air barrier abaa association of america

BUILDING ENCLOSURE CONFERENCE 2023

High Performance Building Envelope

Steven Tratt

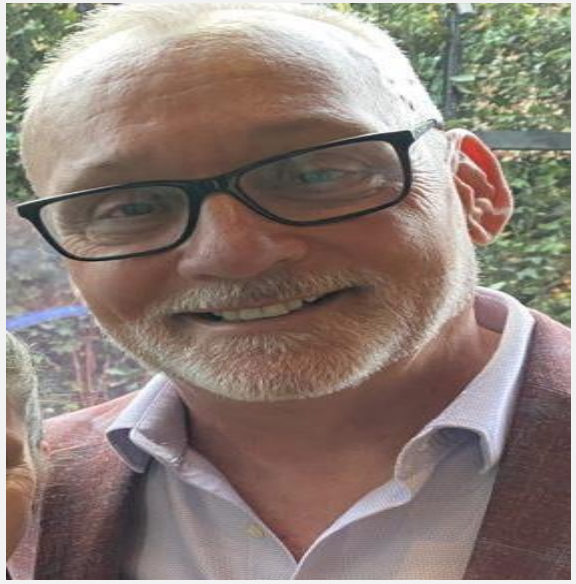
WTI/ CANAM Building Envelope Specialists

AIA Continuing Education Provider

abaa EDUCATION

High Performance Building Envelope

This session is designed for building/property/facility managers, building owners, developers, architects and other design and construction professionals interested in increasing their knowledge of the application and use of air barriers in the building envelopes of commercial and multi-family residential buildings. Researchers, architects and code writers have shown that attention to specific details in both new and retrofitted envelopes result in better performing buildings with better comfort and long durability as well as lower energy consumption. Air leakage through the building envelope is silent, invisible and cunning. It causes numerous building envelope problems including wetting of cavity materials, spalling of masonry, premature corrosion of metals, blistering of paint, icicles, staining of contraction. Continuity is important, but strength is even more important. In buildings, the air barrier system must be designed, and specified on plans. It has specific performance criteria and specific material requirements.



Steven Tratt
WTI / Canam Building Envelope Specialists, Beachwood, OH
Steven Tratt, National Sales Manager, Lead Assessor-Steve has over 30 years of experience in the building envelope air barrier industry as well as the insulation and thermal barrier industry, including expertise in air leakage testing and weatherization materials. He has worked extensively in the custom design of building science solutions for the education, healthcare, commercial, Multi-family, and government markets. He was on the taskforce that wrote the US Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes. He has trained building envelope retrofit contractors in Canada, USA, Ireland, England, and Australia and has made numerous presentations to a wide variety of trade associations. Currently he has been involved in organizing and presenting air barrier seminars for architects, engineers, building owners and facility managers throughout Canada and the United States.
His certifications and qualifications include, Construction Management (NAIT), BPI Certified Building Analyst Professional and Building Envelope Professional, A/D Fire barrier Certified, CMHC Mold Remediation Certified, Six Sigma Certified, Member of CUFCA (Canadian Urethane Foam Contractors Association), Member of ABAA (Air Barrier Association of America).

Learning Objectives

1. How better building envelope can reduce energy demand on heating and cooling and reduce energy.
2. The significance of each part of the building envelope (top, bottom, vertical shafts and the walls) relative to the efficient operation.
3. Identifies problems that can occur with the lack of compartmentalization and/or decoupling between floors in buildings over 3 stories.
4. Learn how a better building envelope can reduce energy demand on heating and cooling and reduce energy.

Definition of the High Performance Building

The term "**high performance building**" means a building that *integrates and optimizes* all major high-performance building attributes, including *energy efficiency*, *durability*, *life-cycle performance*, *and occupant productivity.**

*High Performance Building Council *a council of the National Institute of Building Sciences*

4 Elements of a High Performance Building:

- *Heat Flow = Comfort*
- *Air Flow = Air Pressure*
- *Moisture = RH*
- *Air Quality = IAQ*

Air Barrier Continuity - Identifying breaches :

The Basics of Air leakage

- *Continuity* is the most important characteristic of the air barrier system. It functions to prevent ...

  Infiltration / Exfiltration which is caused by:

  - Diffusion Flow
  - Orifice Flow
  - Channel Flow

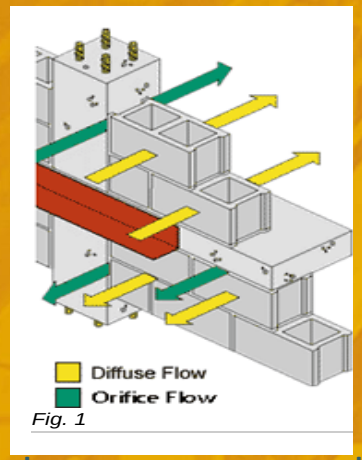


Fig. 1

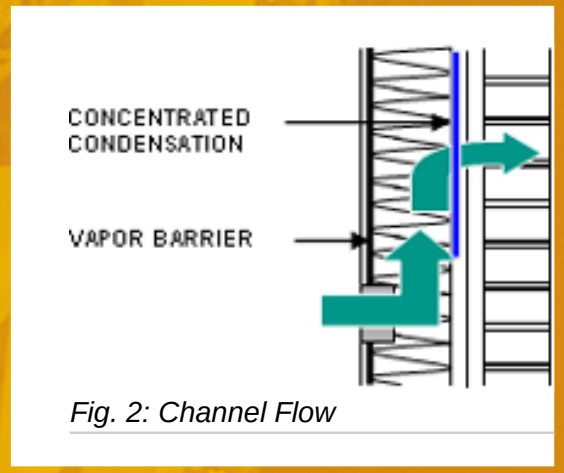
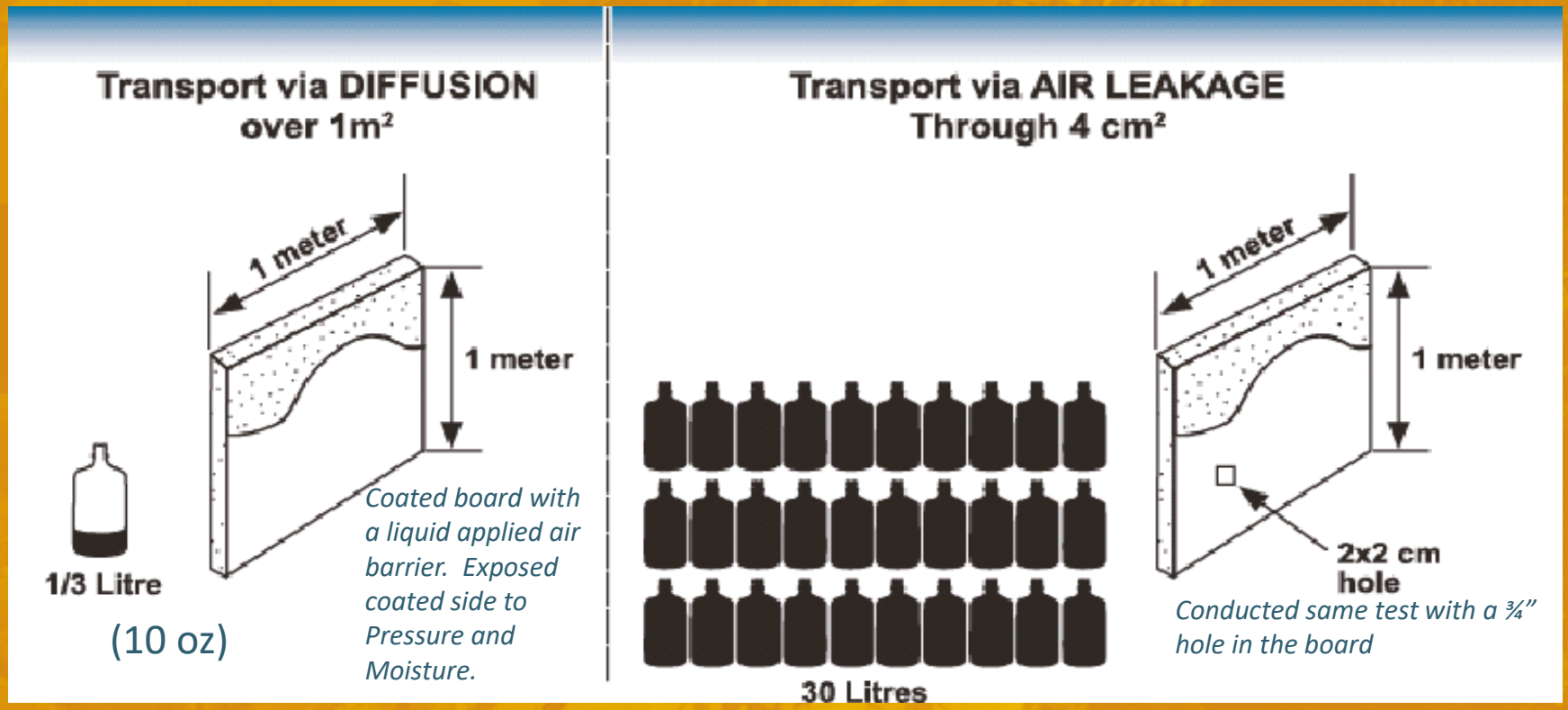


Fig. 2: Channel Flow

- Air Barrier Continuity allows the proper control of air movement into and out of building enclosures
- All six sides of a building enclosure must be continuous within themselves and in conjunction with each other

Air Leakage & Moisture

Test simulating a Ottawa, Canada winter comparing an intact air barrier vs. a ¾" hole in the air barrier



100 times more moisture diffused through the board!

Building Air Leakage Consequences

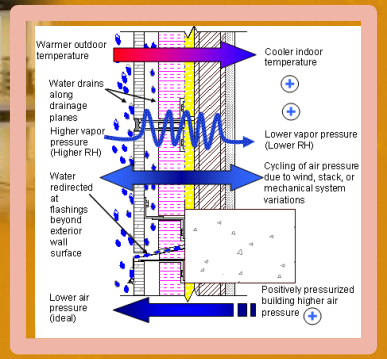
The Air and Moisture Connection – The Building as a SYSTEM

HVAC Sizing

Wind Effect/
Weather

Occupant Comfort

Indoor Air Quality



IAQ / IEQ

= Productivity

Durability

= Sustainability

Energy Efficiency

= Savings ($)

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Basic Diagnostic Tools:

For the forensic field assessor – Identifying the source

Trained Assessor
with camera,
floor plans and intake
form or Air Leakage
Data Collection APP

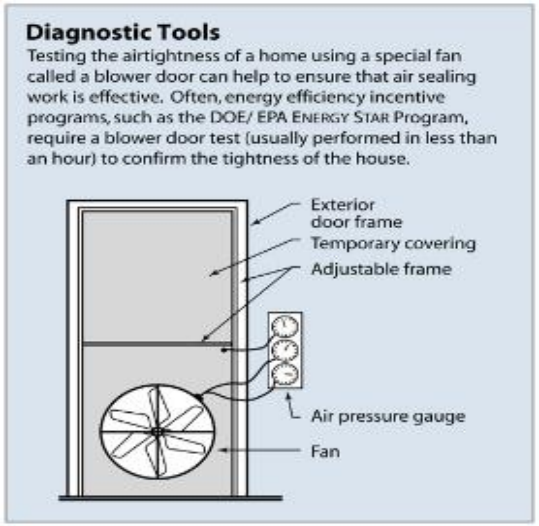
Smoke Pencil
or similar tool to
Provide show
of air flow

Flir E50 BX
IR camera

Velocicalc 9565
IAQ Probe 980 for:
Temp – RH
CO_2 – Pressure
Mold and BIO snaps

Advanced Diagnostic Tools:

Optional cost, additional set-up – Measures leakage



Blower Door

Standard Pressurization Kit and gauges used by Building Science Engineer Partner

Multi-fan or larger

Air Barrier Continuity:

Failure of air barrier systems

- Breaches in the air barrier and its connections/continuity will make buildings:
  - Less healthy
  - Unsafe
  - Less durable
  - Uncomfortable
  - Less Energy Efficient

Air Barrier Continuity:

Failure of air barrier systems

- Leads to:
  - Uncontrolled and Uncontrollable Air Leakage
  - Infiltration / Exfiltration
- Caused by:
  - Stack effect
  - Wind effect
  - Mechanical effect

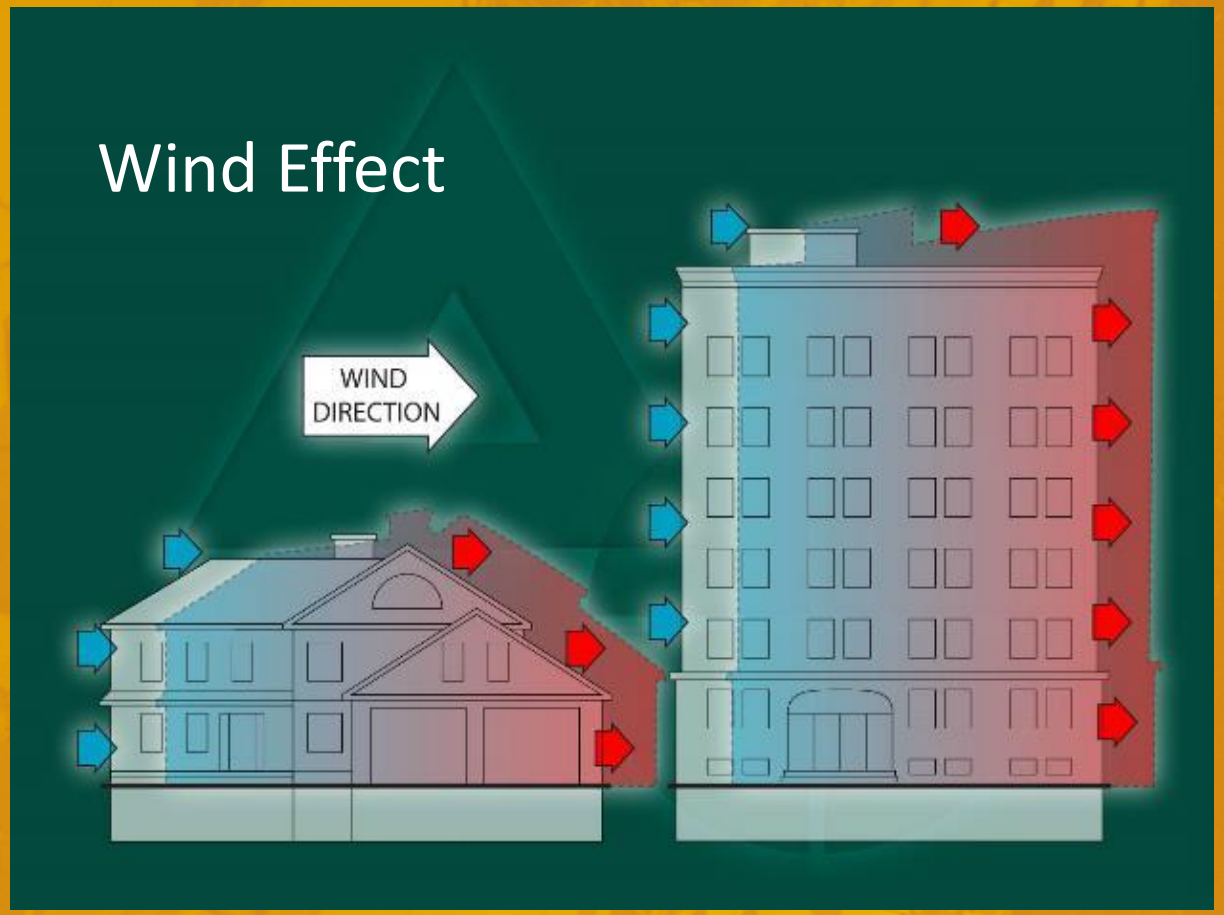
The Building Science of Air Barrier Continuity

Failure of air barrier systems

Stack effect is a temperature-driven phenomenon which is especially noticeable in cold weather when warmer indoor air, which is more buoyant than the colder outdoor air, tends to rise in the building.

The Building Science of Air Barrier Continuity

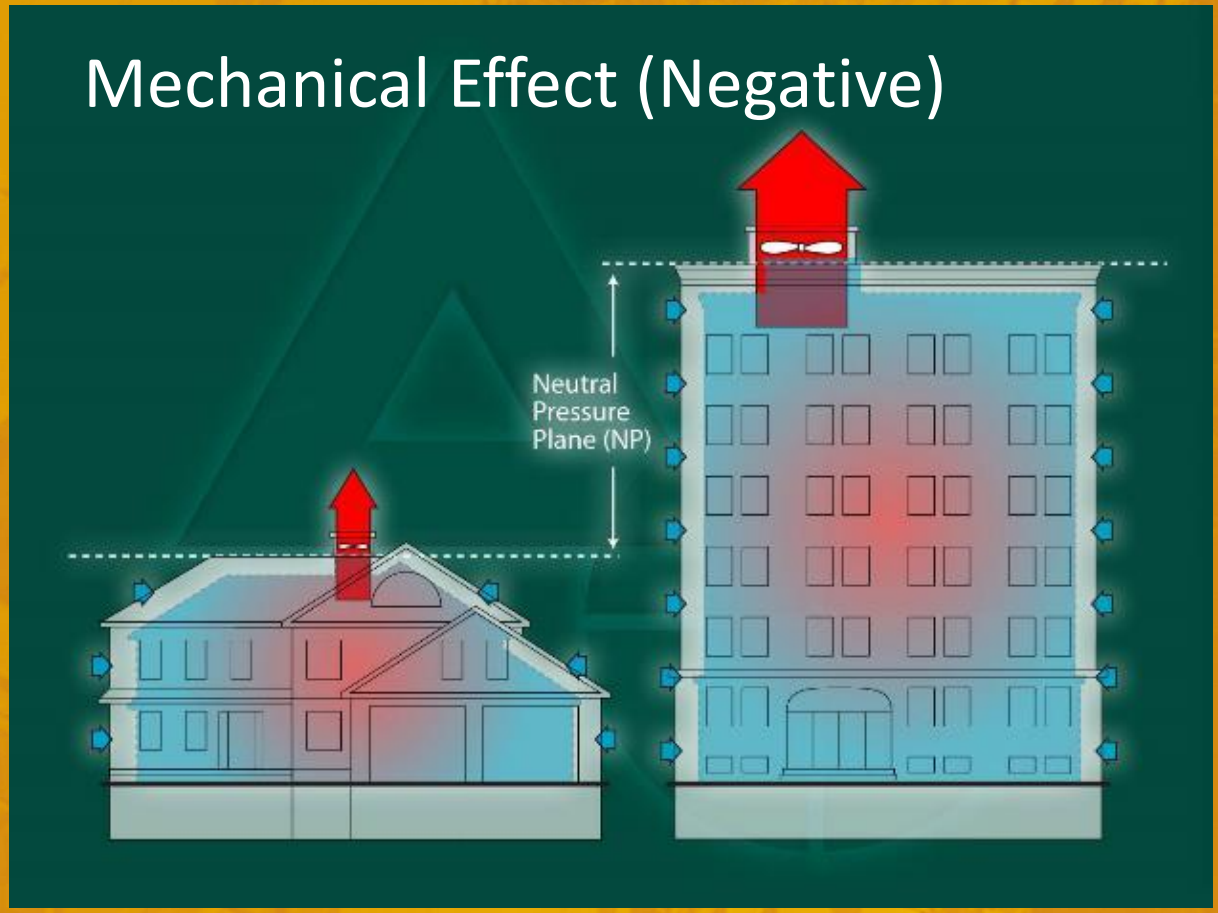
Failure of air barrier systems



Wind Effect is a weather-driven phenomenon which is especially noticeable in regions with seasonal temperature fluctuations.

The Building Science of Air Barrier Continuity

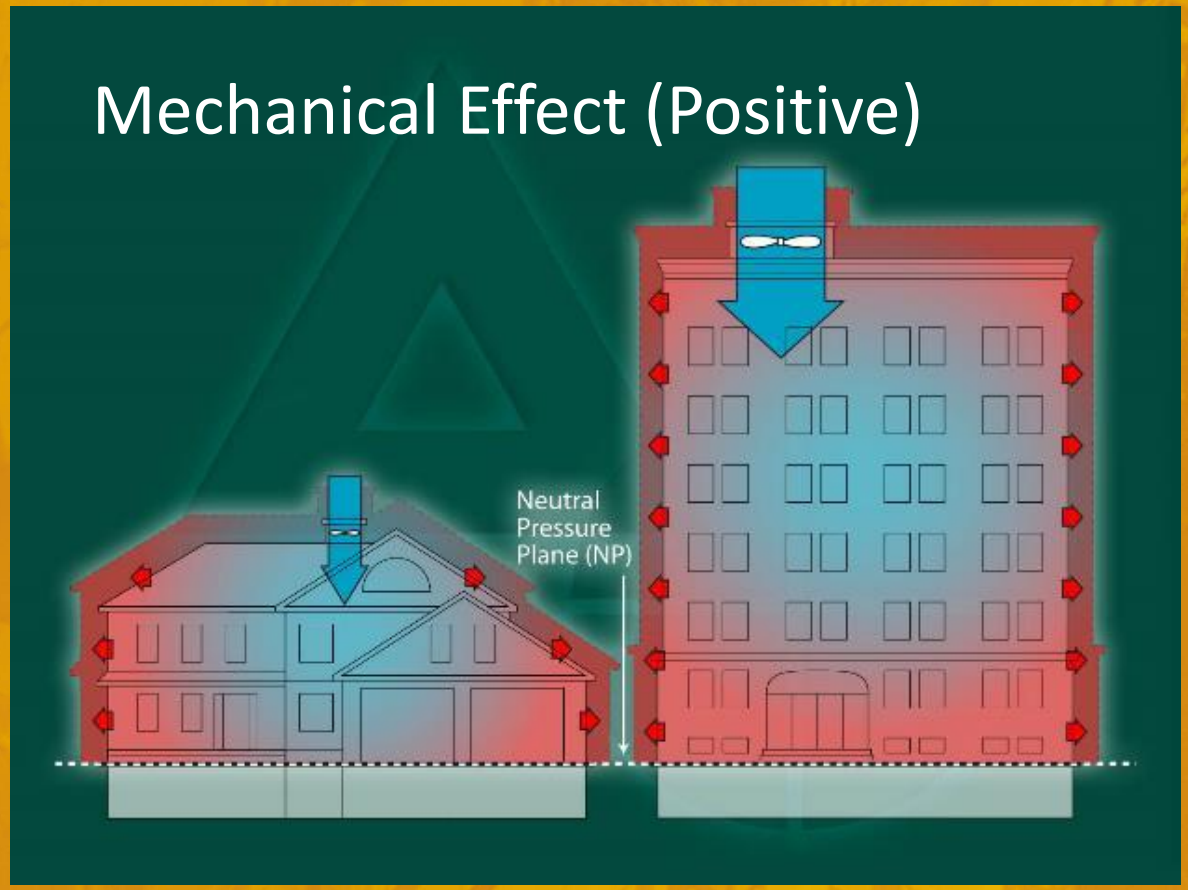
Failure of air barrier systems



Negative Mechanical Effect is an HVAC-driven phenomenon in which the building HVAC exhausts air causing an internal negative pressure that promotes air infiltration.

The Building Science of Air Barrier Continuity

Failure of air barrier systems



Positive Mechanical Effect is an HVAC-driven phenomenon in which the building HVAC draws in enough air to create an internal positive pressure that promotes air exfiltration.

The byproduct / financial benefit of air sealing:

Is a cost justifiable process, not a sole driver

- **Energy Efficiency that will save you MONEY!**
  - More efficient ventilation in the HVAC system
  - More efficient use of pumps and fans within the system
  - Better performance of the system could mean longer operation life of the equipment
- **3 recommendations for all buildings (in order)**
  - **Air Sealing** – *Inexpensive. Is a building maintenance issue that is often ignored. Should be looked at as long-term investment.*
  - **Insulate** – *ALWAYS done after air sealing to enhance the conditioned space.*
  - **HVAC** – *upgrade / redesign. Done in this order will maximizes system efficiency.*

How to Implement??

There is a process for Air Leakage Assessment

Air Barrier Continuity

Fixing and preventing air leakage paths

Steps required for BE Air Leakage Remediation:

- Conduct building assessment
- Determine location and severity of air leakage pathways
- Identify external / internal pathways
- Develop scope of work to create air barrier continuity

Air Barrier Continuity

Diagnosing the problems

Building Envelope Assessments:

Locating air leakage paths

Smoke Puffer (Pencil)

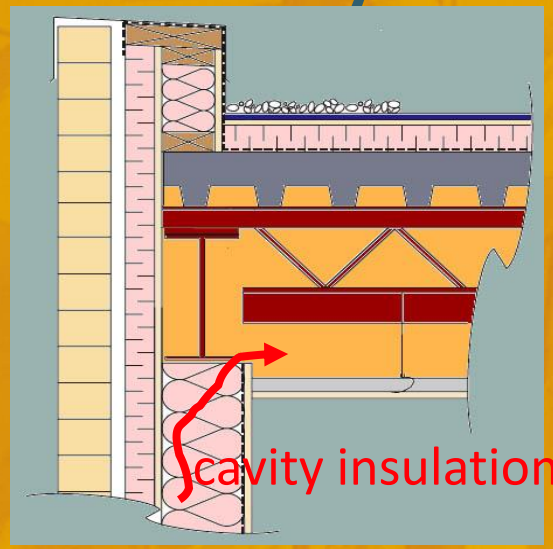
Pressurization testing

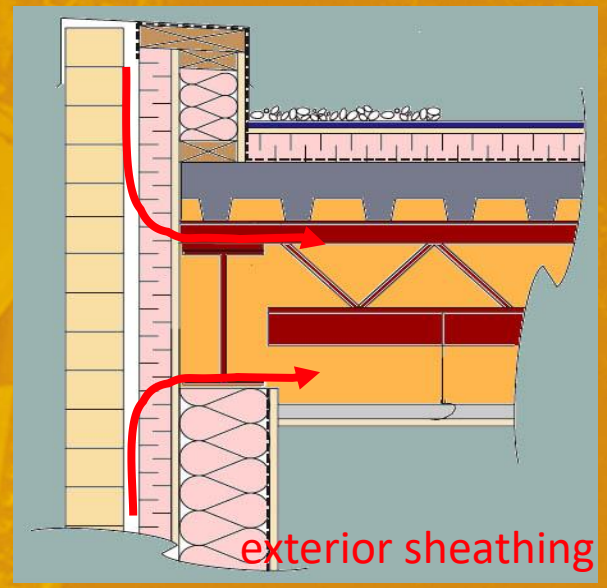
Infrared thermography

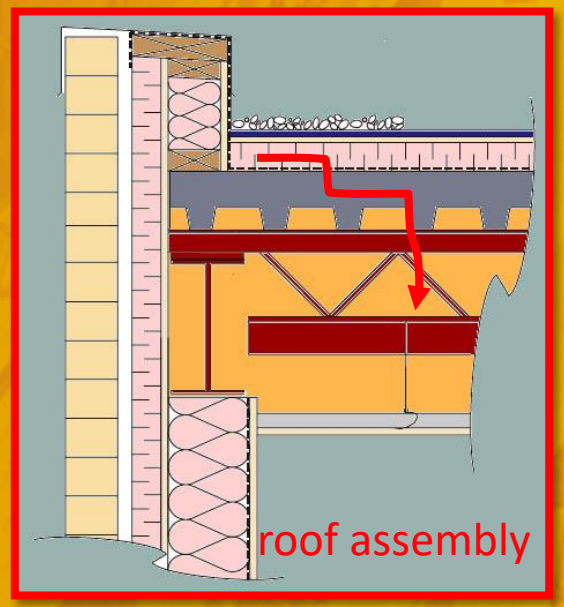
Air Barrier Continuity

The plenum

- Air moves through many different assemblies if air barrier systems are not in place







Air Barrier Continuity

i.	TOP
ii.	BOTTOM
iii.	VERTICAL SHAFTS
iv.	OUTSIDE WALLS
v.	COMPARTMENTALIZE

Air Barrier Continuity

i. **TOP**

Air Barrier Continuity

Seal top of building

Attics

Mechanical penthouse doors and walls

Roof/wall intersections and plenum spaces

HVAC equipment

Other roof penetrations

Air Barrier Continuity

i. TOP

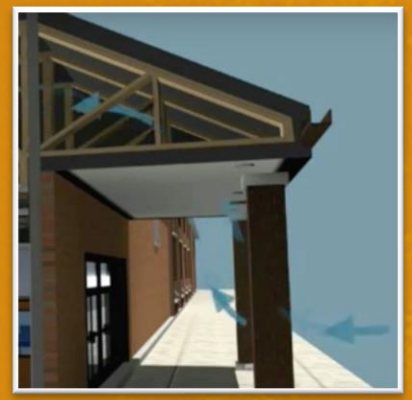
ii. Bottom

Air Barrier Continuity

Seal bottom of building

Defined as: the "**ground floor**" and **anything below grade**

- Typically a unique area of the building. Examples include:
- Soffits and ground floor access doors
- Underground parking access doors
- Exhaust and air intake vents
- Pipe, duct, cable and other service penetrations into core of building
- Sprinkler hangar penetrations, inspection hatches and other holes
- Seal wall to floor slab
- Residential crawl spaces



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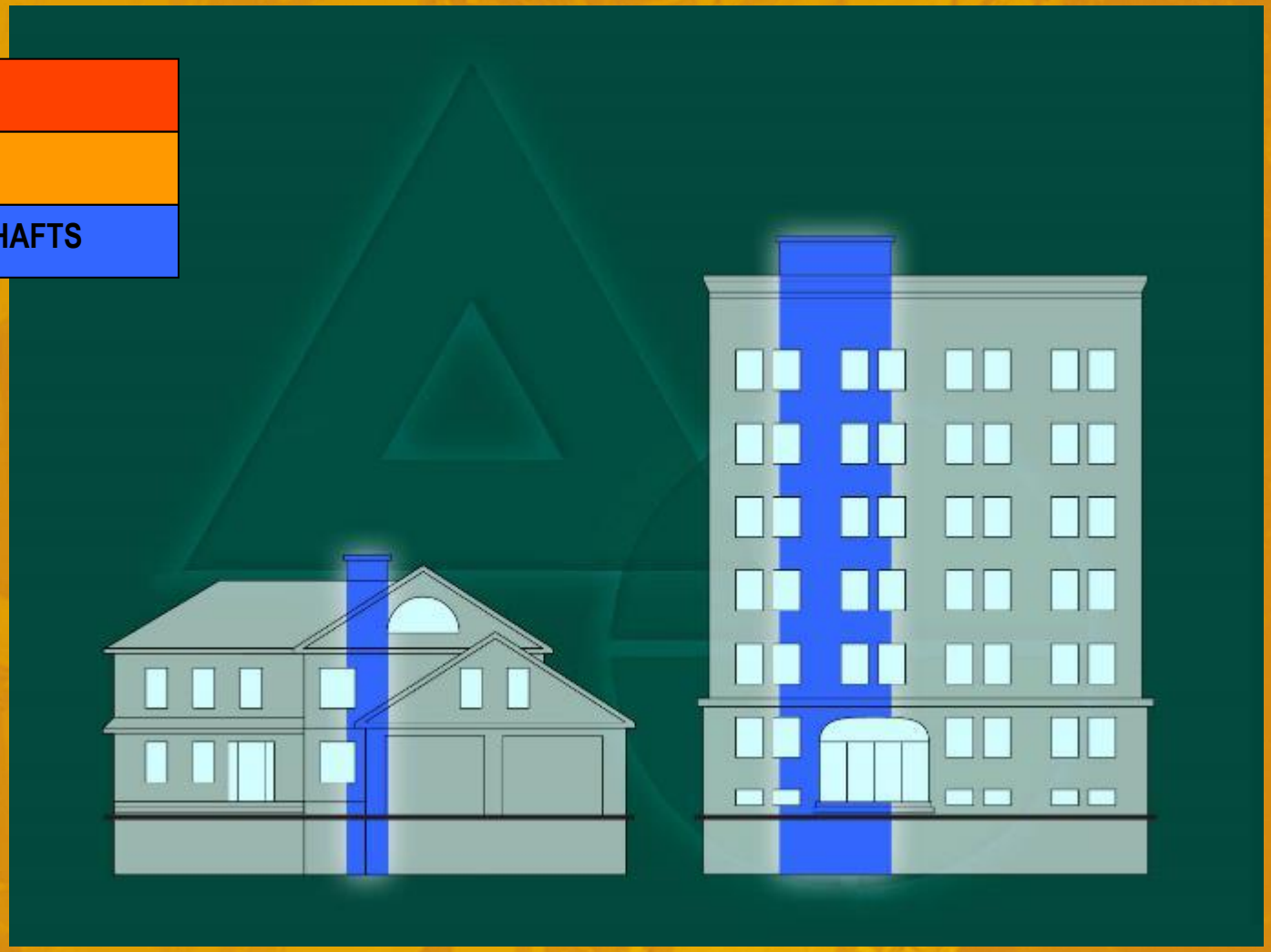
Air Barrier Continuity

i.	TOP
ii.	BOTTOM
iii.	VERTICAL SHAFTS

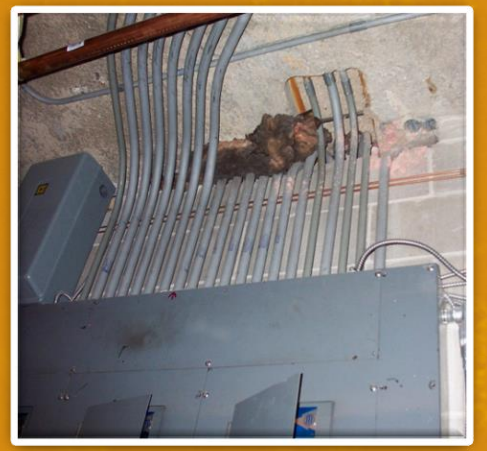


Air Barrier Continuity

Seal vertical shafts

Examples include:

- Stairwell fire doors
- Fire hose cabinets
- Plumbing, electrical, cable and other penetrations within service rooms
- Elevator rooms – cable holes, cable holes, bus bar openings



Air Barrier Continuity

Seal vertical shafts

Other examples include:

- Garbage chute perimeter and access hatches

- Pipe penetrations and escutcheons in restrooms/bathrooms of multi-story buildings
- Smoke shaft access doors, Elevator shaft smoke control grills and service shafts

Air Barrier Continuity

i.	TOP
ii.	BOTTOM
iii.	VERTICAL SHAFTS
iv.	OUTSIDE WALLS

Air Barrier Continuity

Seal outside walls and openings

Examples include:

- Weather-strip windows, doors, including balcony/patio doors and seal window trim

- Exhaust fans and ducting

- All service penetrations
- Baseboard heaters

- Electrical receptacles
- Baseboards

Air Barrier Continuity

v. COMPARTMENTALIZE

Compartmentalization is necessary for any area that is either part-time or full-time vented and which should not be included within the building envelope air barrier.

Air Barrier Continuity

Compartmentalize

Examples of areas that need to be compartmentalized:

- Garages
- Vented mechanical rooms
- Garbage compactor room
- Emergency generator room
- High voltage rooms
- Shipping docks
- Elevator rooms
- Workshops

➢It is important to compartmentalize these areas to provide fire safety, odor and pest control, not to mention energy savings and to reduce GHG emissions measured in **MT CO_2**.

Air Barrier Continuity

Materials used

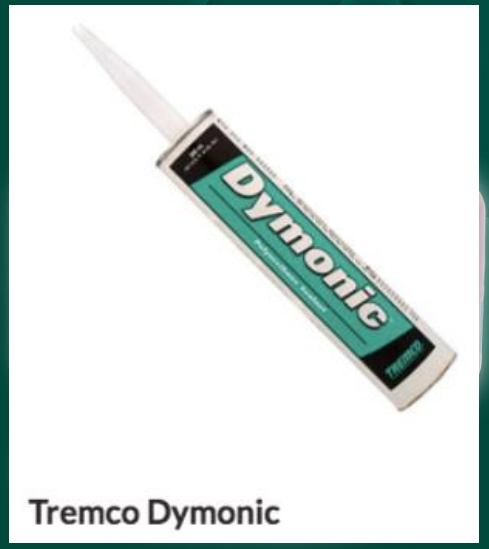
2-component polyurethane foam insulating air seal kits

Must meet requirement of ULC Standard S711.1

Air Barrier Continuity

Materials used

Caulking - Silicones



Tremco Dymonic

DAP Silicone Doors and Windows

Air Barrier Continuity

Materials used

Air Barrier Continuity

Materials used

Air Barrier Continuity

Markets Served

- Education
- Healthcare
- Commercial
- Industrial
- Multi-unit Residential
- Private & Public Sectors
- Rec Centers/Arenas
- Federal/Military

Metrics:

2022 Projected Savings:

- Air Barrier Upgrades result in average annual energy savings (heating/cooling) of $0.097/SF/year

i.e.: 1,000,000 SF x $0.10 = $100,000/year in energy savings

$100,000 x 5 years = $500,000 available capital to help fund building maintenance projects such as roofing.

Air Barrier Remediation Project
Financial Analysis

Key Inputs and Costs

Contract term (Months)	60
Economic Life (Years)	20
Edward Hospital	
Discount Rate	5.00%
Savings % to Operating Expenses	100.00%
Savings Share %	100.0%
Equity Contribution	
Tremco	
Savings Share %	

Impact of Delay

Delay in Months	Cost of Delay	Opportunity Cost
3	$ (942)	$ (942)
6	$ (1,884)	$ (1,884)
9	$ (2,826)	$ (2,826)
12	$ (3,768)	$ (3,768)
15	$ (4,710)	$ (4,710)
18	$ (5,652)	$ (5,652)
21	$ (6,594)	$ (6,594)
24	$ (7,536)	$ (7,536)

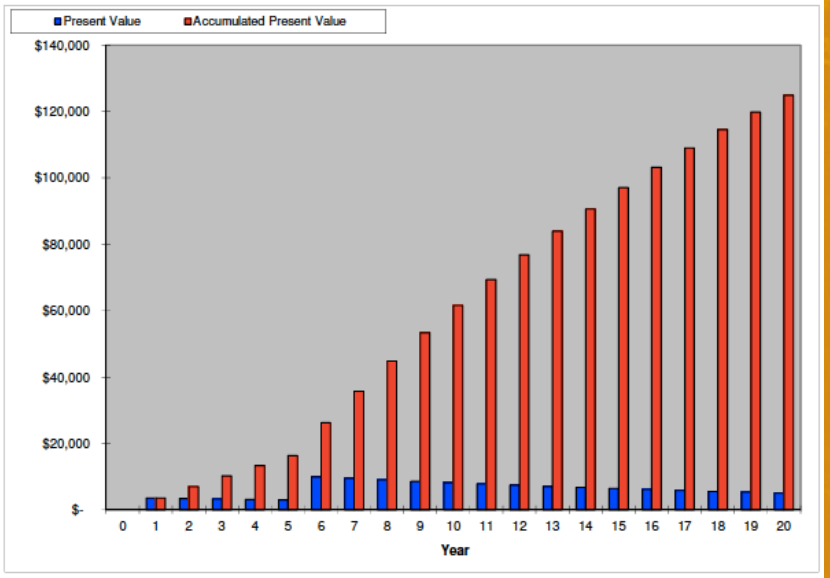
Contribution to Net Cash Analysis

Annual Contribution to Net Cash	$ 3,768
Non-Discounted Contribution to Net Cash	$ 219,083
Discounted Contribution to Net Cash	$ 124,880
Investment / Project Value	**$ 42,321**

Total Project Financial Summary

Project Value	Annual Energy Savings	Annual Operational Savings	Other Savings	Total Annual Savings	Simple Payback
$ 42,321	$ 13,351	$ -	$ 1	13,352	3.2

Year	Net Customer Savings	Present Value	Accumulated Present Value
0	$ -	$ -	$ -
1	$ 3,768	$ 3,589	$ 3,589
2	$ 3,766	$ 3,416	$ 7,005
3	$ 3,766	$ 3,253	$ 10,258
4	$ 3,766	$ 3,098	$ 13,357
5	$ 3,766	$ 2,951	$ 16,308
6	$ 13,350	$ 9,962	$ 26,270
7	$ 13,350	$ 9,488	$ 35,757
8	$ 13,350	$ 9,036	$ 44,793
9	$ 13,350	$ 8,606	$ 53,399
10	$ 13,350	$ 8,196	$ 61,594
11	$ 13,350	$ 7,805	$ 69,400
12	$ 13,350	$ 7,434	$ 76,834
13	$ 13,350	$ 7,080	$ 83,913
14	$ 13,350	$ 6,743	$ 90,656
15	$ 13,350	$ 6,422	$ 97,078
16	$ 13,350	$ 6,116	$ 103,193
17	$ 13,350	$ 5,825	$ 109,018
18	$ 13,350	$ 5,547	$ 114,565
19	$ 13,350	$ 5,283	$ 119,848
20	$ 13,350	$ 5,031	$ 124,880
TOTAL	$ 219,083	$ 124,880	
Customer Net Present Value			$ 124,880



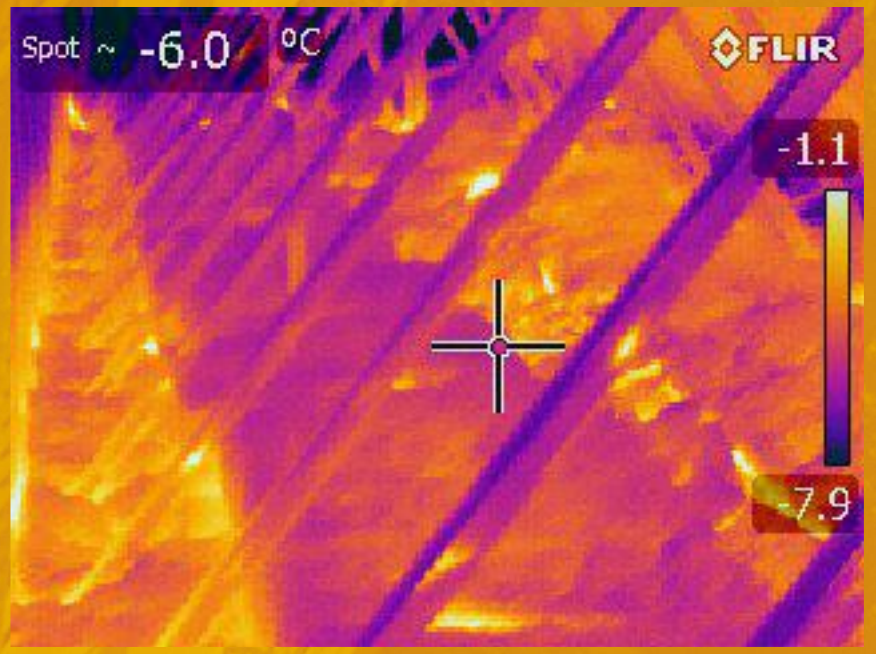
Note: All savings and payback references are projected estimates and are not guaranteed. Neither Canam nor any affiliated entities shall have any responsibility or liability in the event savings amounts or paybacks are not achieved.

Case Study # 1

Issue: Medical Office Building, Comfort issues, Insects, High energy costs

Case Study #1

Knee wall attic



Case Study #1

Knee wall attic, many holes in roof deck below attic space. Condensation issues

Case Study #1

Window Trim- signs of insect migration

Case Study #1

Exterior Façade Issues-Thermal bridging

Medical Office Bldg Case Study #1

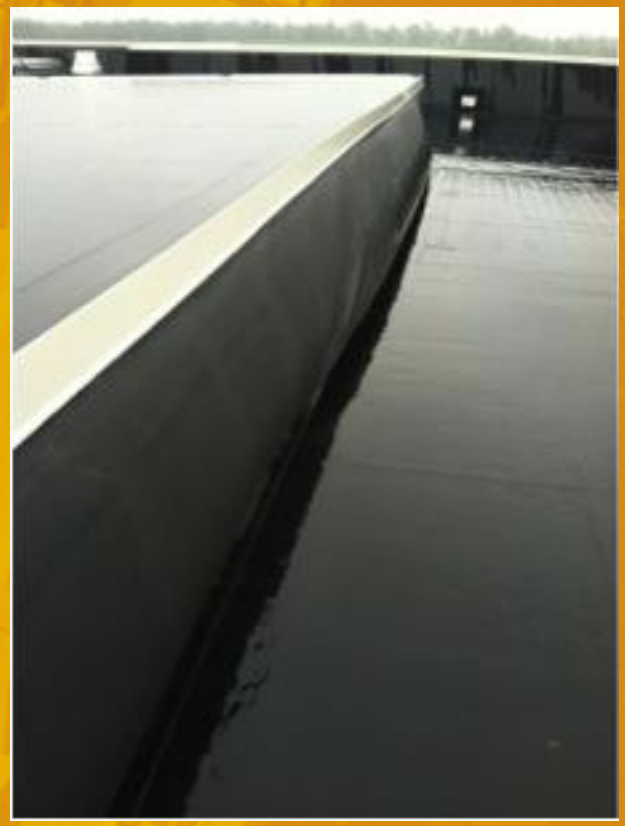
Results

24,000 sq ft
Cost to rectify $86,827
Hole size sealed 12 sq ft.

- Annual Savings $ 8,247
- Over $0.35/ sq ft/ year
- Years Payback 10.5 years
- No more insect migration
- Increased occupant comfort

Case Study # 2

Issue: Manufacturing Company with pressure blowing roof into roof flashings causing failure



Case Study # 2

Results: Project coordinated with Roofing contractor to install metal wall panels and remediate air leakage at Roof Wall connection.

Case Study # 2

Results: Air leakage controlled, providing enhanced; durability, life cycle of roof wall, energy efficiency benefit and overall better appearance.

Case Study #3 – Effects of Air Leakage in a Humid Environment

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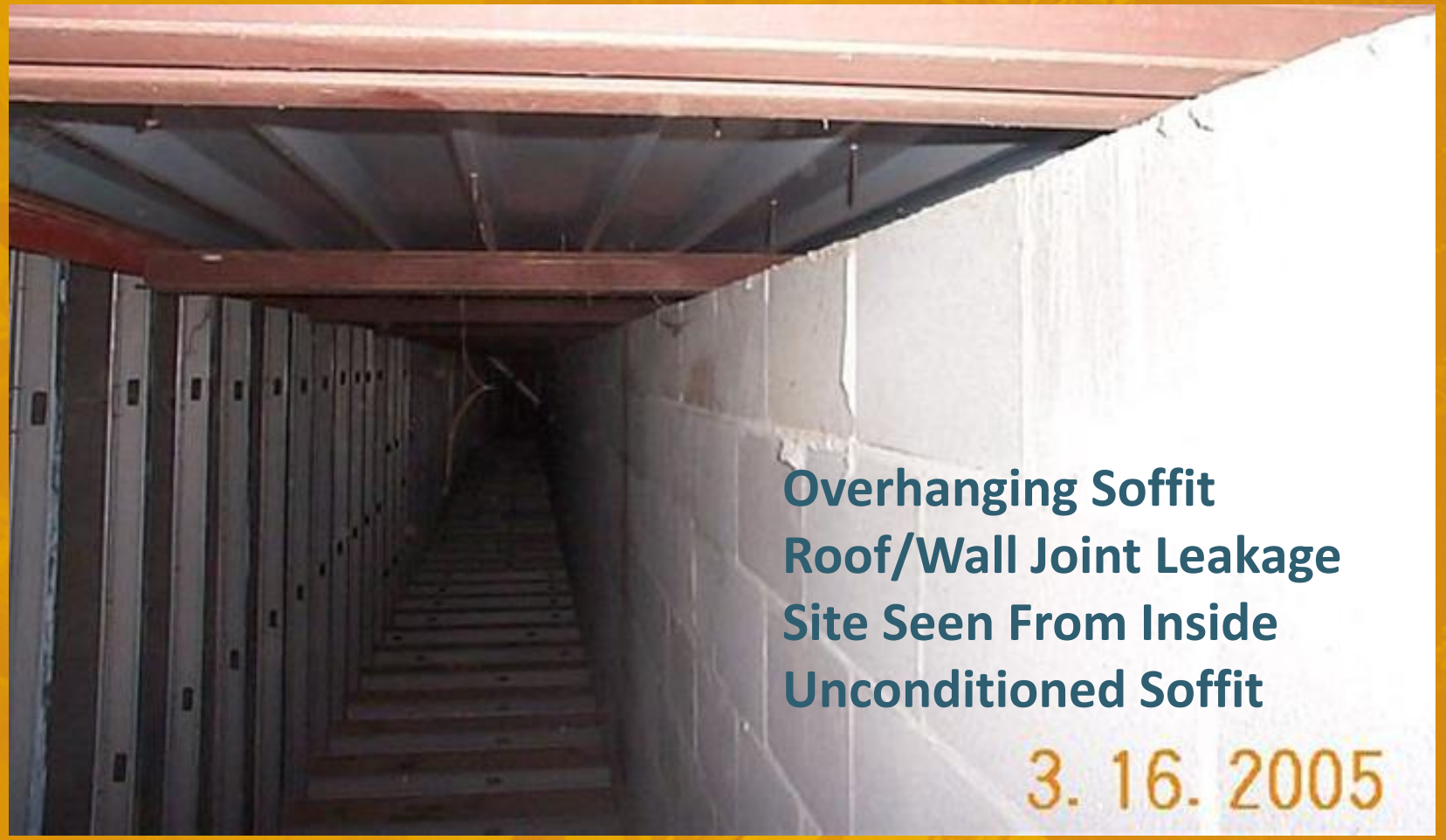
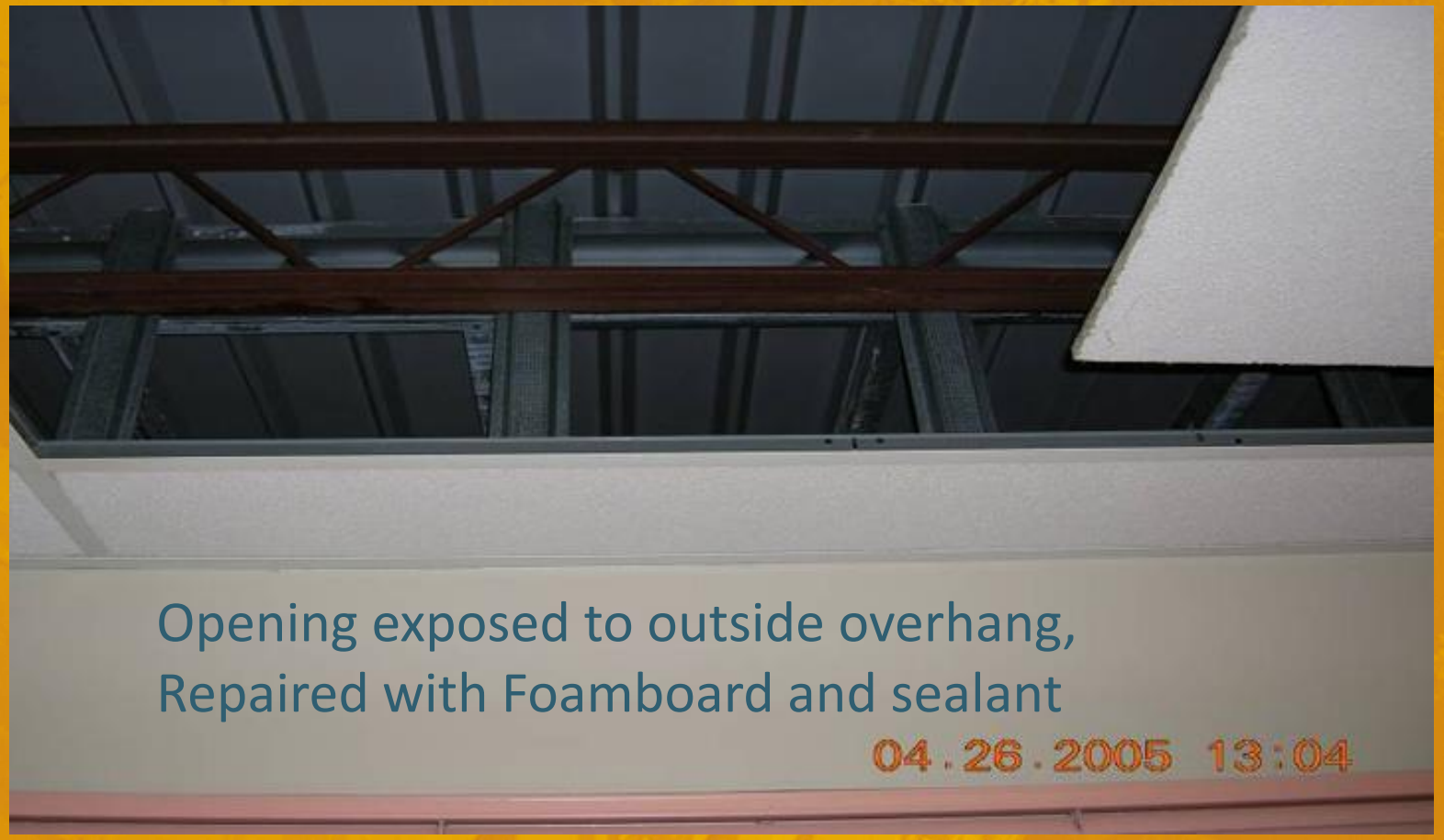


Case Study #3 – Effects of Air Leakage in a Humid Environment

Overhanging Soffit Roof/Wall Joint Leakage Site Seen From Inside Conditioned Space

Case Study #3 – Effects of Air Leakage in a Humid Environment



Case Study #3 – Effects of Air Leakage in a Humid Environment

Metal soffit panel seams, sealed with foam sealant

Case Study #3 – Effects of Air Leakage in a Humid Environment

Case Study #3 – Effects of Air Leakage in a Humid Environment

Improving health, safety, durability, comfort
and energy efficiency
in healthcare, commercial, institutional
and
multi-family buildings
*is as easy as **ABC***

*(**A**ir **B**arrier **C**ontinuity)*

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