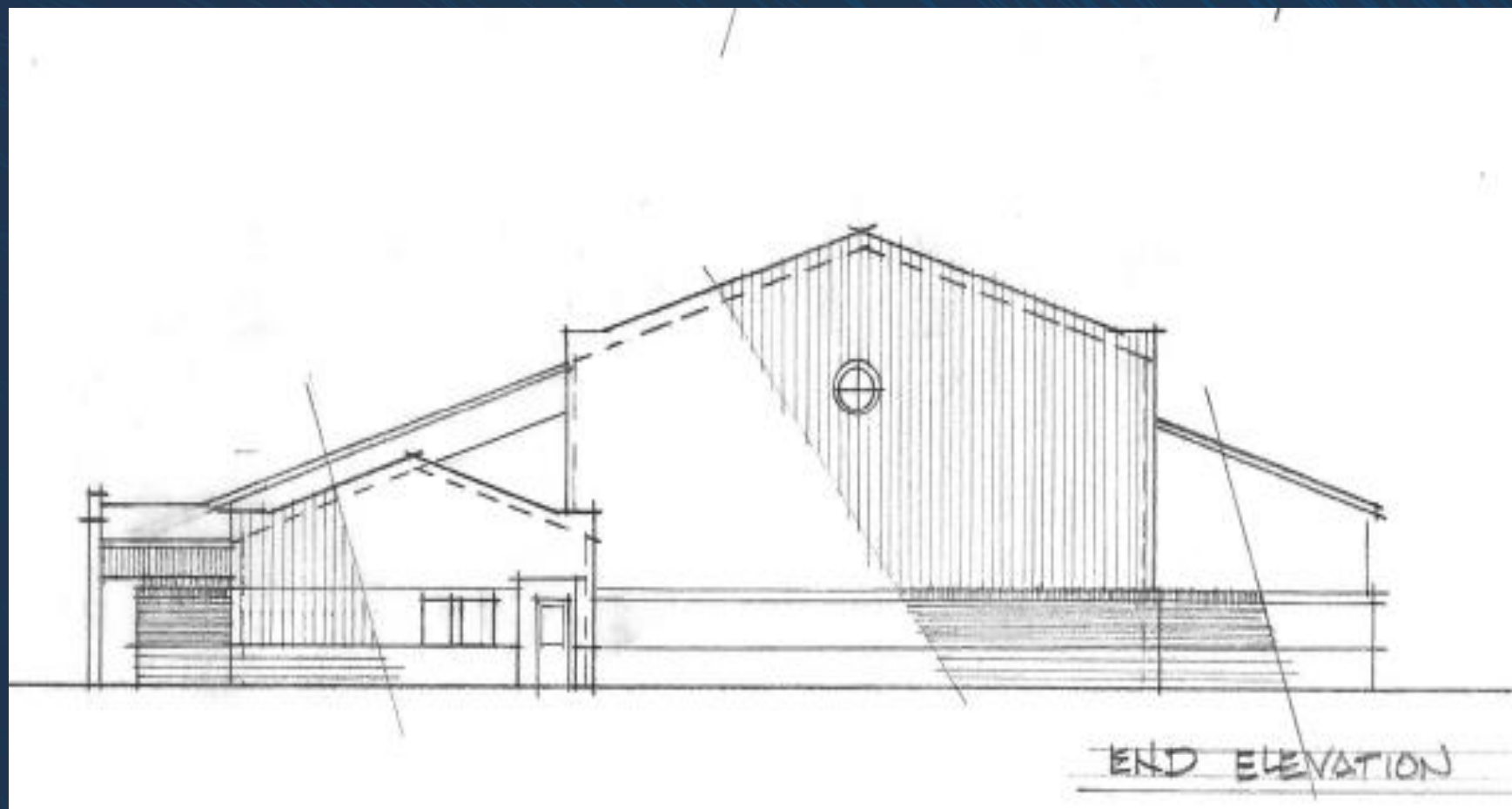




# Infrared Survey

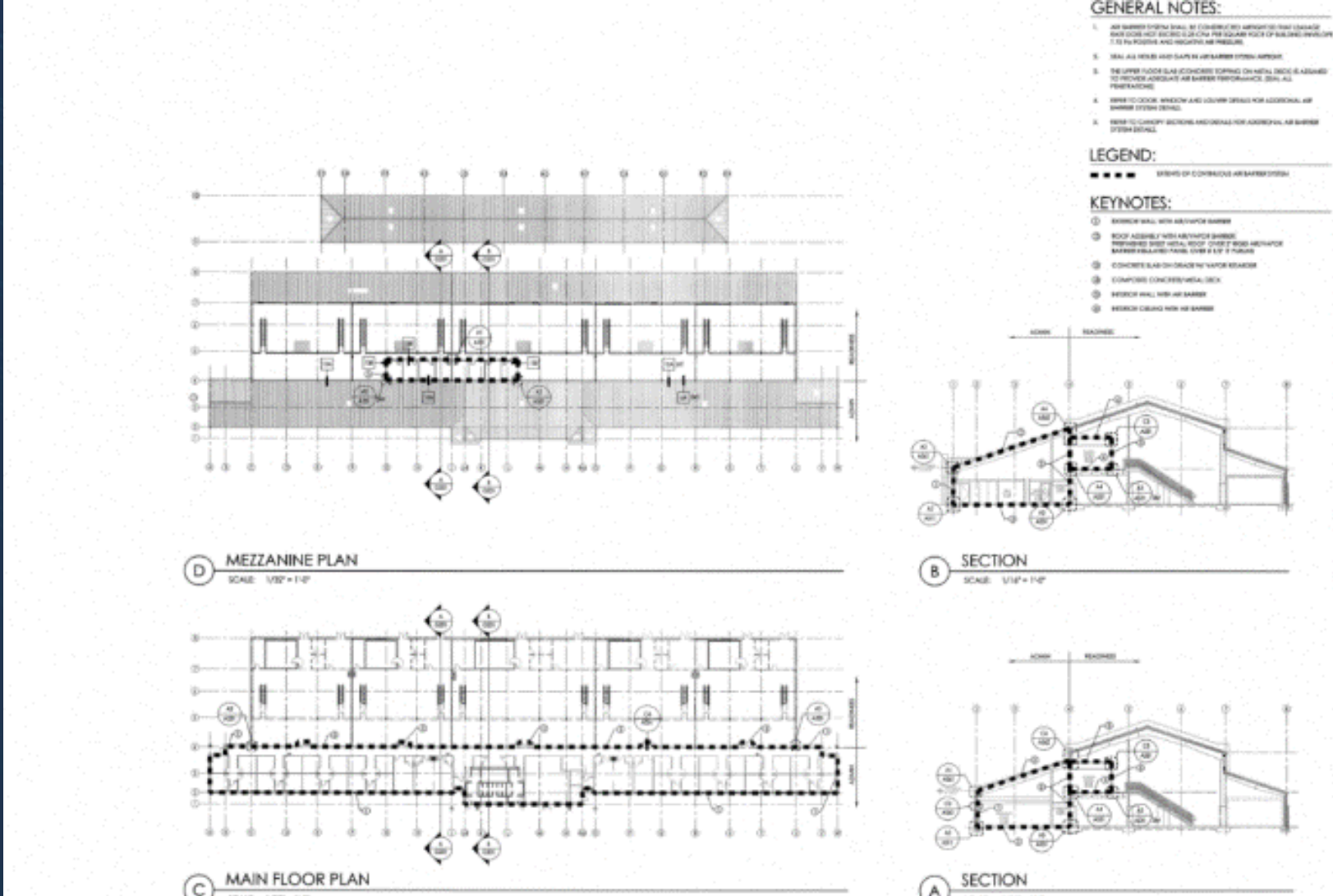


# Size Does Matter- Case Study 5-5 ADA COF

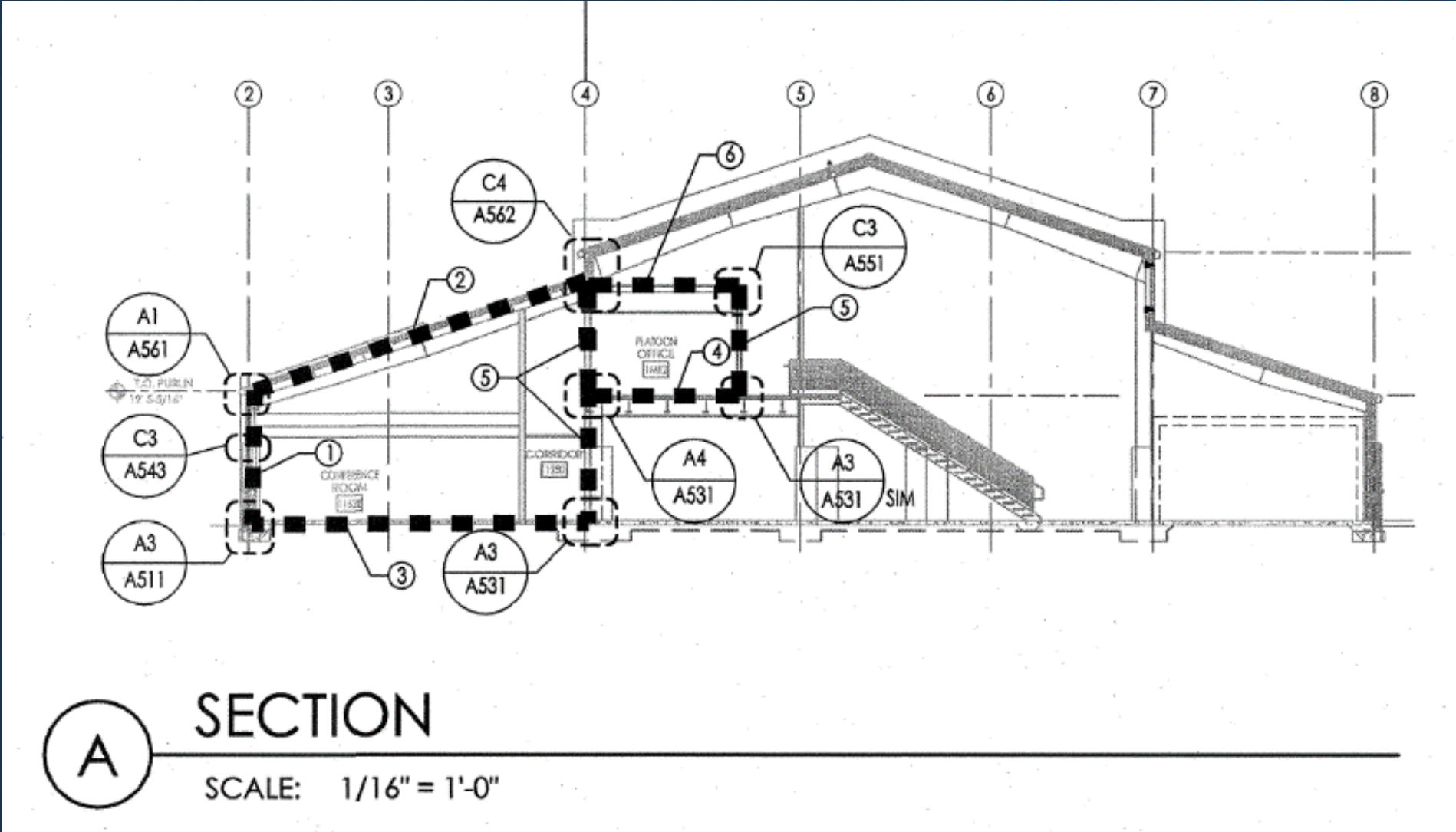




# Extents of Air Barrier



# Extents of Air Barrier





# 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	1,222 cfm

# Results

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



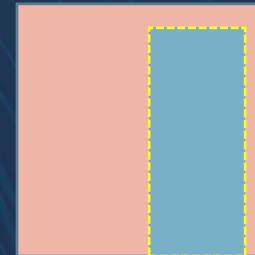
# Proportion of Operational Leaks

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

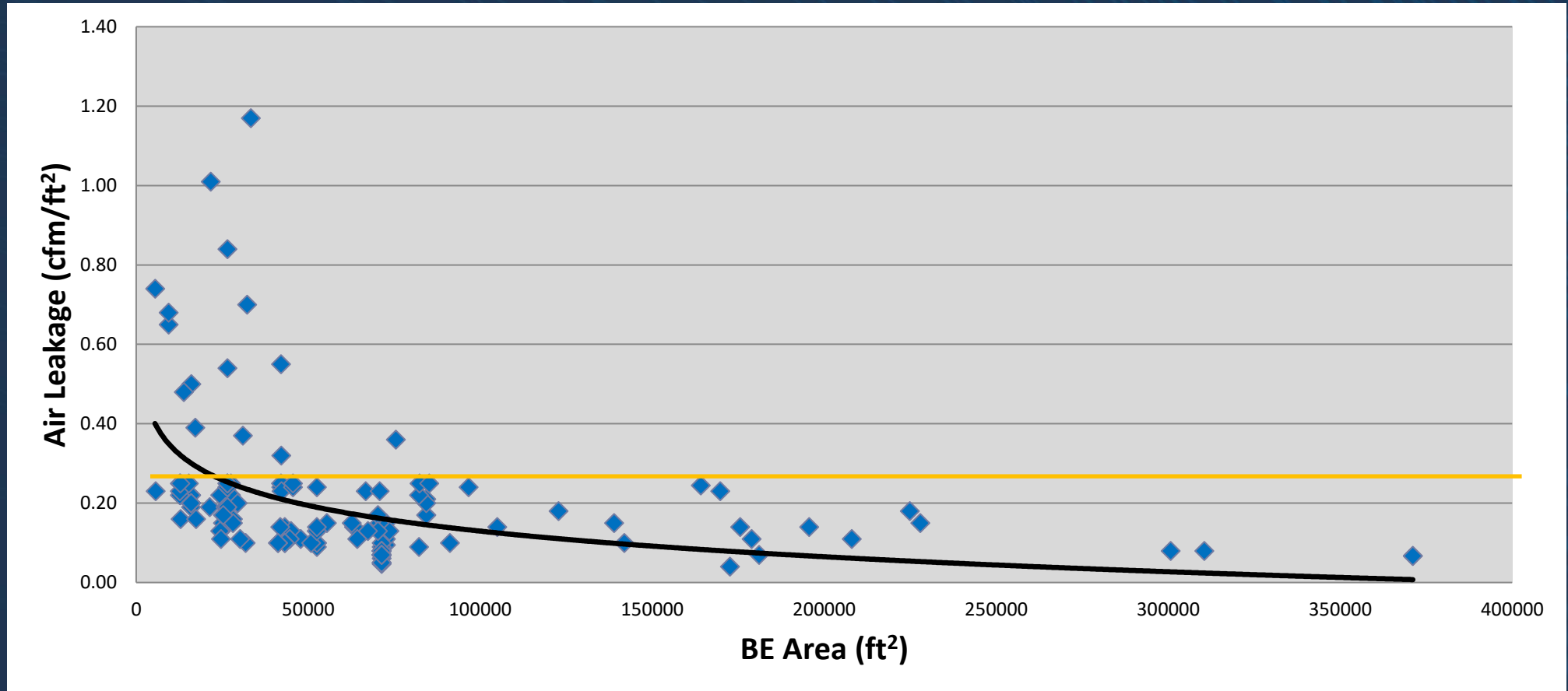
150cfm @ 75Pa



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



# Leakage Rate vs. Building Size



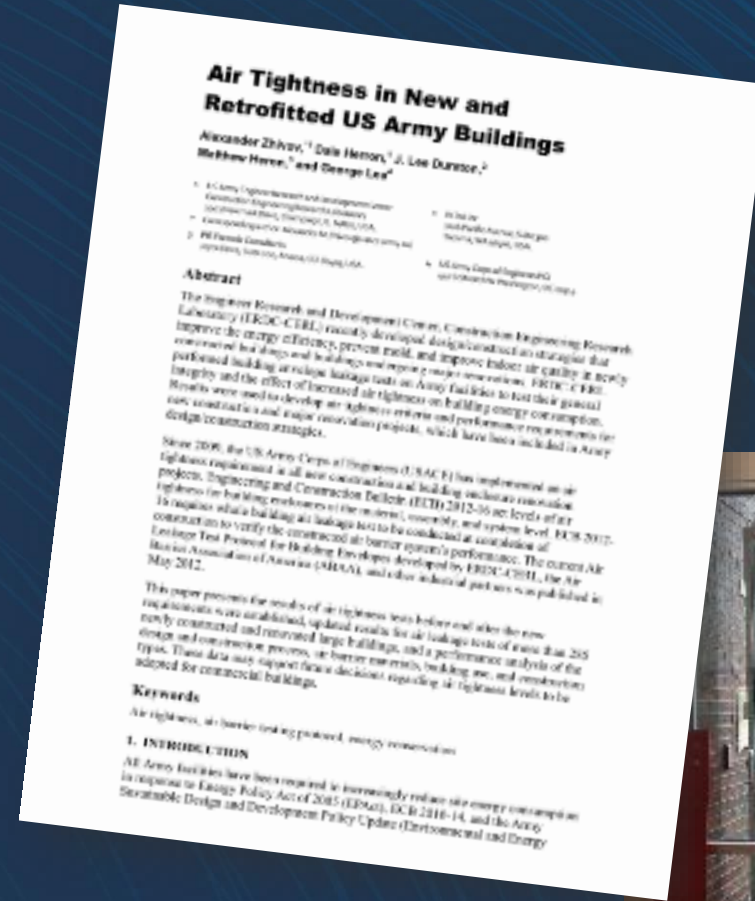






# Success of the Air Tightness Requirement

- Achievable
- Applicable
- Does not limit construction type
- Does not limit construction materials
- Building envelope discipline






# Energy Code Requirements

- Federal: Passing 0.25 cfm/ft<sup>2</sup> since 2009 (UFC)
  - Military Departments\*
  - Defense Agencies
  - DoD Field Activities
- Federal Level Construction\*
- SOFA, HNFA, BIA, etc.




# What is the Right Number?

- Energy
- Durability

		<small>cfm/ft² [L/s·m²] at 75Pa</small>	
US	ASHRAE / IECC	0.40 cfm/ft² at 75Pa	<b>0.40/2.02</b>
US	LEED	1.25 in² EflA @ 4 Pa / 100 ft²	<b>0.30/1.52</b>
US	ASHRAE Average <small>handbook of fundamentals</small>	0.30 cfm/ft² at 75Pa	<b>0.30/1.52</b> <i>Leakier</i>
	<b>USACE / FEDERAL</b>	<b>0.25 cfm/ft² at 75Pa</b>	<b>0.25/1.27</b>
UK	TS-1 Commercial Tight	2 m³/h/m² at 50 Pa	<b>0.14/0.71</b>
CAN	R-2000	1 in² EqLA @ 10 Pa / 100 ft²	<b>0.13/0.66</b> <i>Tighter</i>
US	ASHRAE 90.1 Tight <small>handbook of fundamentals</small>	0.10 cfm/ft² at 75Pa	<b>0.10/0.51</b>

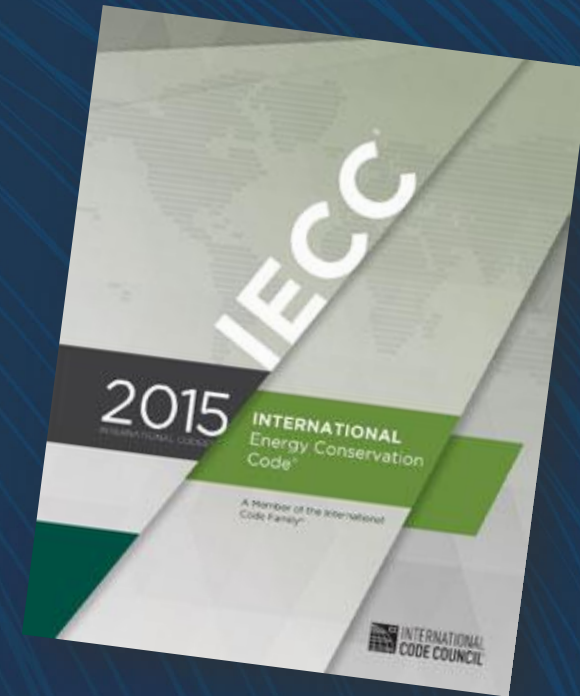
*For a 4 story building, 120 x 110 ft, n=0.65*

 Passive House 0.06 cfm/ft² at 75Pa



# IECC – 2012, 2015.....

- IECC - 0.4 cfm/ft<sup>2</sup>
  - Materials
  - Assemblies
  - WBALT
    - The IECC exempts buildings in Climate Zones 1 through 3 and 90.1-2010 exempts semi-heated spaces in Climate Zones 1 through 6 in addition to single wythe concrete buildings in Climate Zone 2B





# IECC – 2021 new developments

A modification to Section C402.5 (Air Leakage) of the 2021 International Energy Conservation Code (IECC) states that in Section C402.5, air leakage requirements are expanded to include requirements for residential and non-residential air leakage testing and for building envelope performance verification for buildings not tested.

Air leakage testing was introduced as a compliance alternative to meeting the material or assembly selection and installation provisions of the 2012 IECC, and the requirements remained largely unchanged until the expansion of requirements in the 2021 IECC. Three significant changes related to air leakage are made to the 2021 IECC:

1. New requirements for dwelling unit air leakage testing for Group R and I occupancies
2. Revised and required air leakage requirements for occupancies other than Group R and I
3. New performance verification requirements





# IECC – 2021 new developments

The updated air leakage testing requirements of Section C402.5 take into consideration occupancy type, climate zone and building size. Commercial buildings under 5,000 square feet can be tested using residential methods, technicians and equipment with the maximum leakage rate set at 0.30 cfm/ft<sup>2</sup> (1.5 L/s 3 m<sup>2</sup>) at 0.2 in. w.g. (50 Pa). This testing pressure differential is common for residential testing and is equivalent to a leakage rate of 0.40 cfm/ft<sup>2</sup> (1.5 L/s 3 m<sup>2</sup>) at 0.3 in. w.g. (75 Pa). Implementing the residential procedure can significantly reduce testing costs for these smaller buildings. Buildings that are not tested must meet the materials or assemblies requirements and the air barrier must be visually inspected. A final commissioning report is required for such inspections.





# IECC – 2021 new developments

There are instances when the building is tested and it exceeds the maximum leakage rate. Section C402.5.3 provides reasonable options for mitigating air leakage when the rate is greater than allowed in the code but does not exceed 0.60 cfm/ft<sup>2</sup>, including the use of a smoke tracer or infrared imaging along with a visual inspection. Leaks must be sealed where it is possible to do so without destroying building components. Documentation showing all leaks that were found and mitigating measures must be submitted to the code official and building owner.





# Specified Air Leakage Rates

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

*Past Construction Practices: 0.4 to 1.0 cfm/ft<sup>2</sup>*



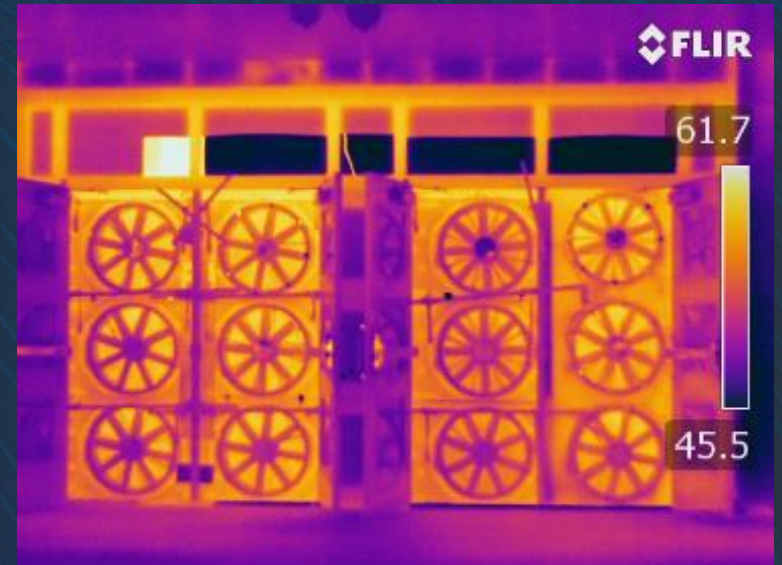
# Materials or Assemblies or WBALT



ASTM 2178



ASTM 2357

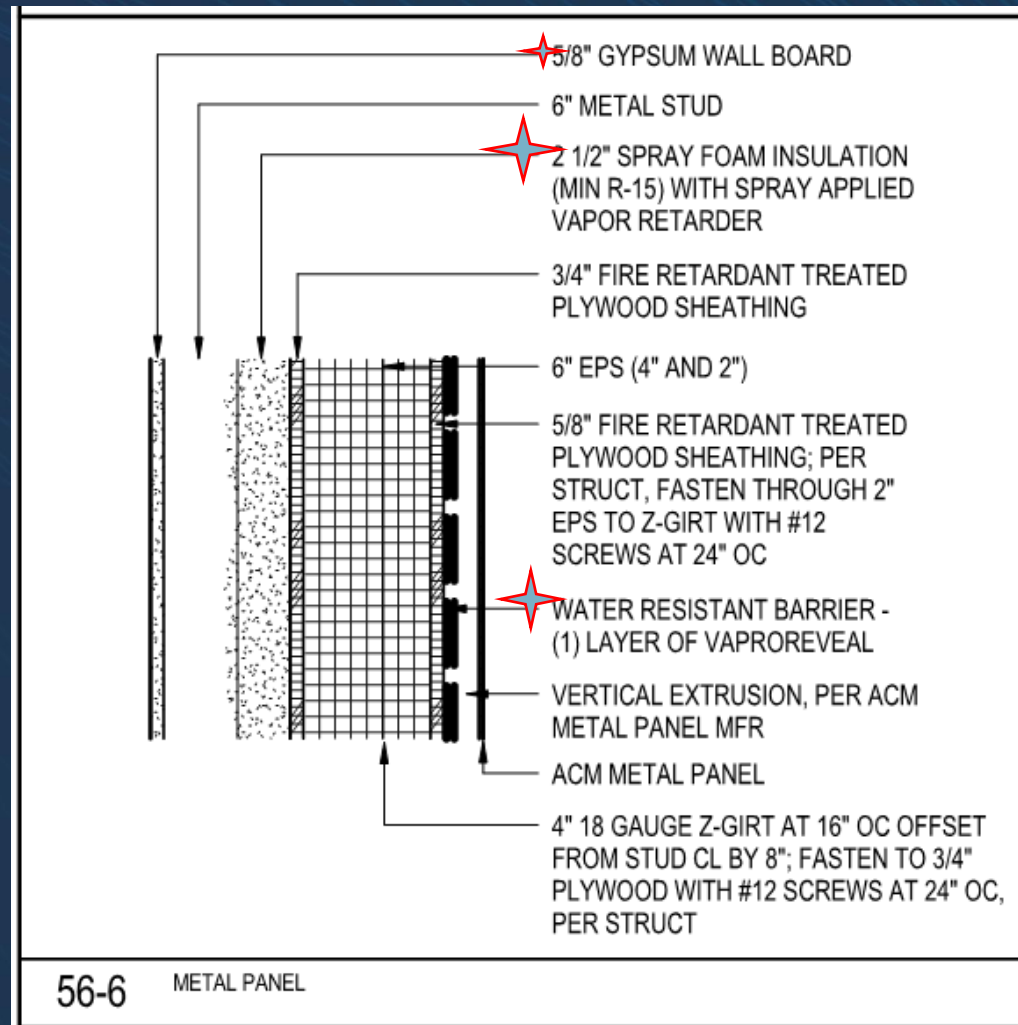


ASTM e779....

*Shouldn't it be and, and*



# Materials, Assemblies...all Good...right?



# No Continuity





# Ice Maker





# The Truth

Pacific Northwest National Laboratory's technical brief, titled, "Envelope Air Tightness for Commercial Buildings" notes:

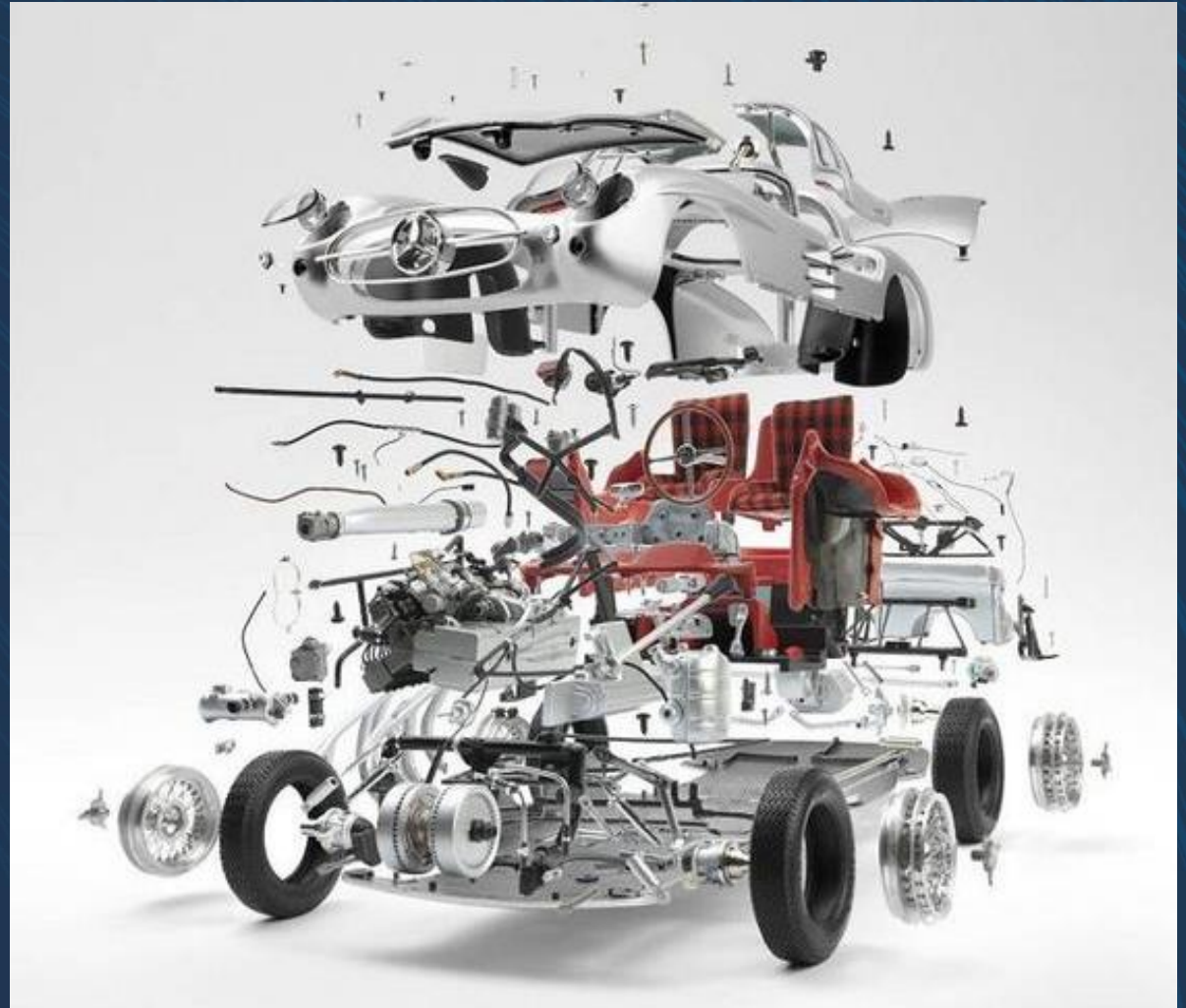
*While it is important that the materials and assemblies have limited leakage, that alone does not guarantee a low leakage building. Recent research<sup>1</sup> (Wiss 2014) shows that 40% of buildings constructed without an envelope consultant have air leakage exceeding the currently optional test standard requirements, while buildings with envelope consultants all had leakage below 0.25 cfm/ft<sup>2</sup>. Testing is the most reliable means of ensuring that the intent of this code section—limiting unintended energy waste in buildings due to air infiltration—will be achieved.*



# The Building is a Patchwork



Materials, Assemblies...all Good...right?





# Washington State & Seattle Energy Codes

- All applicable buildings must be tested per ASTM E779 or equivalent and must pass at a rate of 0.25 cfm/ft<sup>2</sup> (1.27 L/s m<sup>2</sup>).
- If air leakage rate between 0.25 cfm/ft<sup>2</sup> and 0.40 cfm/ft<sup>2</sup>, contractor must provide report outlining locations of excessive air leakage and provide repairs within reason.
- If air leakage rate exceeds 0.40 cfm/ft<sup>2</sup>, then air leakage must be addressed, and building must be re-tested until less than 0.40 cfm/ft<sup>2</sup>.





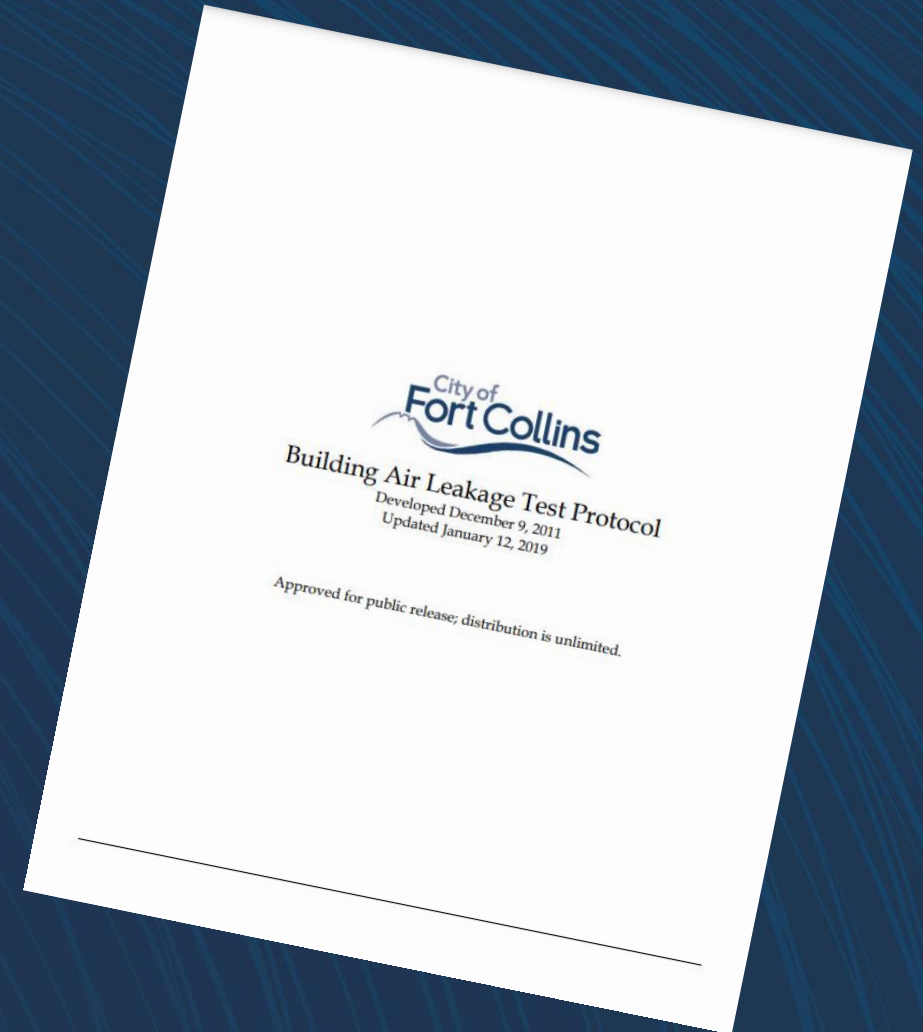
# C406 Compliance (Performance Options)

- Reduced air leakage can be selected as one of the eleven (11) C406 options (C406.11).
- Selecting reduced air leakage as a C406 option can potentially save time and cost associated with achieving higher building energy performance.
- **Commercial building** envelope air leakage rate  $< 0.17$  cfm/ft<sup>2</sup> (0.86 L/s m<sup>2</sup>) @ 0.3" H<sub>2</sub>O (75 Pa)
- Can be achievable with additional planning, design, execution, and inspection.



# City of Fort Collins, CO

- All new construction, including commercial buildings, are required to pass a building air tightness test.
- Mirrors the USACE Protocol
- 0.25cfm/sf @ 75Pa





# City of Denver, CO

Section C402.5.1.2 (p. 542) of the Denver 2019 Amendments requires buildings other than Group I to meet the requirements of Section C402.5.1.2.3 Building Thermal Envelope Performance Verification. Section C402.5.1.2.3 requires:

1. Review of Documents (Materials, Assemblies)
2. Inspection of the air barrier components and assemblies during construction. 100% inspection is required unless testing is performed.
3. Or.... Whole Building Air Leakage Test
4. Report





# Next... How to Test

- ASTM E779 or equivalent....
- USACE Protocol
- ASTM e3158
- ABAA T0001-2016

This international standard was developed in accordance with internationally recognized principles and procedures established in the Decision on Principles for the Development of International Standards, Guidelines and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

**Designation: E779 - 10 (Reapproved 2018)**

**Standard Test Method for Determining Air Leakage Rate by Fan Pressurization<sup>1</sup>**

This standard is issued under the Joint ASTM E779, the number immediately following the designation indicates the year of original approval or the year of last revision, number in parentheses indicates the year of last reapproval, and superscript indicates the number of editorial changes since the last revision or reapproval.

**1. Scope**

1.1 This test method measures air-leakage rates through a building envelope under controlled differential and de-pressurization.

1.2 This test method is applicable to small temperature differentials and low-wind pressure differentials, therefore using winds and large indoor-outdoor temperature differences shall be avoided.

1.3 This test method is intended to quantify the air tightness of building envelopes. This test method does not measure air change rate or air leakage rate under normal weather conditions and building operation.

1.4 This test method is intended to be used for measuring the air tightness of building envelopes of single-zone buildings. For the purpose of this test method, many multi-zone buildings can be treated as single-zone buildings by opening interior doors or by installing equal pressures in adjacent zones.

1.5 Only metric units of measurement are used in this standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. For specific hazard statements see Section 7.

1.7 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guidelines and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

**2. Referenced Documents**

2.1 *ASTM Standards*<sup>2</sup>

E011 Terminology of Building Construction  
E741 Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution  
E125 Test Method for Airflow Calibration of Fan Pressure Test Devices

2.2 *Terminology*

3.1 For definitions of terms used in this test method, refer to Terminology E011.

3.2 *Definition of Term Specific to This Standard*

3.2.1 *air-change rate, n*—air leakage rate in volume (unit) divided by the building space volume with identical volume units, normally expressed as air changes, ACH.

3.2.2 *air-leakage, n*—the movement of air through the building envelope, which is shown by either a both positive (infiltration) and negative (exfiltration) pressure differences across the envelope.

3.2.3 *air-leakage graph, n*—the graph that shows the relationship of measured airflow rates to the corresponding measured pressure differences, plotted on a log-log scale.

3.2.4 *air-leakage rate, n*—the volume of air penetrating through the building envelope including airflow through joints, cracks, and porous surfaces, or a combination thereof driven by mechanical pressurization and de-pressurization, natural wind pressures, or air temperature differentials between the building interior and the outdoors, or a combination thereof.

3.2.5 *building envelope, n*—the boundary or barrier separating different environmental conditions within a building and from the outside environment.

3.2.6 *effective leakage area, n*—the area of a hole, with a discharge coefficient of 1.0, which, with a 4 Pa pressure difference, leaks the same as the building, also known as the sum of the instantaneous openings in the structure.

**3. Terminology**

3.1.1 For definitions of general terms related to building construction used in this test method, refer to Terminology E011 and for general terms related to accuracy, bias, precision, and uncertainty, refer to Terminology E456.

3.2 *Definitions of Terms Specific to This Standard*

3.2.1 *barrier pressure, n*—internal test envelope pressure with the air movement equipment off and sealed, recorded while the building is configured for the test.

3.2.2 *building envelope, n*—defined boundary of the test sample to determine air leakage rate excluding the HVAC related devices (HVAC devices sealed).

**3. Significance and Use**

3.1 Unintentional air leaks through the building enclosure can cause various building related problems such as excessive energy use for heating and cooling, occupant comfort, poor indoor air quality, freezing pipes, ice dams, and premature building degradation from condensation and fungal growth.

3.2 This test method does not establish requirements for airtightness but provides means of assessing compliance with airtightness requirements established elsewhere.


3.3 This test method is used to determine the airtightness of building enclosures or portions thereof at a specified reference pressure. This is different than field testing of air leakage using tracer dilution methods (see ASTM E741). In service tracer gas test results are a combination

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee E08 on Performance of Building and is the direct responsibility of Subcommittee E08.01 on Air Leakage and Barrier Performance.  
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<sup>2</sup> The referenced ASTM standards, cited in the ASTM website, www.astm.org, are the current editions of ASTM Standards. For information on the current ASTM Committee Series or for information on the current ASTM website, visit the standard's Executive Summary page on the ASTM website.

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**U.S. Army Corps of Engineers  
Air Leakage Test Protocol for  
Measuring Air Leakage in Buildings**



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This international standard was developed in accordance with internationally recognized principles and procedures established in the Decision on Principles for the Development of International Standards, Guidelines and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

**Designation: E3158 - 18**

**Standard Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building<sup>1</sup>**

This standard is issued under the Joint ASTM E3158, the number immediately following the designation indicates the year of original approval or the year of last revision, number in parentheses indicates the year of last reapproval, and superscript indicates the number of editorial changes since the last revision or reapproval.

**1. Scope**

1.1 This standard test method provides a quantitative field-test procedure and calculation method for assessing an air leakage rate using a fan-induced pressure differential across the building envelope, generated by blowers doors or equivalent equipment.

1.2 Building setup conditions in accordance with defining the test boundaries appropriate for testing the envelope's air leakage are defined in this test method.

1.3 Procedures to determine the air pressure boundaries of the test envelope to be tested are provided in this test method.

1.4 This test method applies to all multizone and large-building types and portions or subsections thereof.

1.5 This test method defines three test procedures: multi-point regression, repeated single point, and repeated two-point air leakage rate testing.

1.6 This test method allows for testing the test envelope in a pressurized condition, a depressurized condition, or in both conditions and averaging the results.

1.7 This test method applies to an air leakage rate specification with a reference pressure greater than 10 Pa (0.04 in. WC) and not greater than 100 Pa (4.0 in. WC).

1.8 This test method describes two methods of preparation for the building in order to conduct the test: the building envelope where HVAC-related openings are excluded, and the operational envelope where the HVAC-related openings are included.

1.9 *Notes*—The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.10 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. For specific hazard statements, see Section 8.

**2. Referenced Documents**

2.1 *ASTM Standards*<sup>2</sup>

E416 Terminology Relating to Quality and Statistics  
E011 Terminology of Building Construction  
E779 Test Method for Determining Air Leakage Rate by Fan Pressurization  
E1186 Practices for Air Leakage Rate Detection in Building Envelopes and Air Barrier Systems  
E1258 Test Method for Airflow Calibration of Fan Pressure-Test Devices  
E1827 Test Methods for Determining Airtightness of Buildings Using an Outdoor Blower Door  
E2178 Test Method for Air Penetration of Building Materials  
E2437 Test Method for Determining Air Leakage Rate for Air Barrier Assemblies

**3. Terminology**

3.1 *Definitions*

3.1.1 For definitions of general terms related to building construction used in this test method, refer to Terminology E011 and for general terms related to accuracy, bias, precision, and uncertainty, refer to Terminology E456.

3.2 *Definitions of Terms Specific to This Standard*

3.2.1 *barrier pressure, n*—internal test envelope pressure with the air movement equipment off and sealed, recorded while the building is configured for the test.

3.2.2 *building envelope, n*—defined boundary of the test sample to determine air leakage rate excluding the HVAC related devices (HVAC devices sealed).

**3. Significance and Use**

3.1 Unintentional air leaks through the building enclosure can cause various building related problems such as excessive energy use for heating and cooling, occupant comfort, poor indoor air quality, freezing pipes, ice dams, and premature building degradation from condensation and fungal growth.

3.2 This test method does not establish requirements for airtightness but provides means of assessing compliance with airtightness requirements established elsewhere.

3.3 This test method is used to determine the airtightness of building enclosures or portions thereof at a specified reference pressure. This is different than field testing of air leakage using tracer dilution methods (see ASTM E741). In service tracer gas test results are a combination

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**Designation: ABAA T0001-2016**

**Standard Test Method for Building Enclosure Airtightness Compliance Testing**

**1. Designation**

To be designated once sent to ASTM.

**2. Scope**

2.1 This standard test method provides a quantitative field-test procedure and calculation method for assessing compliance of a building enclosure with an airtightness specification using fan-induced pressure differentials.

2.2 Building setup conditions appropriate for testing the enclosure's airtightness are defined in this standard.

2.3 Guidelines to identify the air barrier system boundaries of the test enclosure to be tested are provided in this standard.

2.4 This test method applies to all building types and portions thereof.

2.5 This test method is applicable to typical indoor-outdoor temperature differentials and low to moderate wind pressure conditions.

2.6 This standard defines three test procedures: multi-point regression, repeated single point and repeated two-point airtightness testing.

2.7 This standard allows for testing compliance with the test enclosure in a pressurized condition, a depressurized condition, or an average of both.

2.8 This standard applies to airtightness specifications with a reference pressure greater than 45 Pascals (Pa) and not greater than 100 Pascals (Pa).

2.9 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For specific hazard statements, see Section 8.

**3. Significance and Use**

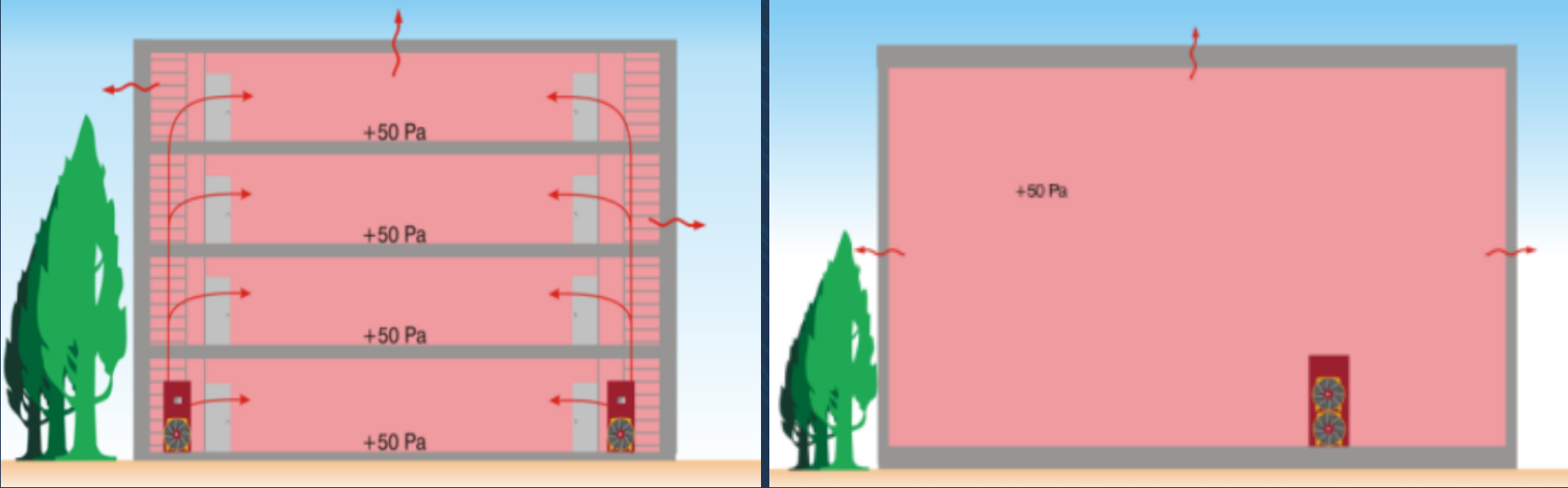
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3.2 This test method does not establish requirements for airtightness but provides means of assessing compliance with airtightness requirements established elsewhere.

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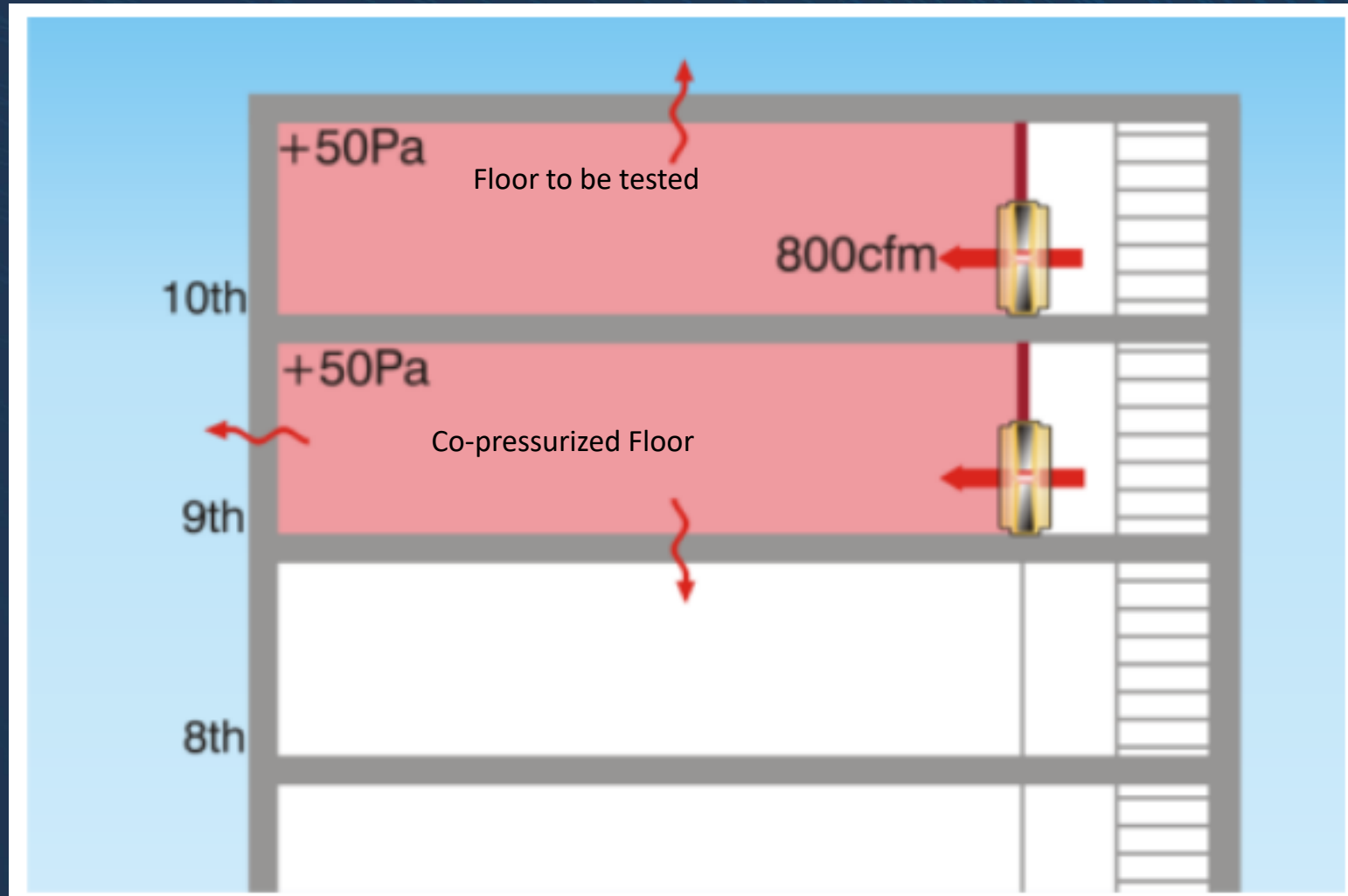
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# Single Zone Test



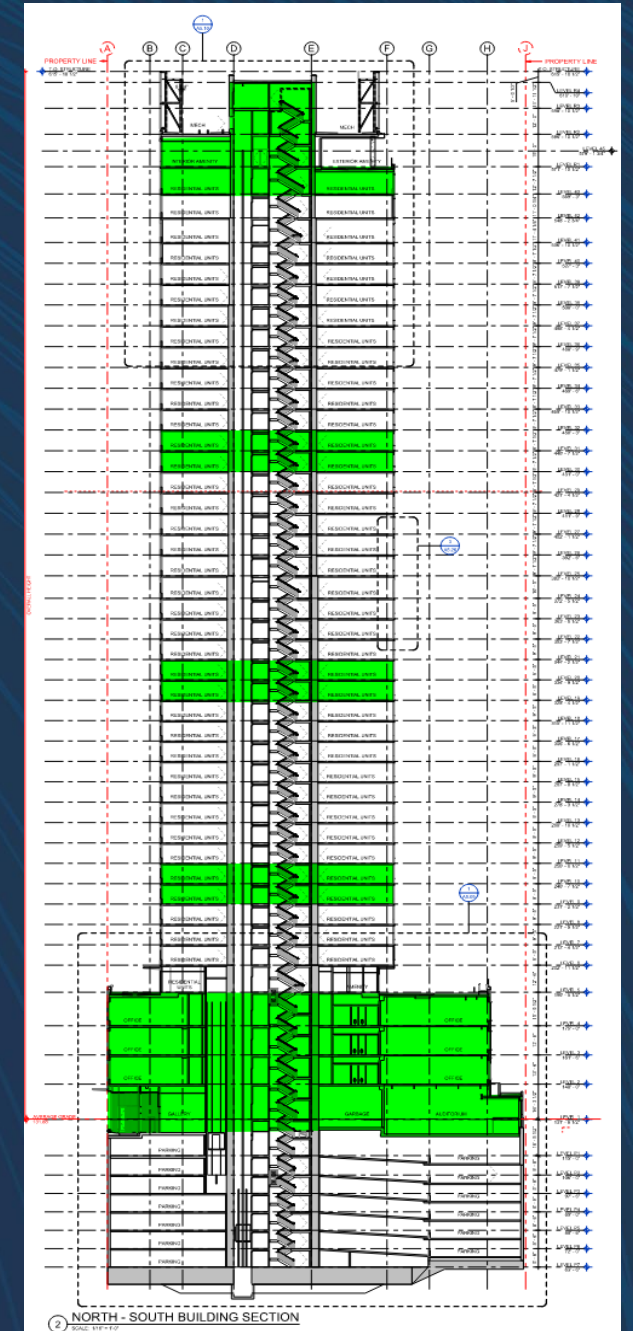


# Multi-Zone Test (Sectional Method)



# Sectional Method- Sampling

- A solution to reduce the impacts to the construction schedule and cost associated with preparation work.
- Larger buildings can be divided and tested in isolated sections.
- Will require the approval from the code official.
- Can reduce the amount of preparation work but will increase the cost of testing due to multiple mobilizations.
- May impact the accuracy of the test results
- Certain building designs and envelope types may not permit this method of testing



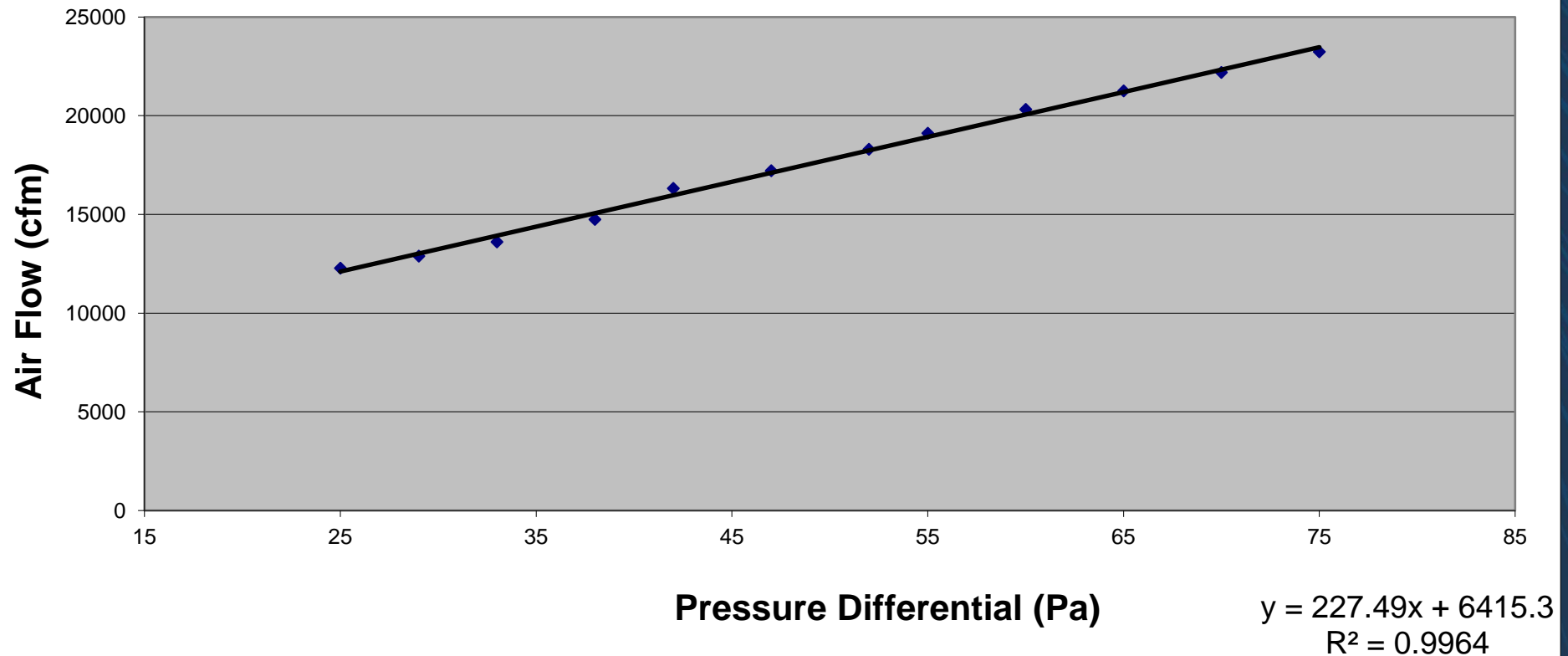


# How to Test...What to Test



# How to Test...Statistically Accurate

## Building Pressurization Test Results





# Conclusions/Summary

- Understanding of Air Barrier Systems and Air Leakage Testing has come a long way in a short period of time.
- An Air Barrier System that performs in a way that reduces energy use and improves durability of the enclosure is achievable with current construction and materials.
- Typically, the building can be made to be as tight as it is required to be.
- Overall, an air tightness requirement is easier to implement when the entity writing the requirement is also owning the delivery.
- To date the US DoD / Passive House models have performed the best.
- Its not all about energy....shouldn't we also consider durability?

# Major Take-Away

With multiple jurisdictions defining air leakage requirements and how to confirm compliance we need to make sure what is being required isn't just greenwash and actually results in improved performance (energy and durability) of the building.



*Fancy Air Barrier System*



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