GOTTA KEEP ‘EM SEPARATED

NET ZERO READY MURBS

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The ultimate in comfort and efficiency

Where is it coming from? From semi-detached and townhomes to mid and high-rise construction, **compartmentalization to achieve airtightness between units, as well as to the exterior, is a challenge**.

This was an applied research focus throughout the Net Zero MURB project. We'll hear from Mark Rosen and the evolution of the 'Rosen Factor' throughout this project to where it has landed in code. Andy Oding & Dr. Michal Bartko will present research findings from work with both Landmark and Avalon, correlating firewalls with target air compartmentalization.

From the construction side, we'll hear from the MURB Project builders how compartmentalization is integrated into both modular and panelized solutions.

THE HOME THAT SCIENCE BUILT

Compartmentalization

Air Barrier Control Layer In Common Assembly Walls

Why Now?

2024 CHBA Net Zero Summit

Andrew Oding MEA NZQEA LEED AP BSSO
Vice President

BUILDING KNOWLEDGE CANADA INC.

BUILDING KNOWLEDGE CANADA INC.

AIR TIGHTNESS IN MULTIFAMILY UNITS

Are we putting Air Barriers in the right walls?

BUILDING CODE AND MULTIFAMILY AIR BARRIERS

Building Code only identifies an air barrier for walls separating interior from exterior spaces….

Building Code does NOT recognize the need for air barriers BETWEEN units (e.g., **compartmentalization**)

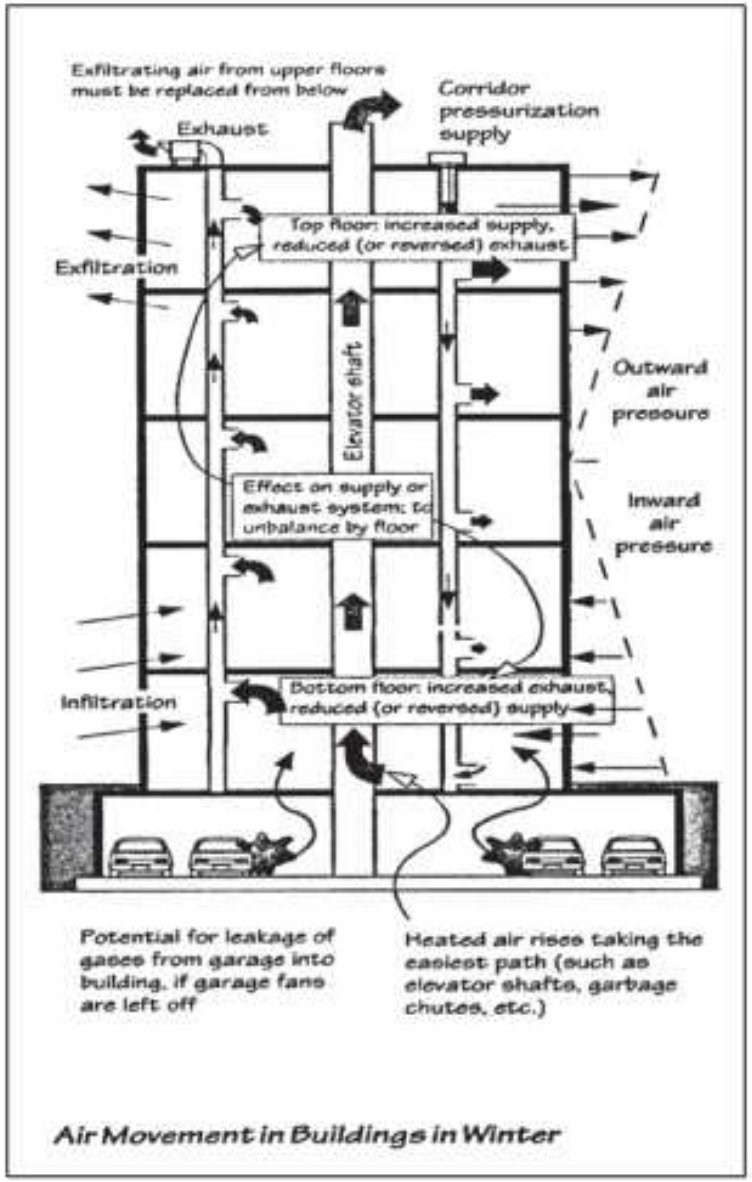
COMPARTMENTALIZATION

Compartmentalization, as a concept, dates back to the Empire State Building during the Great Depression. It was espoused as an approach to deal **with durability, fire safety, comfort** , and **indoor air quality in high-rise and multifamily construction** . However, the concept was not formally memorialized untilHandegord (Canadian IRC, 2001).

HISTORICAL PERSPECTIVE: MURB AIR BARRIERS / AIR TIGHTNESS

2007 CMHC Research Report: Air Leakage Control Manual : Multi-Unit Residential Buildings

- In MURBs, it isimportant to understand who pays the heating bills as this will have a significant impact on whether or not the ALC work gets done and the size (and budget) of the project.
- Typical MURB mechanical design strategies utilize relatively simple central corridor ventilation and kitchen/bathroom exhaust systems. Uncontrolled infiltration can significantly impact the performance of these systems.
- MURBs can experience high moisture loads and widely varying occupant expectations for comfort.



COMPARTMENTALIZATION : THE BENEFITS BEYOND ENERGY

- improved airtightness is reduced heating and cooling energy use.
- increases occupant comfort.
- reduces the risk of air leakage-drive (interstitial condensation) failures of building enclosures.
- improves the ability of space conditioning systems to control interior humidity levels.
- research has shown that good compartmentalization is vital for fire, smoke, odour, contaminant, and sound control.
- can ensure more reliable suite ventilation in buildings with common ventilation systems.

*These issues are summarized in the **literature search presented by Finch et al. (2009), and are covered in work by Hill (2005, 2006). Environmental tobacco smoke is an airborne contaminant of particular concern; measurements of compartmentalization before and after retrofit airtightness measures were studied by the Center for Energy and Environment (CEE 2004).***

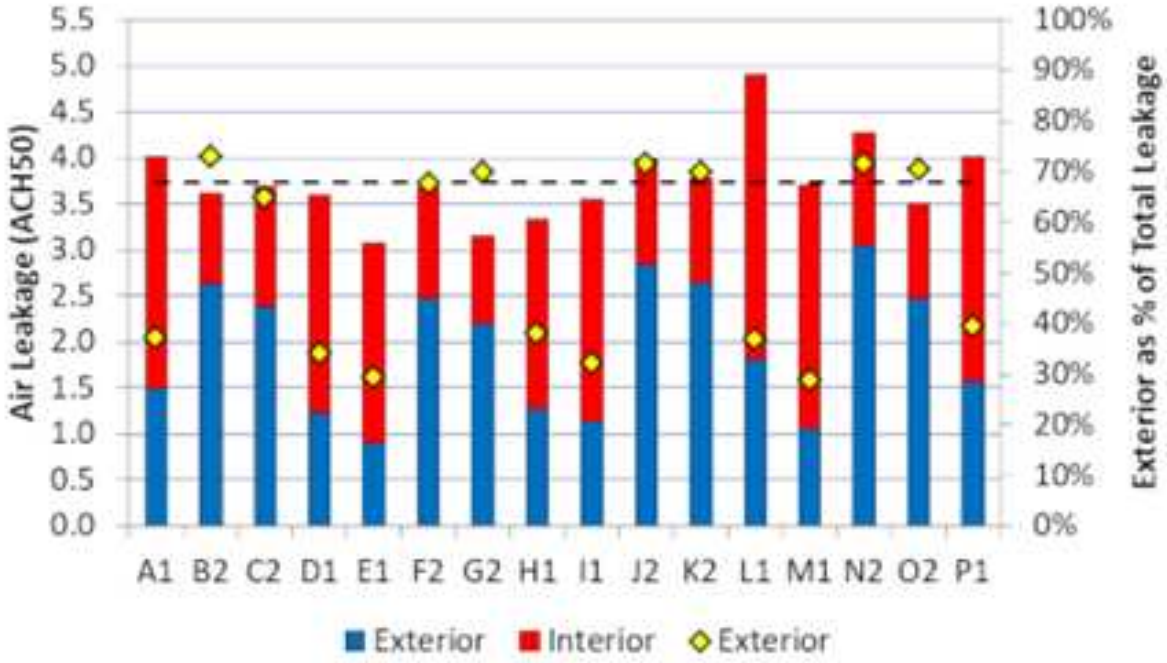
AIR TIGHTNESS BENCHMARKS

- R-2000 – 1.5 ACH@50 Pa
- Net Zero Ready/Net Zero: SD 1.5 ACH50 /AT 2.0 ACH50 (or**0.15NLR)**
- ENERGY STAR– SD 2.5 ACH50 / AT 3.0 ACH50 (or**0.26NLR)**
- Passive House– 0.6 ACH@50

NOTE: Due to small interior volume of AT homes, most AT homes in Canada choose to comply with ESNH, NZR , ON SB12, NBC ***using the NLR metric*** *–As NLR references Surface area as opposed to volume*

2016 MINNESOTA CASE STUDY : 16 UNIT AT HOME AIR TIGHTNESS CASE STUDY
EXTERIOR-TO-INTERIOR AIR VS INTERIOR-TO-INTERIOR AIR

- Completed using **guarded testing protocol**
- **Guarded testing is incredibly expensive** (as opposed to individual suite or whole building testing (where possible)
- **Nearly impossible to reproduce if results are questioned after occupancy**



This chart shows the measured leakage of the 16 units in a garden style building. Each bar represents a unit's total leakage, divided between exterior (blue) and inter-unit (red).

IMPORTANT RESEARCH

- Fire-resistance rated wall assemblies (or area separation walls) have been **identified as the major source of difficulty in air sealing/compartmentalization,** **particularly in townhouse construction** .

- **Middle units had worse air leakage than end units** ; guarded testing showed greater reductions for middle units than end units.

- As a result, the leakage between units was not completely eliminated in these guarded tests. **Average results showed leakage from: 50% outside / 50 inside(conditioned area).**

- In both the unguarded and guarded (pressure neutralized) testing, **no units met the 3 ACH50 target of the 2012 IECC** . For reference, typical results for this builder were 4.8 ACH50 at this development, and 3.2 ACH50 at a development that had used a spray latex sealant (both unguarded tests). **However, these units either achieved or were close to the NLR 0.30 CFM50/ft2 enclosure standard used by some programs (e.g., PHIUS).**

RECOMMENDATIONS

- "Area-based metrics (e.g., NLR) address the penalty seen here for smaller units, and have been espoused by Building Science Corporation, ASHRAE, Passive House Institute US, Steven Winter Associates, and others. Maxwell (2014) **suggested that 0.30 CFM50/ft2 enclosure may be a useful target for multifamily construction, and Brennan (2014) has stated that ASHRAE 62.2 is shifting to this standard as well** . Overall, much of the industry appears to be converging, if and when the relevant standards change, the direction of research should be adapted accordingly."

WHAT ARE AIR SEALING ISSUES WITH ATTACHED UNITS?

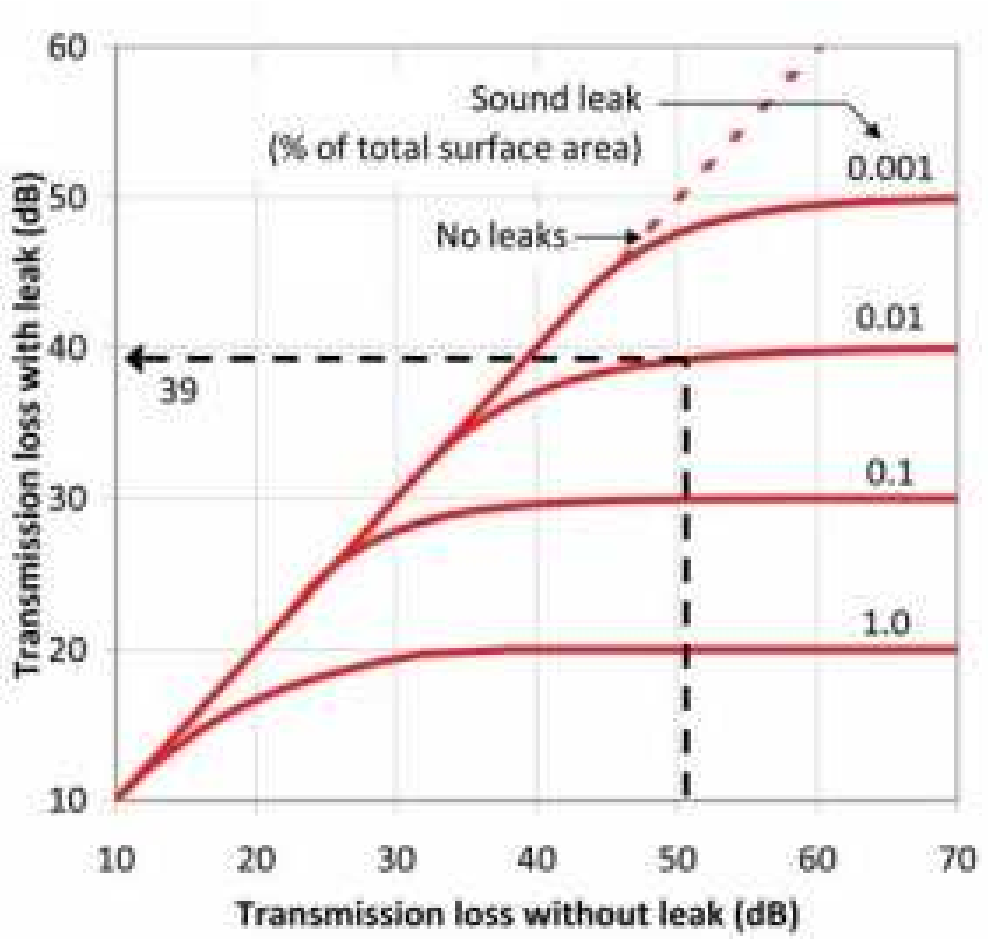
Sound isolation is compromised by air leakage

Sound travels by:

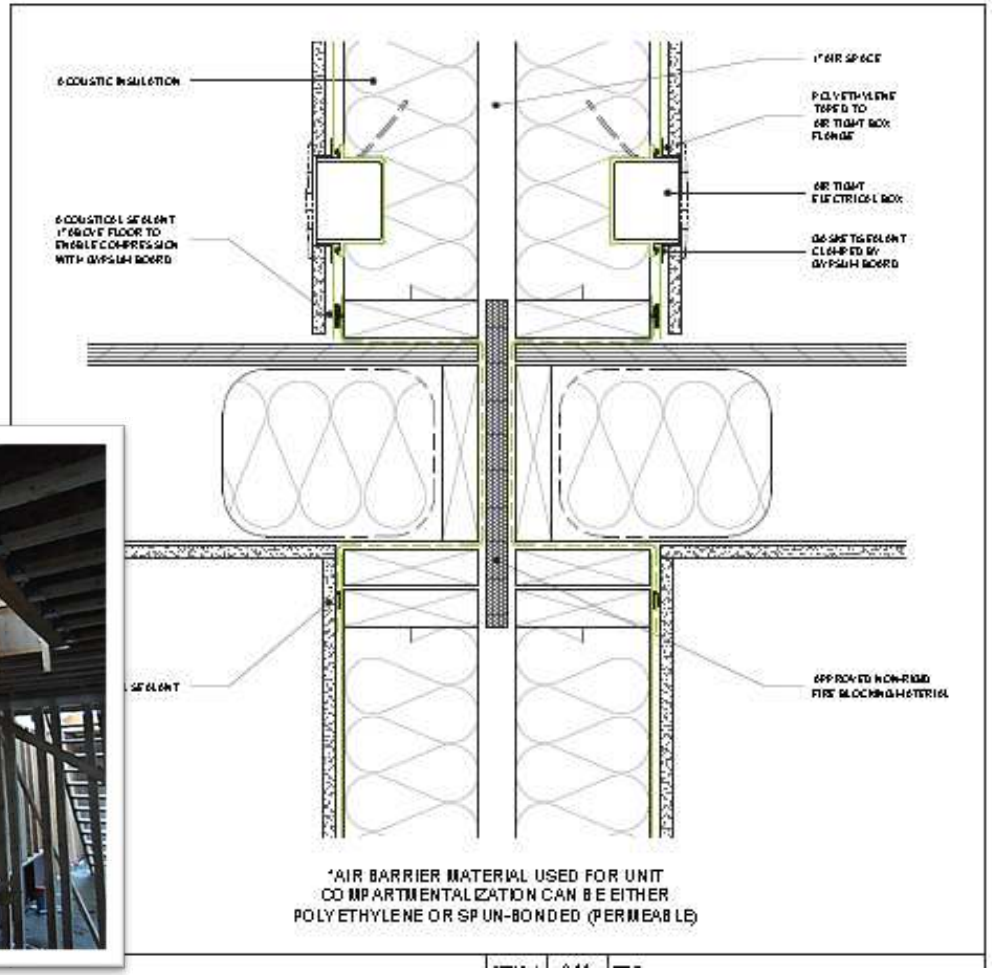
1. Structure-borne elements- vibration(energy)

2. Airborne sound waves or vibrations

3. An opening or crack 1/100th of 1% of a total wall's surface area can reduce the sound transmission loss (I) of a wall from 50 to 39 db.



WHAT AIR SEALING / COMPARTMENTILIZATION PRACTICES AE BEING USED IN THE FIELD ?



Compartmentalization is the key

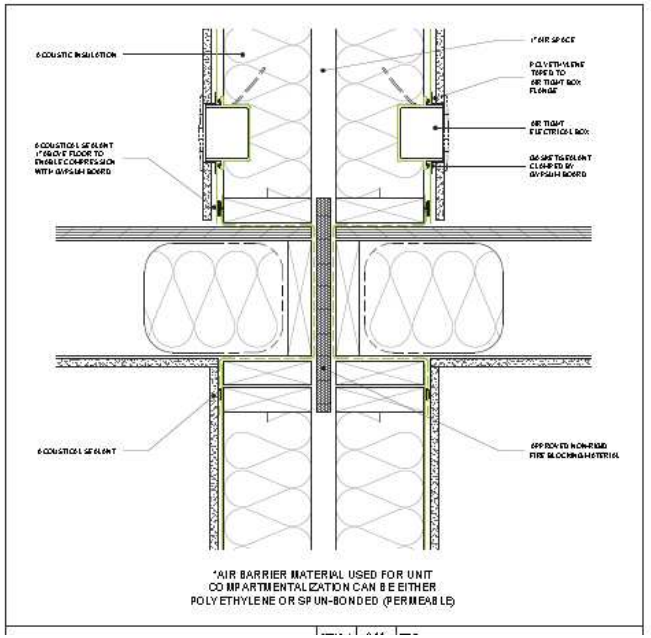
Understanding air can infiltrate between units in:

- Common walls
- Common floors

1 HR DOUBLE STUD WALL COMPARTMENTILIZATION + Spunbonded Polyolephin OR Aerosolized Sealant?

	Block 12- With Poly/TYVEK	Block 13- Without
Pre ACH@50	4.58	8.9
Pre NLR	**0.23**	**0.45**
Pre Energy Star Level	N/A	N/A
Post ACH@50 (Aerobarrier Software)	**1.17**	**1.48**
Post ACH@50	2.03	3.14
	0.10	**0.13**

3x tighter than PHIUS Multifamily NLR !



jame.zaiyouna@enbridge.com

THE CHALLENGE WITH COMPARTMENTALIZATION:

WHAT ABOUT THE FIRE RATING OF THE ASSEMBLY?

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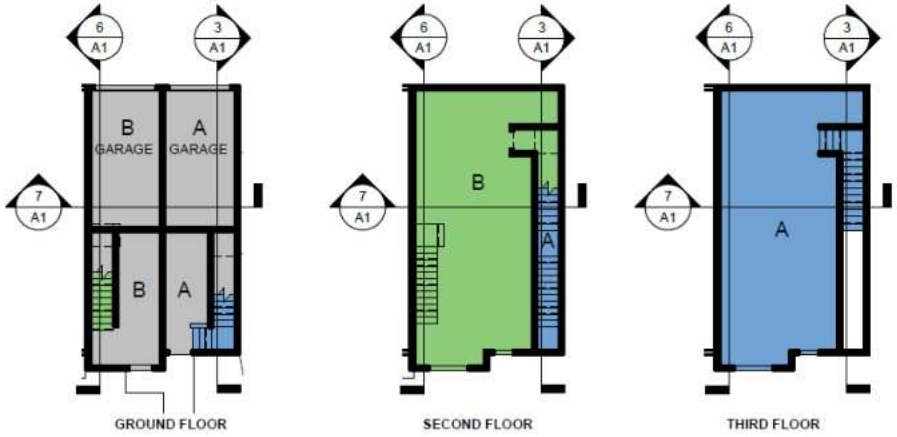
TYPE 1 STACKED TOWNHOME ARRANGEMENT

3 story stacked townhomes typically have a slab on grade foundation and all units are located above grade, often with attached garages provided for the units. Variations occur in how the unit configuration but typically involve a combination of 1 and 2 story units. The following example is based on an example design being constructed by residential builders.

The design has detail conditions that commonly occur between the garage and dwelling unit and between two dwelling units separated by a floor or wall. Where referenced on the plan details have been provided showing a typical detail condition, a photo of a similar site condition and a recommended best practice approach to maintaining the continuity or the air barrier between units.

Photos and Thermal Camera images has been provided by 4 Elements Integrated Design.

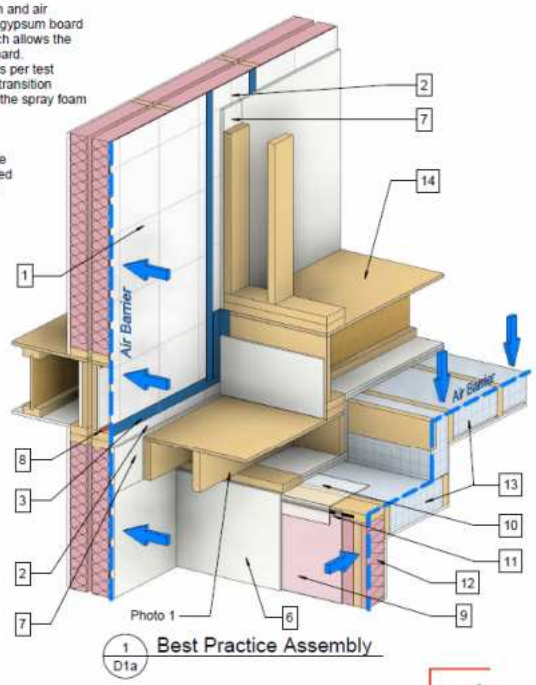


Best Practice Approach 1

Dwelling Unit to Garage
Where spray applied foam insulation is use to provide the insulation and air barrier it is best practice to provide furring and insulation under the gypsum board membrane to maintain the continuity of the air barrier. This approach allows the spray applied insulation to seal the joints in framing and gypsum board. Additionally the fire rating and STC of the floor assembly remains as per test data. A starter strip of polyethylene at the wall top plate provides a transition between to polyethylene air / vapour barrier at the garage wall and the spray foam insulation at the garage ceiling.

Dwelling Unit to Dwelling Unit
To maintain the continuity of the air barrier at the wall separating the dwelling units, a continuous air barrier membrane should be provided behind walls and landing framing. All joints must be taped with and approved air barrier tape.

1. Air Barrier Membrane - Air barrier membrane to be continuous and sealed at all intersection and joists (Applied by Insulation Trade)
2. Air Barrier Membrane Starter Strip Behind Framing
3. Air Barrier Membrane Tape - Tape all joints between air membrane sheets
4. Acoustic Caulking - Caulk all transitions between membrane and other materials
5. Gypsum Board Membrane
6. Fire Rated Gypsum Board Membrane
7. Fire Rated Gypsum Board Membrane Starter Strip
8. Fire Caulking
9. Polyethylene Sheet Membrane
10. Polyethylene Starter Strip Lapped Between Top Plate
11. Acoustic Caulking
12. Batt Insulation
13. Spray Applied Foam Insulation
14. Wood Framing



CHBA Multi Unit Residentail Air Tighness Details | Prepared by Front Porch Design Build

fpdb

SHIFT
Environmental Design and Consulting Inc.

COMING SOON: JUNE 2024: MURBS Design Details

fpdb

Session 7
POLLS

CANADIAN HOME BUILDERS' ASSOCIATION
netzero home
LEADERSHIPSUMMIT

MARK ROSEN
DIRECTOR OF BUILDING SCIENCE, BUILDING KNOWLEDGE CANADA

Blower Door Testing of Attached Units

MARK ROSEN
Director of Building Science

June 12th, 2024

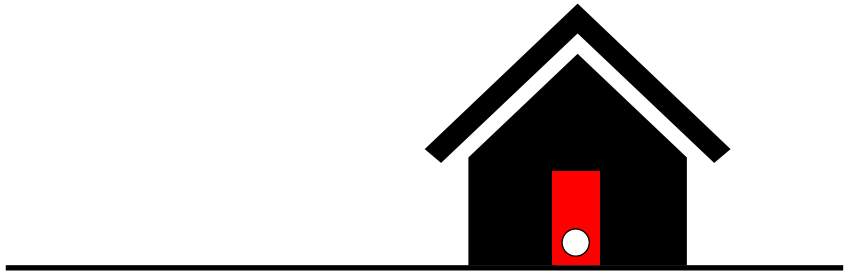
BUILDING KNOWLEDGE CANADA INC.

Timeline

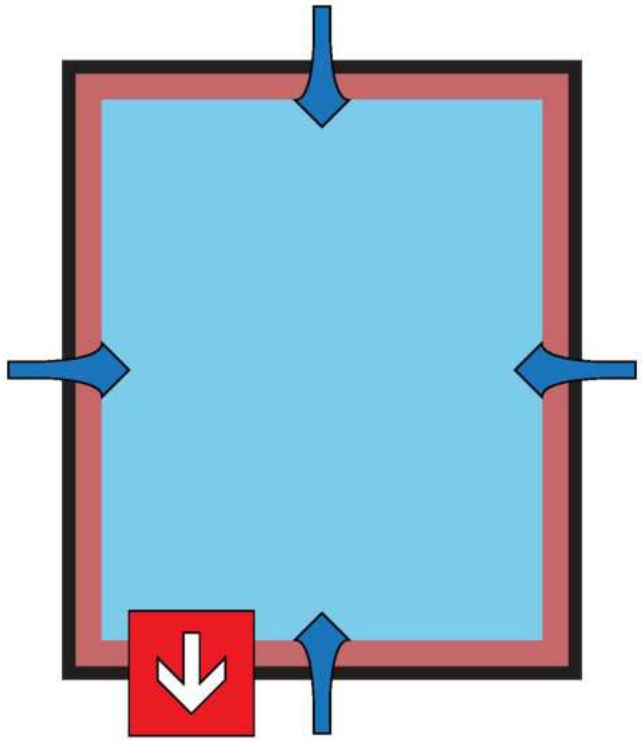
- 2017: Presentation to CHBA TRC
- 2020: Presentation to MURB Pilot Project Team, proposal to pilot an “Adjustment Factor”
- 2020-2021: In-field data collection & Analysis with NRC
- 2022: First meeting of the TG-Airtightness
- 2024: PCF 1819 out for public review

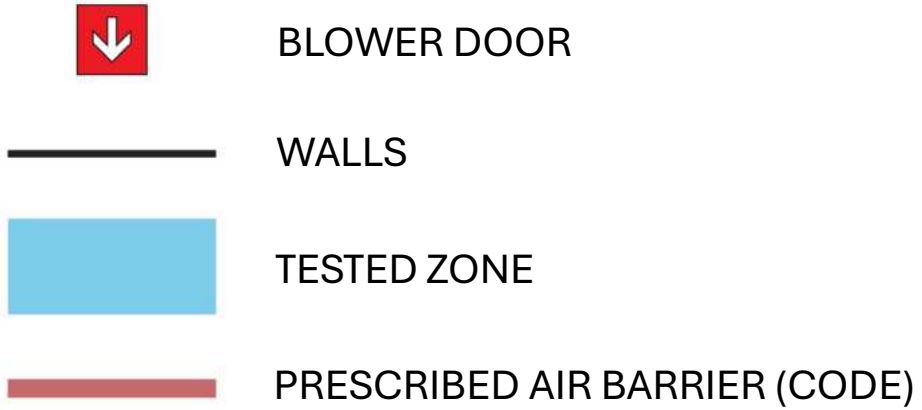
In the beginning…

In the beginning…
and then…
and it was good!

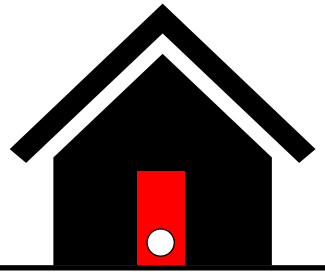


SINGLE DETACHED HOUSE BLOWER DOOR TEST

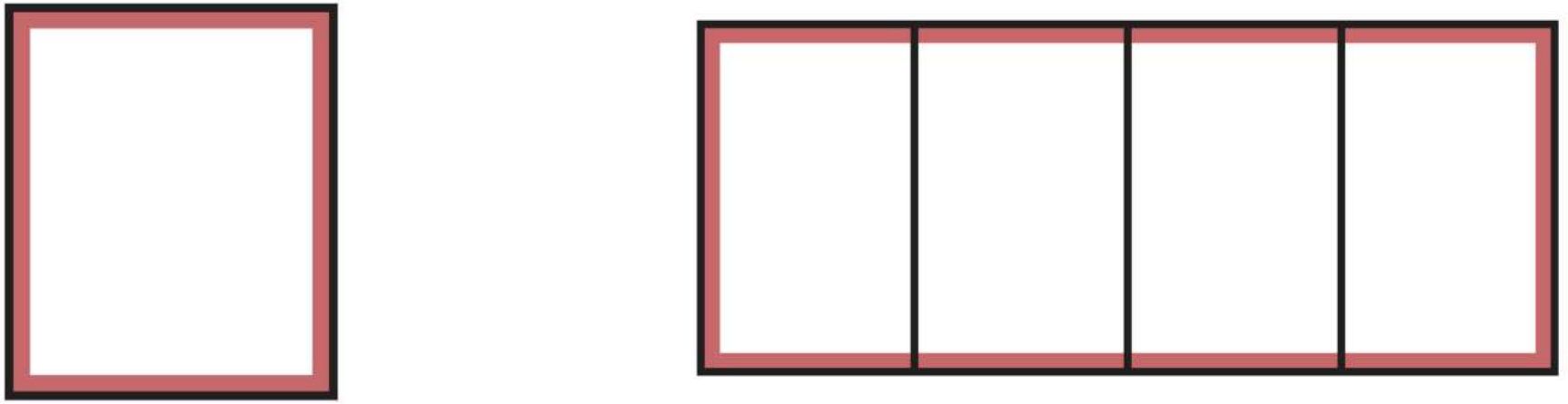




In the beginning…
and then…
and it was good!
Until…

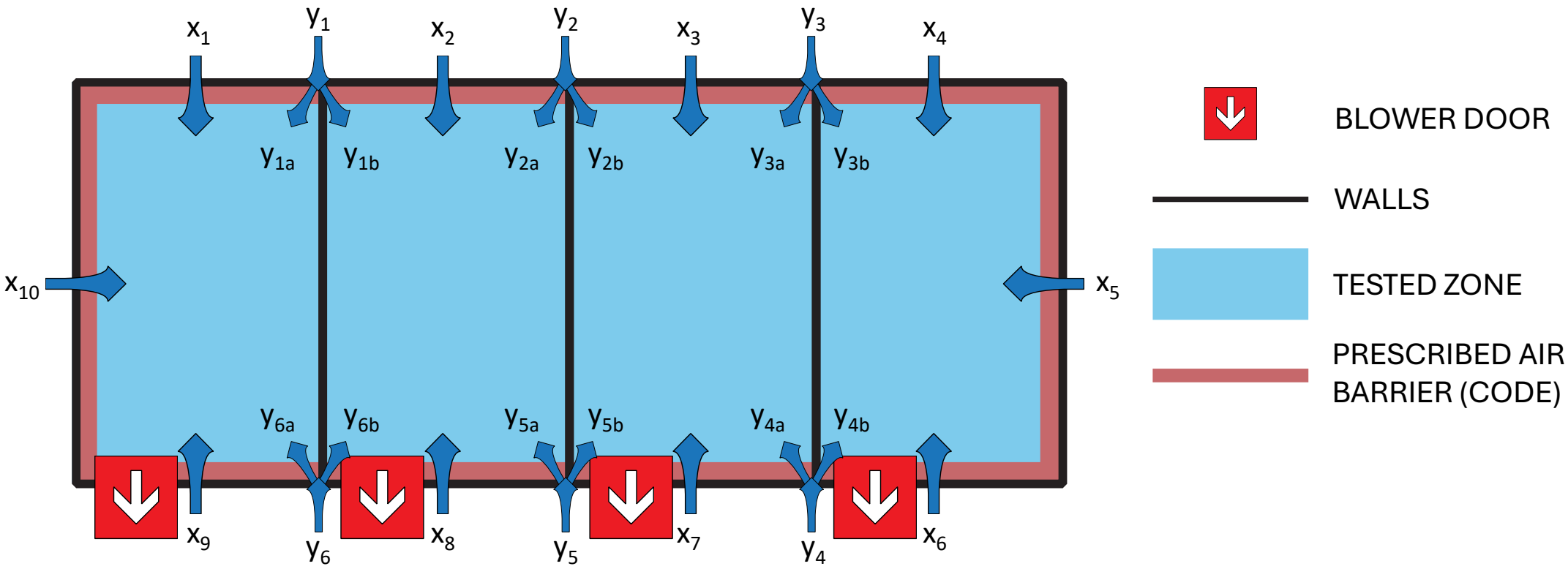


Where is the air barrier (prescribed by code)?



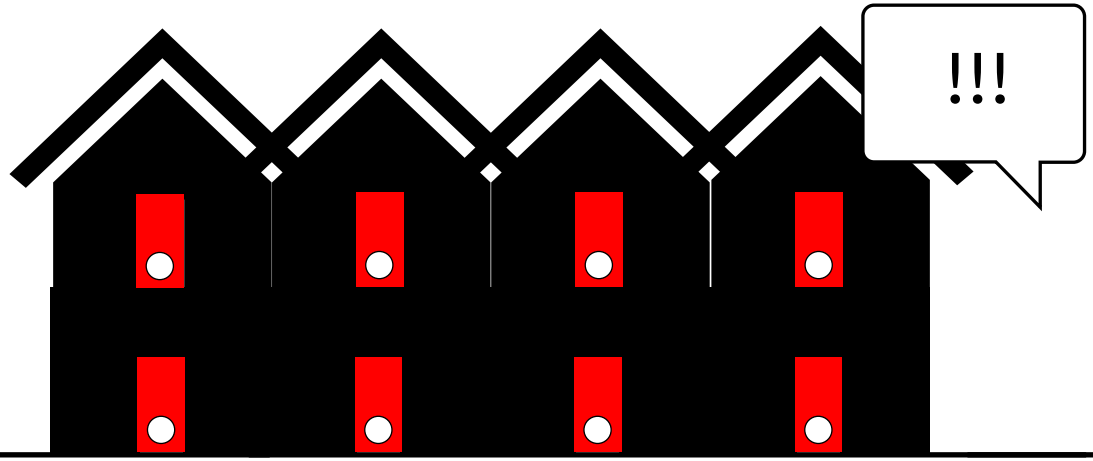
ATTACHED TOWNHOUSE **GUARDED** BLOWER DOOR TEST

Only unconditioned air leakage is measured



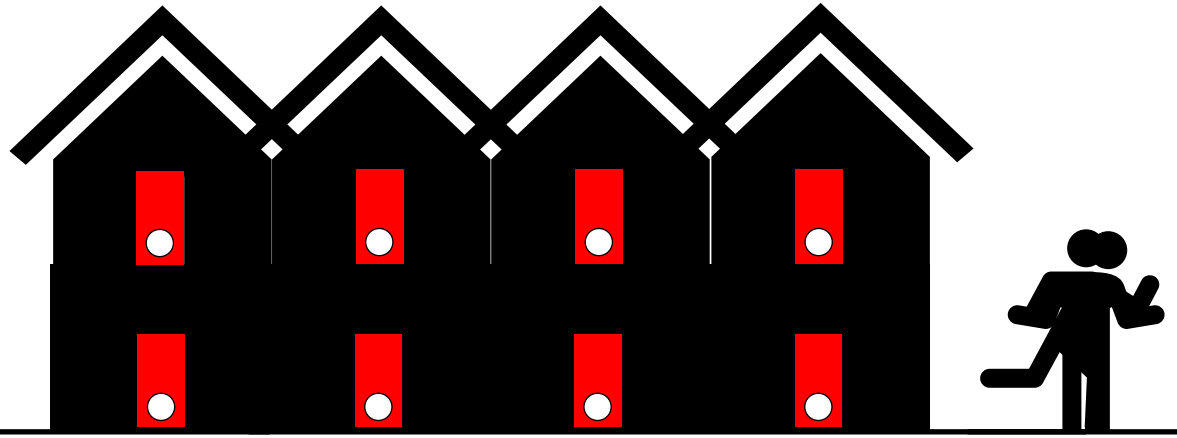
Until...
and then...

Until…
and then…
so obviously…

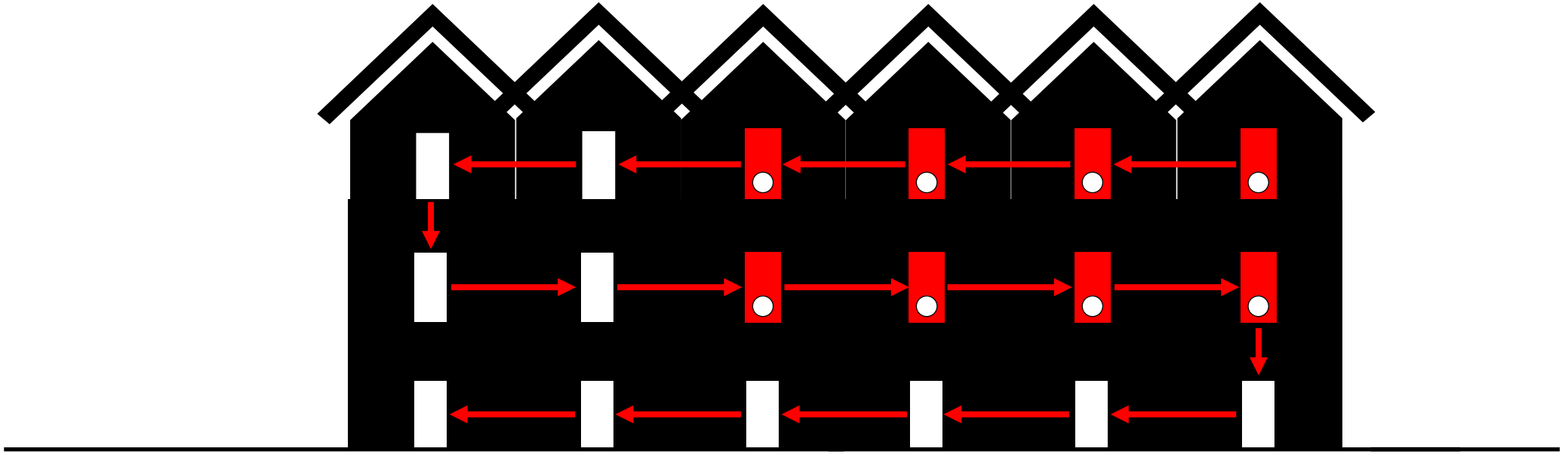


Energy Advisor

and then...



Wait! Come back!

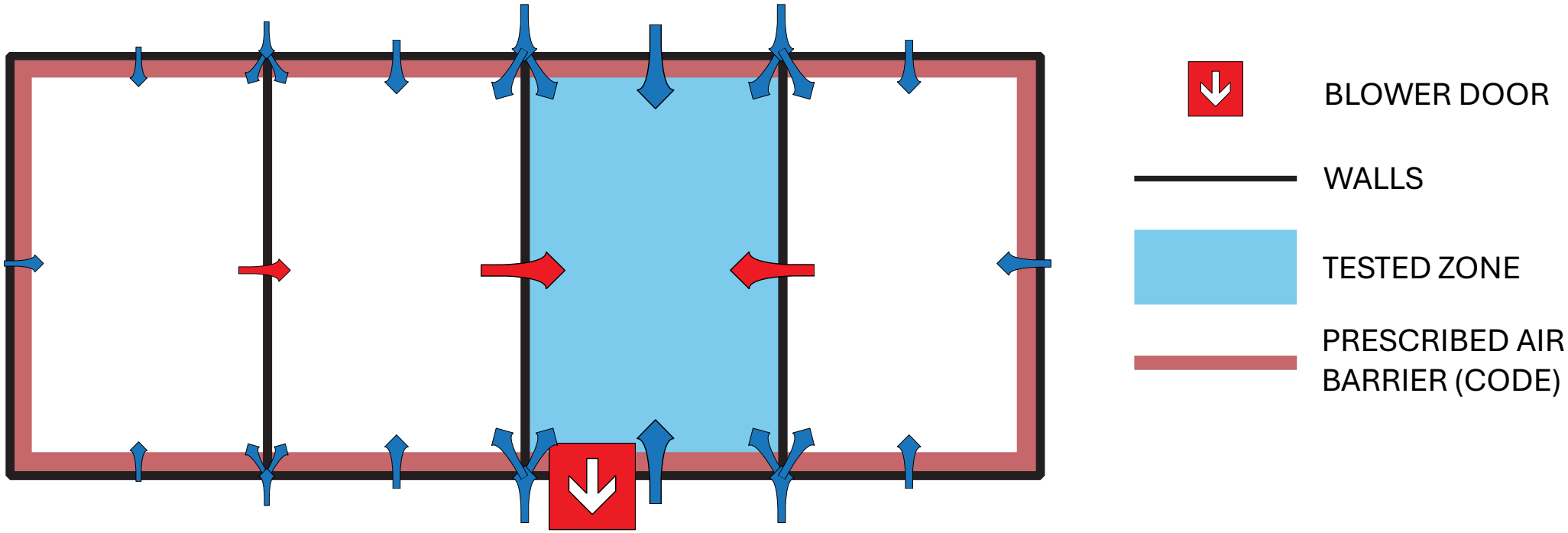


- This is doable – and being done
- This is testing for Compartmentalization

ATTACHED HOUSE **UNGUARDED** BLOWER DOOR TEST

Both conditioned and unconditioned air leakage are measured

It is not possible to accurately quantify or differentiate these values with this test

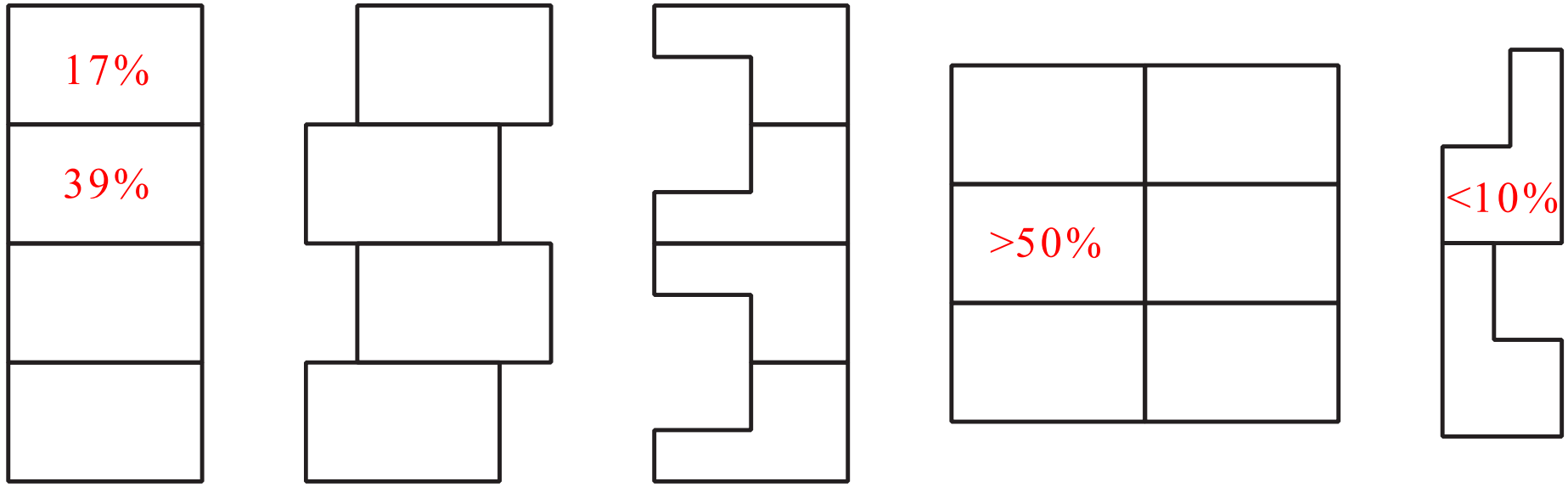


Some of this leakage may be counted multiple times as individual tests are completed on the whole block.

2017: CHBA TRC

- No differentiation between attached and detached homes
- Prescribed vs. Measurable air leakage
- Assumption of 2.5 ACH50 in Reference House (ERS and NBC)

Attached Homes: Variation

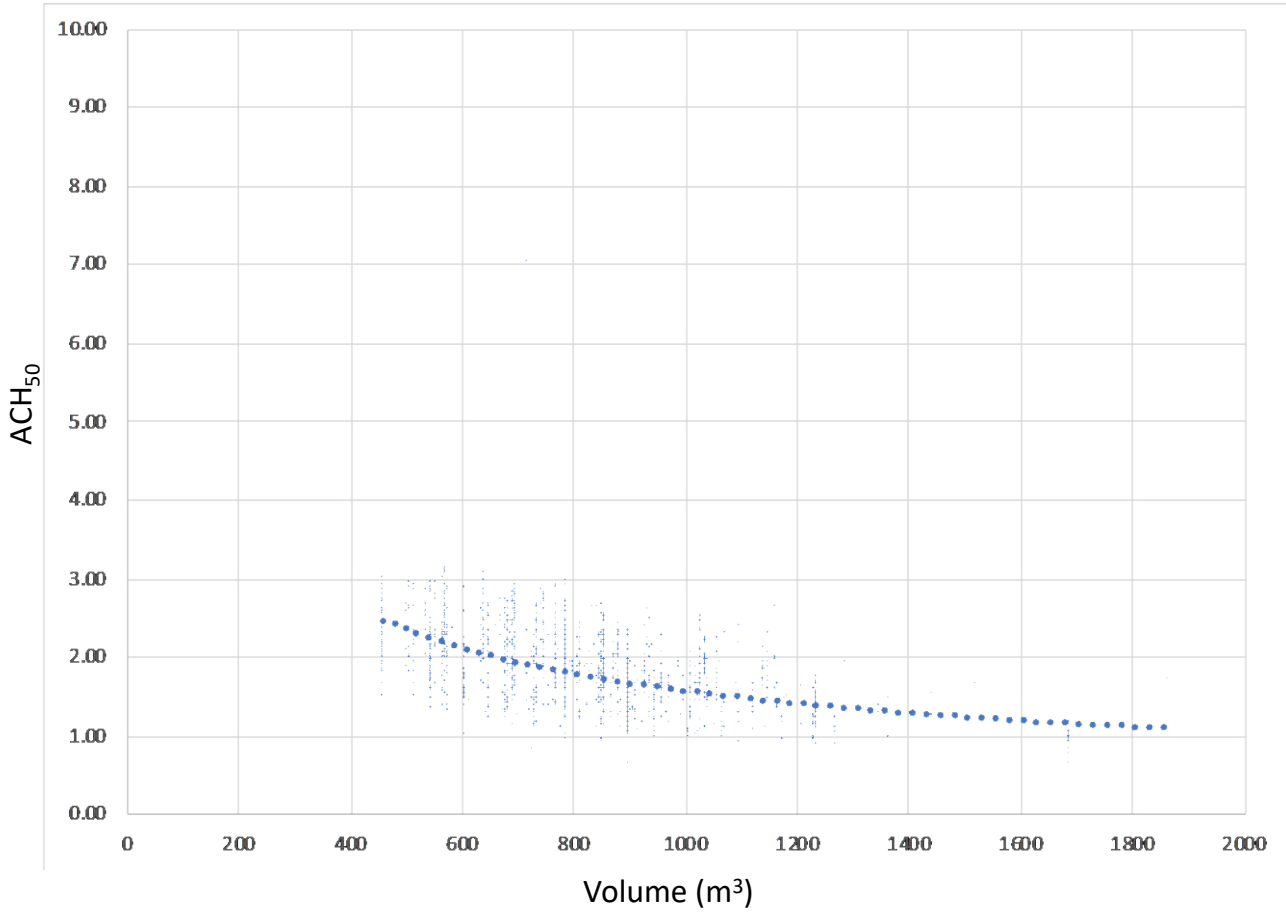


2020: CHBA NZ MURB

- All unguarded test results on **attached** housing are wrong!
- ...at least, the ones we use for **energy modeling** are wrong...
- ...and the ones we use for **compliance** with various targets...

Solution: **Adjustment Factor, ACH_{50}**

1. Results from single detached homes
   - As volume decreases, ACH_{50} avg goes up, but on a relatively predictable curve



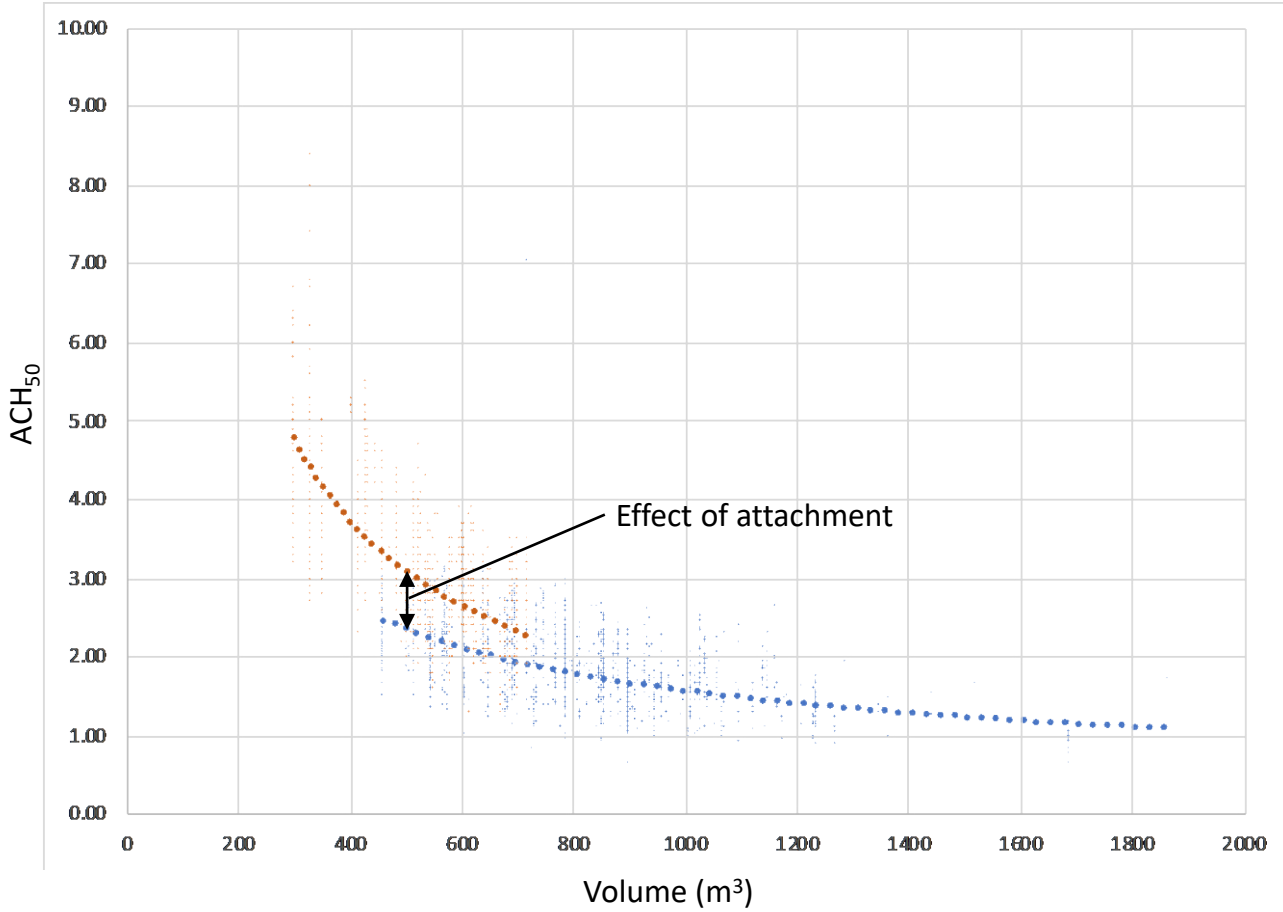
Solution: **Adjustment Factor, ACH_{50}**

1. Results from single detached homes

   As volume decreases, ACH_{50} avg goes up, but on a relatively predictable curve

2. Results from attached homes
   - Semis & Ends, Mids

   Attached home curves follows same trend, but does not align with detached homes curve.



Solution: **Adjustment Factor, ACH_{50}**

1. Results from single detached homes

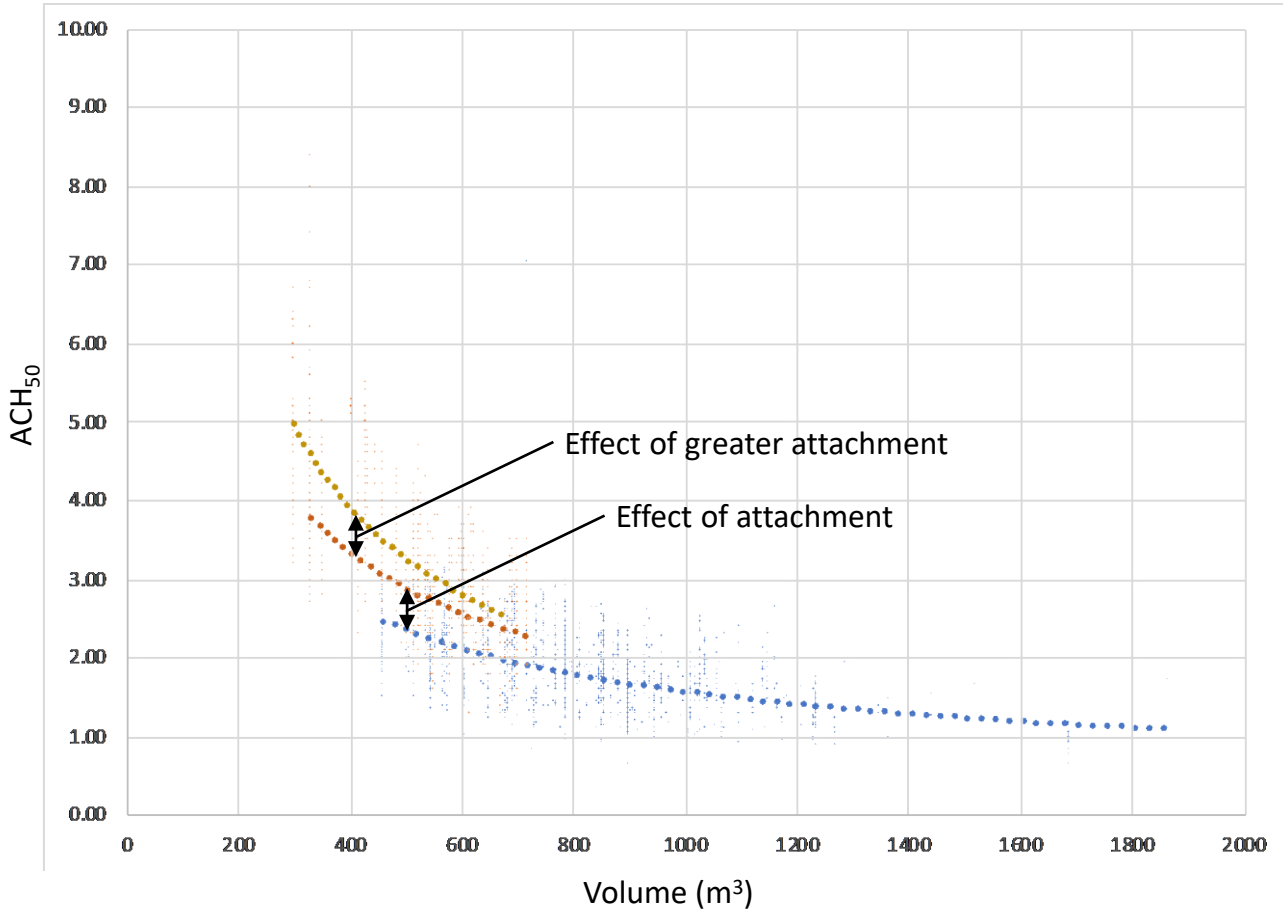
   As volume decreases, ACH_{50} avg goes up, but on a relatively predictable curve

2. Results from attached homes
   1. Semis & Ends
   2. Mids

   Both attached home curves follow same trend, but as attachment increases, curves move up in ACH_{50}

3. Application of Adjustment Factor to ACH5– results:

   $ACH_{50} \div (1 + \%_{att})$



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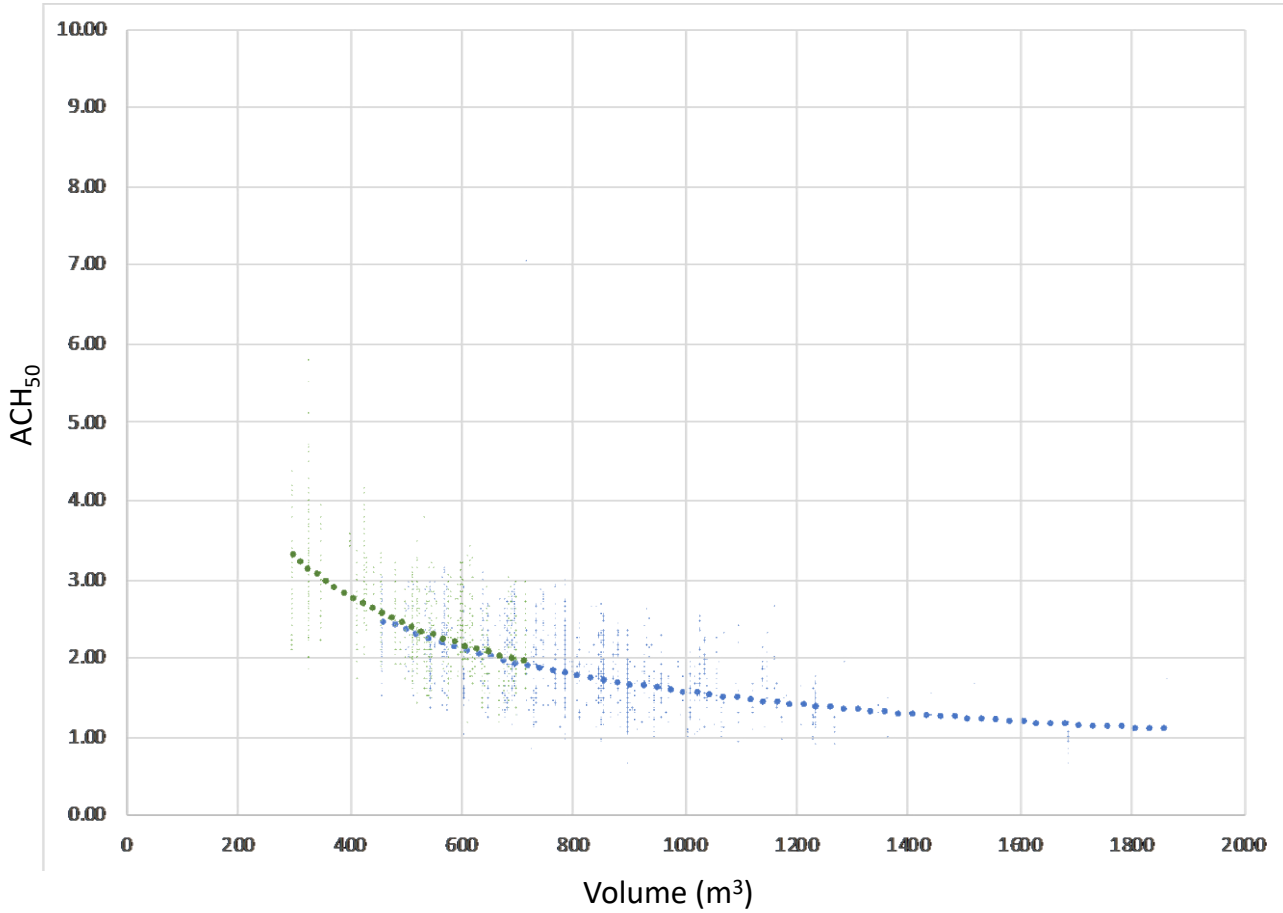
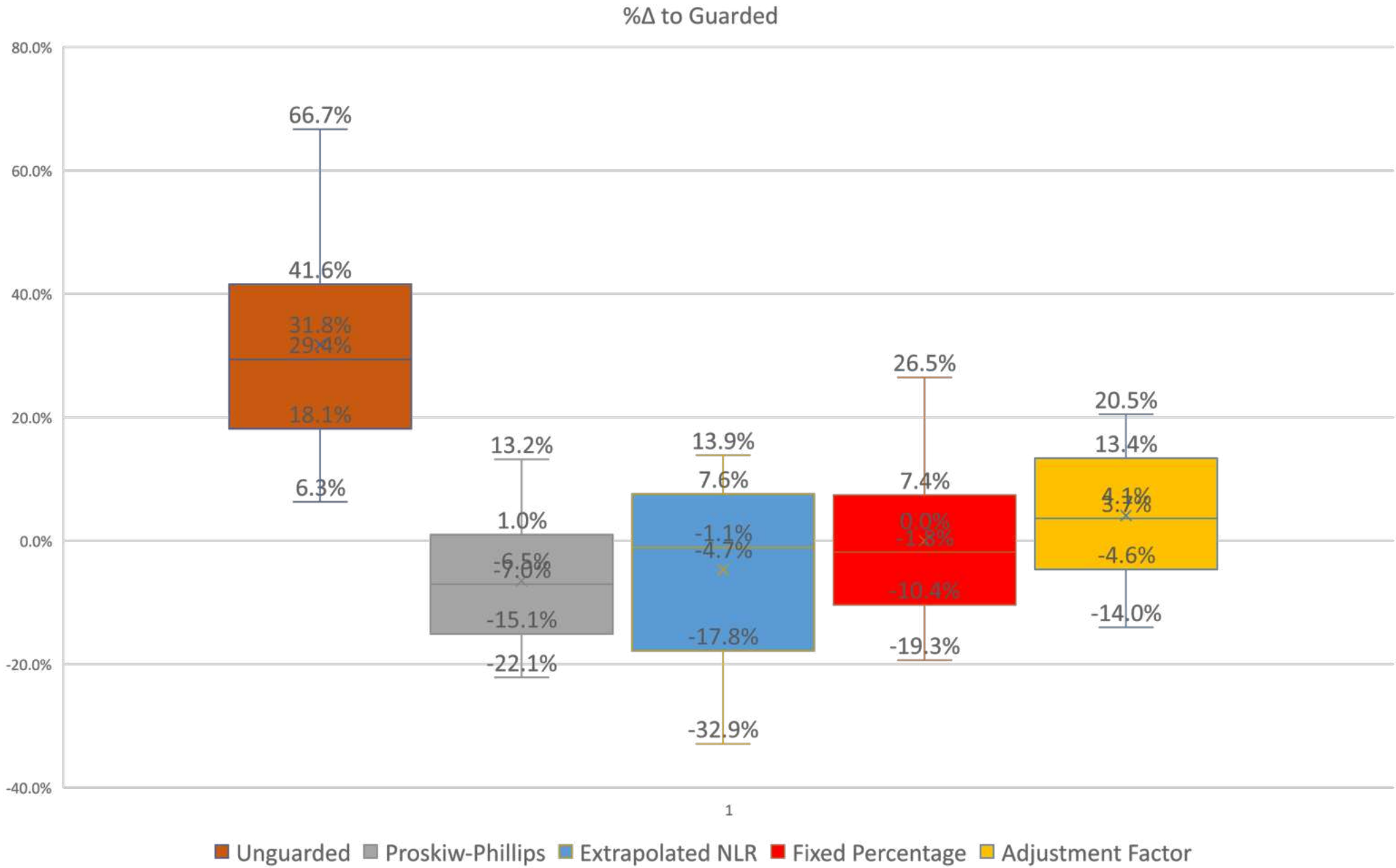


2020-2022: NZ MURB Pilot & NRC Field Data

- Collection of data from the field to validate the Adjustment Factor
- Perform both Guarded and Unguarded testing
- Data from 34 attached homes and 28 MURB units collected

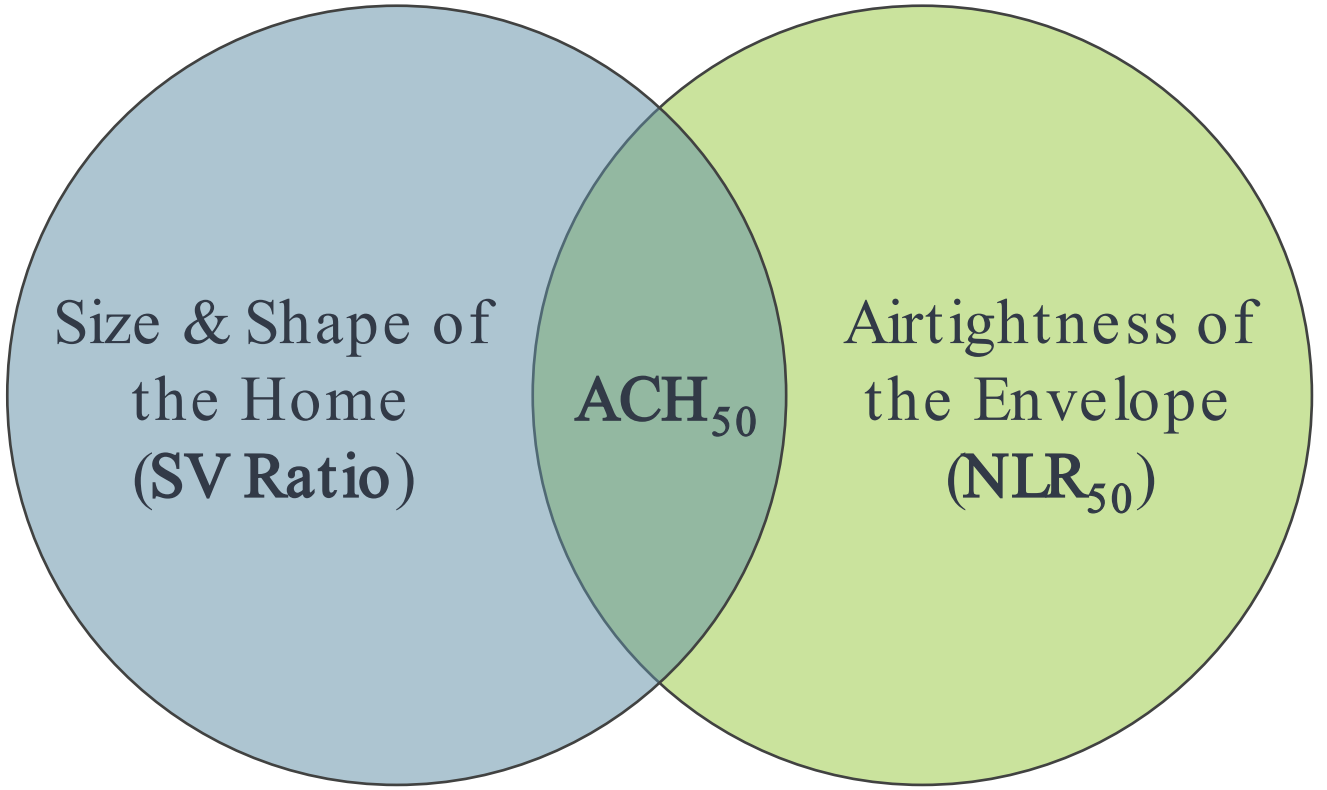

%Δ to Guarded
80.0%
60.0%
40.0%
20.0%
0.0%
-20.0%
-40.0%
66.7%
41.6%
31.8%
29.4%
18.1%
6.3%
13.2%
1.0%
-6.5%
-7.0%
-15.1%
-22.1%
13.9%
7.6%
-1.1%
-4.7%
-17.8%
-32.9%
26.5%
7.4%
0.0%
-1.8%
-10.4%
-19.3%
20.5%
13.4%
4.1%
3.7%
-4.6%
-14.0%
1
Unguarded
Proskiw-Phillips
Extrapolated NLR
Fixed Percentage
Adjustment Factor

2022 TG-Airtightness & PCF 1819

- Recommendation of **NLR50** instead of **ACH50** as the governing metric.
- Evolution of the **Adjustment Factor** to **NLR50 formula** applied to exposed envelope
- **Work is ongoing…**

ACH_{50} vs NLR_{50} in Code

Not controlled by code



Section 9.25.3 and 9.36.2.9-.10 (Prescriptive)

Takeaways

- Work to improve how we translate unguarded blower door tests into energy models is ongoing (in Codes and Programs)
- **Compartmentalization** is worthwhile and **always helps blower door results!**

Thank you

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BUILDING KNOWLEDGE CANADA INC.

CANADIAN HOME BUILDERS' ASSOCIATION
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LEADERSHIPSUMMIT

DR. MICHAL BARTKO
RESEARCH OFFICER, NRC

NRC·CNRC

NRC.CANADA.CA

Net Zero Leadership Summit 2024, CHBA
June 12, 2024

Evaluation of Partitions between Adjoining Residential Units

Airtightness, Fire Resistance and Acoustic Performance

Michal Bartko *, Travis Moore, Iain Macdonald, Mike Nicholls, Heather Knudsen

Construction Research Centre
National Research Council Canada

Outline

1. **Introduction, Background**
2. **Air Leakage Testing**
   - Test specimens, Test Procedure and Test Facility, Test Results
3. **Fire Resistance Testing**
   - Test specimens, Test Procedure and Test Facility, Test Results
4. **Acoustic Testing**
   - Test specimens, Test Procedure and Test Facility, Test Results
5. **Conclusions**

Introduction

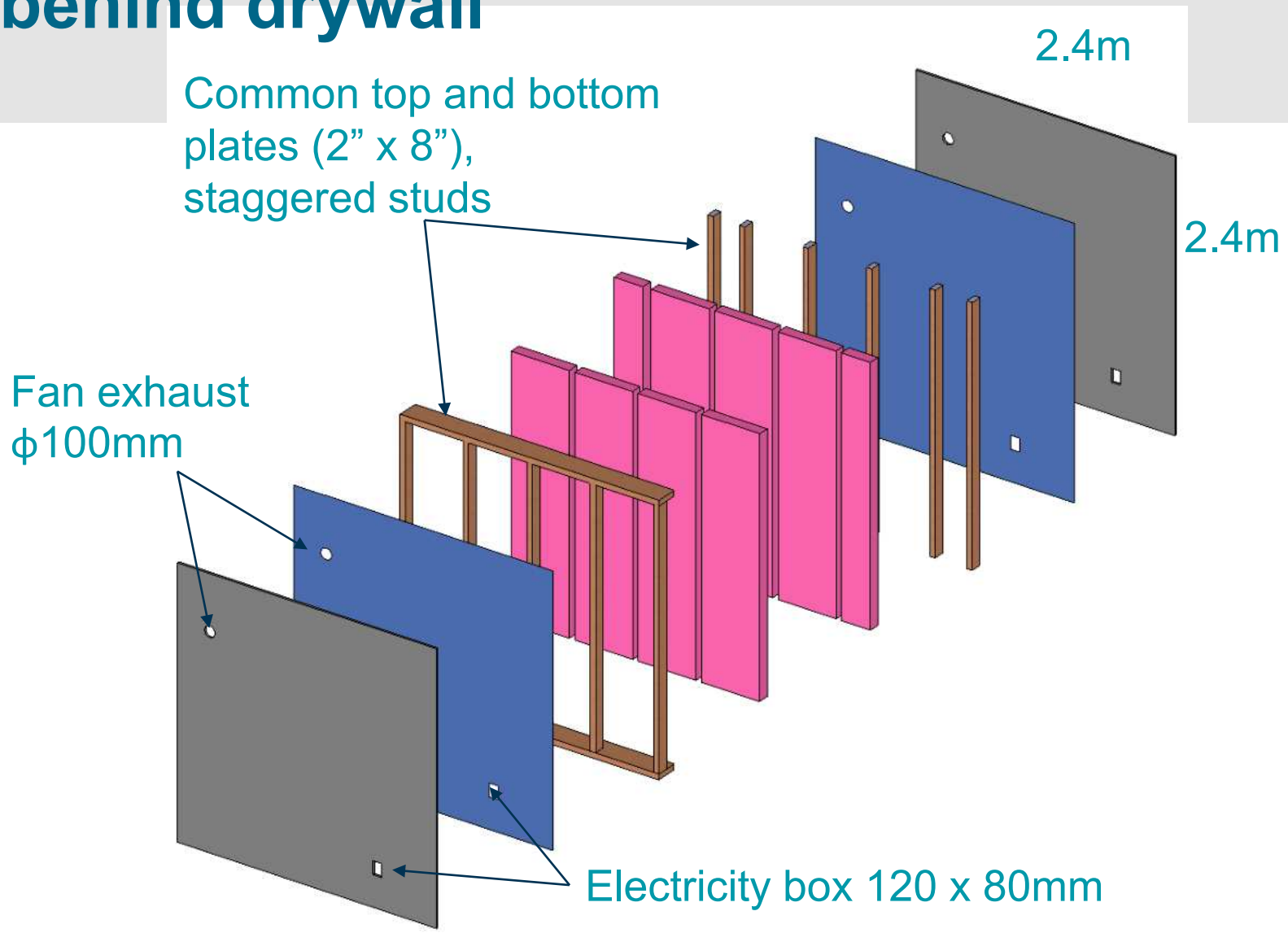
- **With increasing number of multi-unit residences, partition wall airtightness is becoming a greater concern in adjoining units with possible:**
  - **Transfer of pollutants** (tobacco & cannabis smoke, kitchen fumes, etc.)
  - Radon intrusion etc.
- **Airtight partitions help with unit compartmentalization (important in high-rise, midrise MURB construction)**
- **Partition wall airtightness is not included in the NBC. Should it be?**
- **How do partition walls perform?**

Background

- January 2020: initiated discussions with a **key stakeholder- CHBA**
- November 2020 - November 2021, **Phase 1 testing**
  - Air leakage
- January 2023 - August 2023, **Phase 2 testing**
  - Air leakage, Fire resistance, Acoustic performance
- September 2023: Project Completed

Air Leakage Evaluation

Specimen Example: Double wood stud wall fragment AB behind drywall



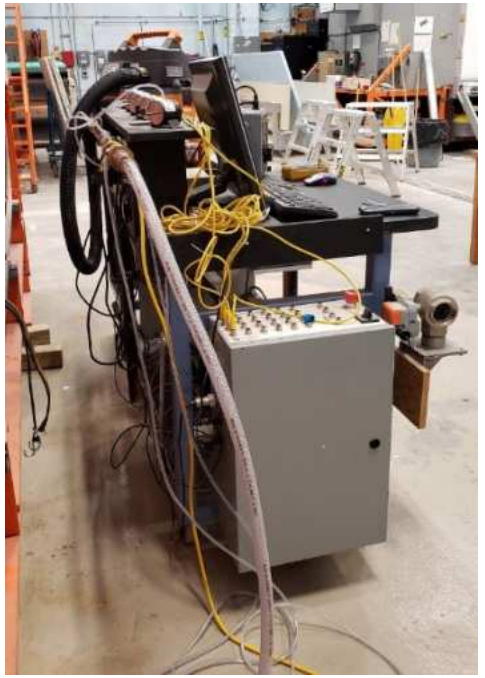
- Drywall 5/8” type X
- Drywall 1/2”
- **AB**
- Wood stud (2”x4”), 24”o.c. with batt insulation 100mm
- Air cavity 25mm
- Wood stud (2”x4”), 24”o.c. with batt insulation 100mm
- **AB**
- Drywall 1/2”
- Drywall 5/8” type X

Example of Specimen Preparation

List of Specimens

	Air barrier systems	Tested conditions
1	Gypsum board (drywalls 1.27cm (1/2 in.) + 1.59 cm (5/8 in.) X-type- fire resistant	Sealed
		Fastener penetrated
2	1 sheet, Polyethylene (PE) foil (6-mil poly sheet)	Unsealed
		With construction opening (2m vertical cut)
3	2 sheets, Polyethylene (PE) foil (6-mil poly sheet)	Sealed
		Sealed, fastener penetrated
		Unsealed
4	2 sheets, Spun bonded polyolefin (SBPO) membrane	Sealed
		Sealed, fastener penetrated
		Unsealed

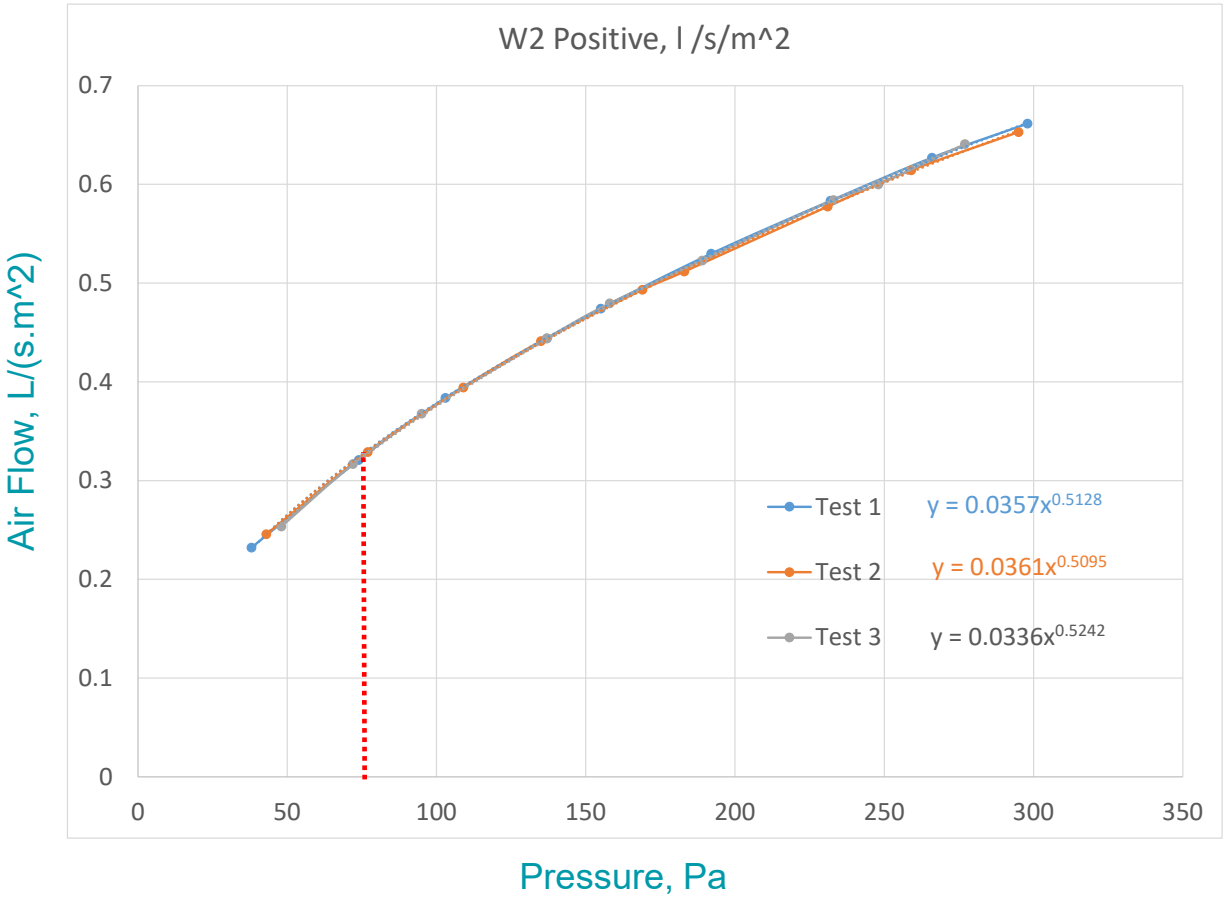
NRC, Air Leakage Test Facility



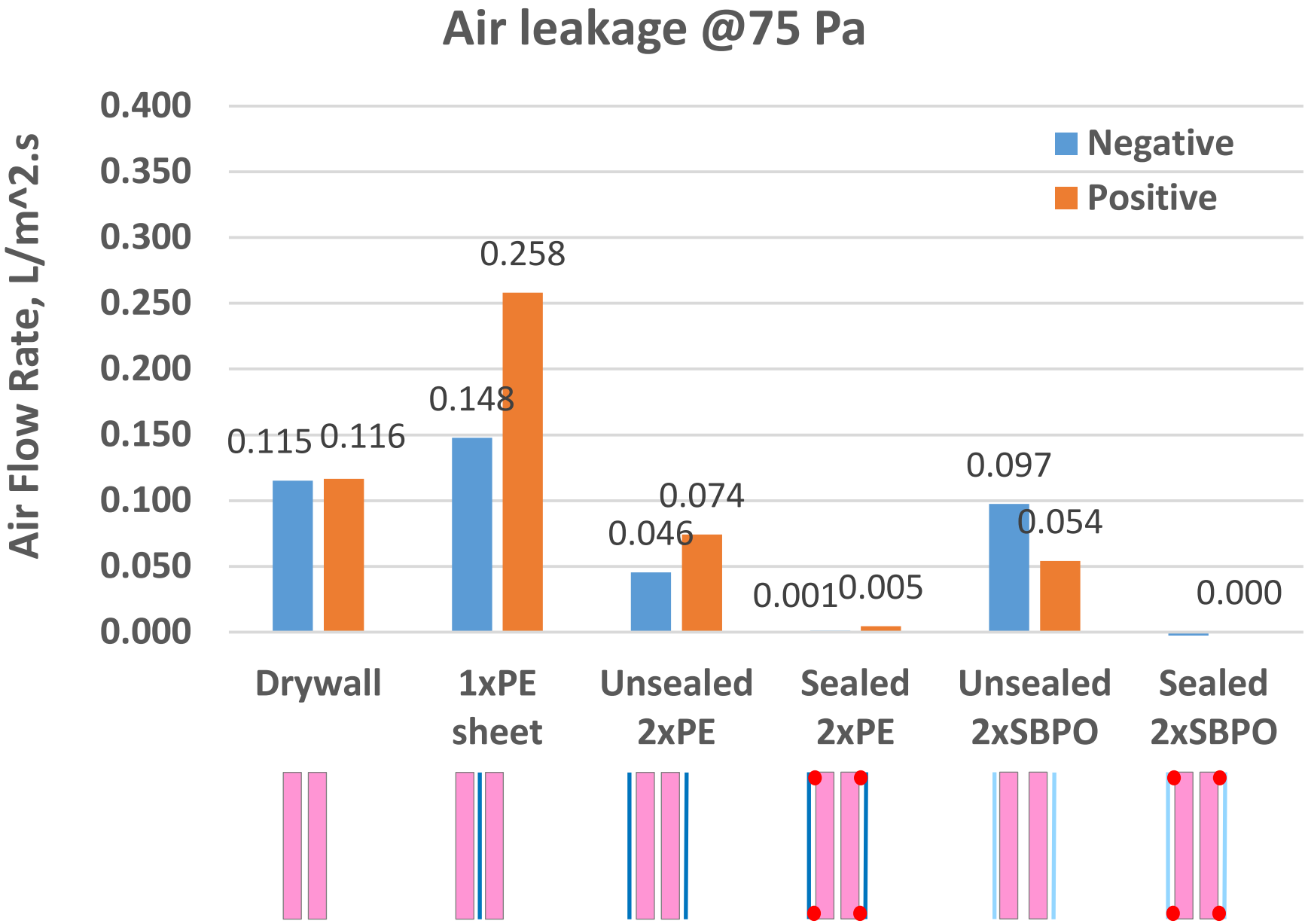
Test Procedure

ASTM E2357 – 18, Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies

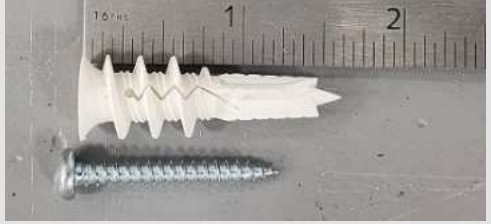
- Measure min. 7 points in 1 test
- Pressure from **25 Pa to 300 Pa**
- Average value of **3 independent tests**
- Calculation equation **$Q = C^{*}\Delta p^{n}$**
  - Q – air flow rate
  - C – Flow coefficient
  - Δp – pressure difference (**@75 Pa**)
  - n – flow exponent

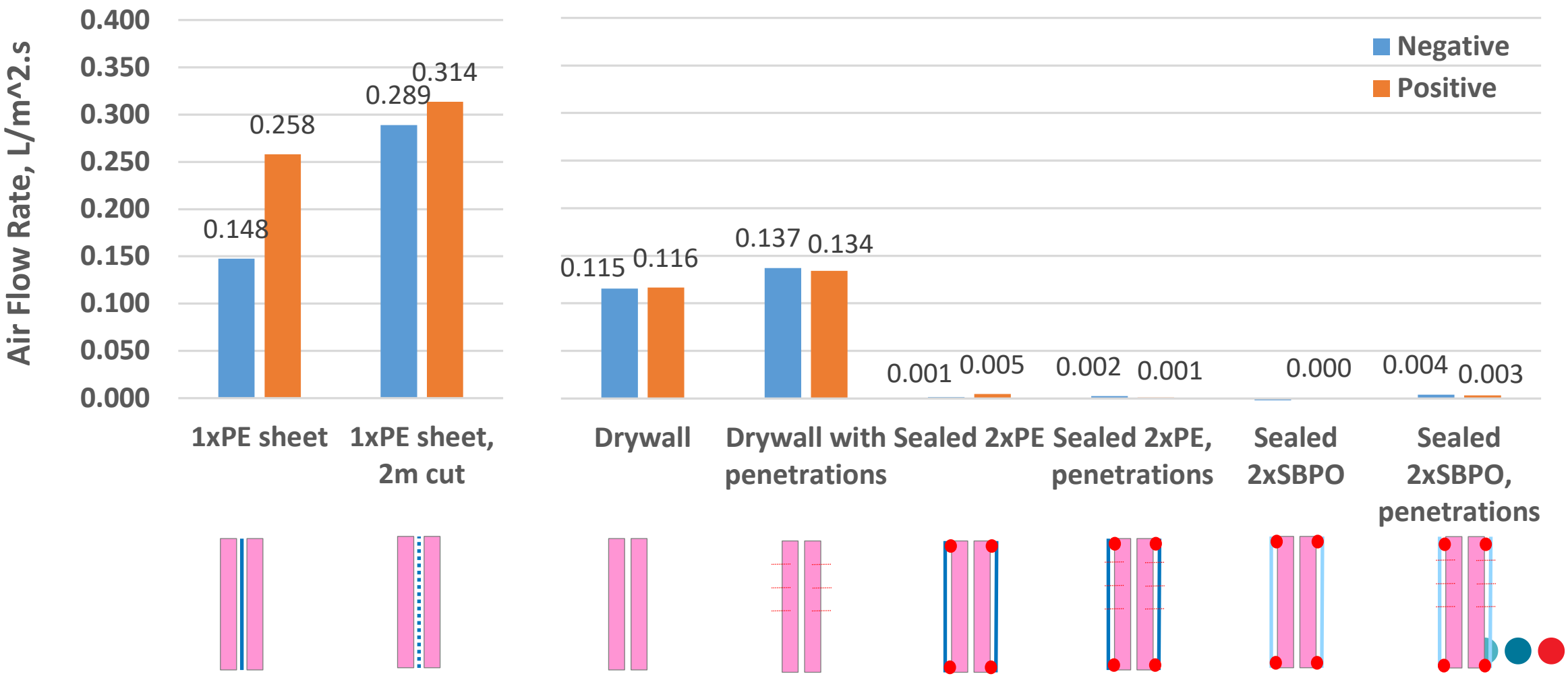


Test Results AB Fragments



Test Results Penetrations





Fire Resistance Evaluation

Fire Test Protocol, Test Facility

- **In accordance with the test protocol of the CAN ULC-S101-14 Standard Methods of Fire Endurance Tests of Building Construction and Materials**

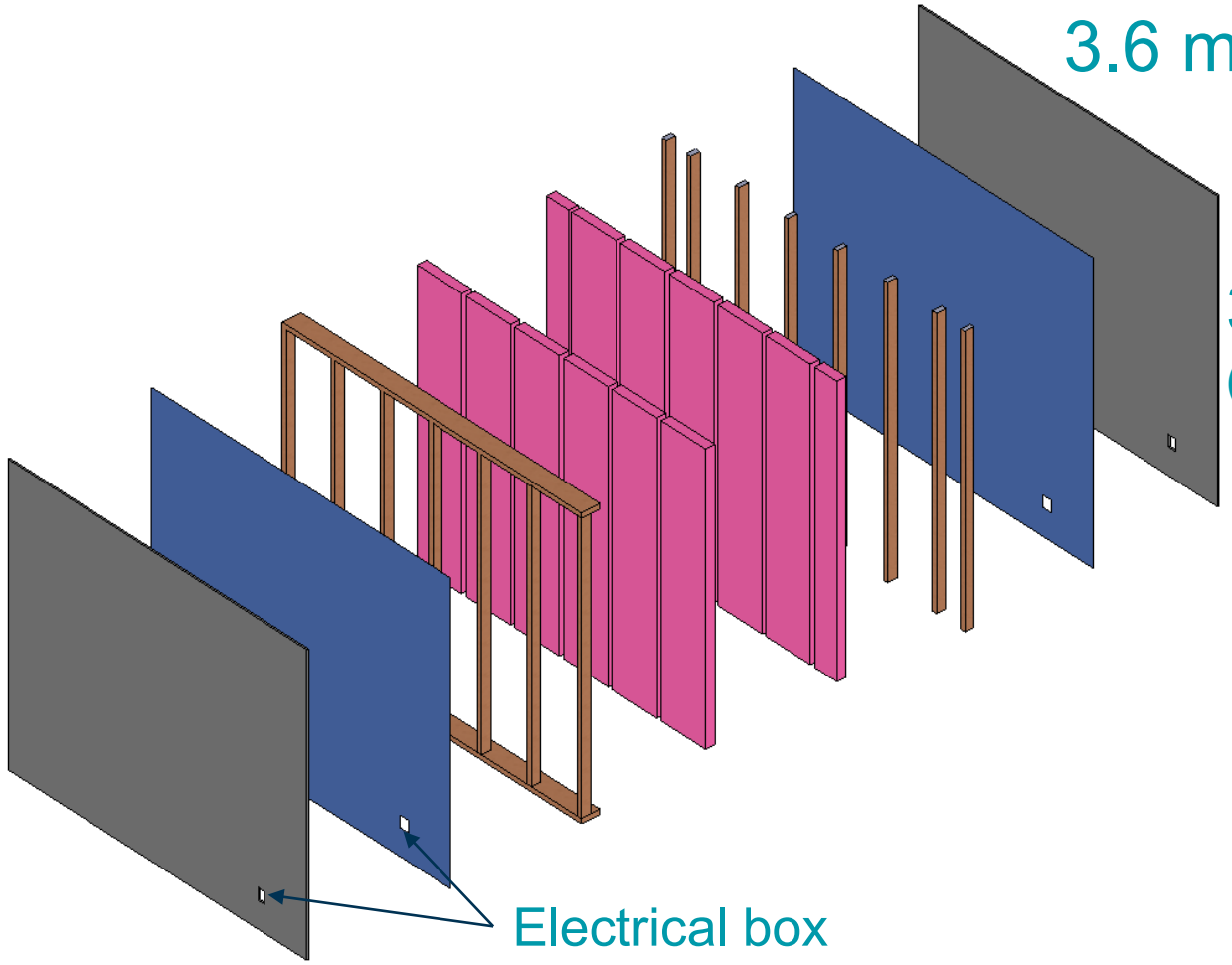
NRC Wall Furnace Test Facility

List of Specimens for Fire Resistance Evaluation

1) Specimen with two layers of **spun-bonded PO membrane** used as an air barrier with **unsealed** electric box and stapled in the field and at the perimeter

2) Specimen with two layers of **spun-bonded PO membrane** used as an air barrier with **sealed** electric box and stapled at the perimeter only

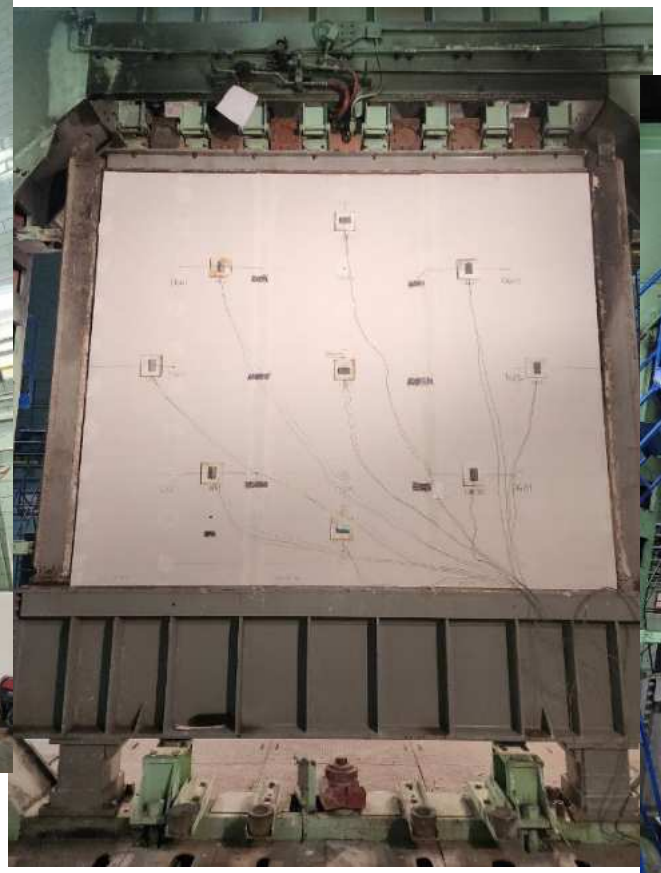
Fire Test Specimens



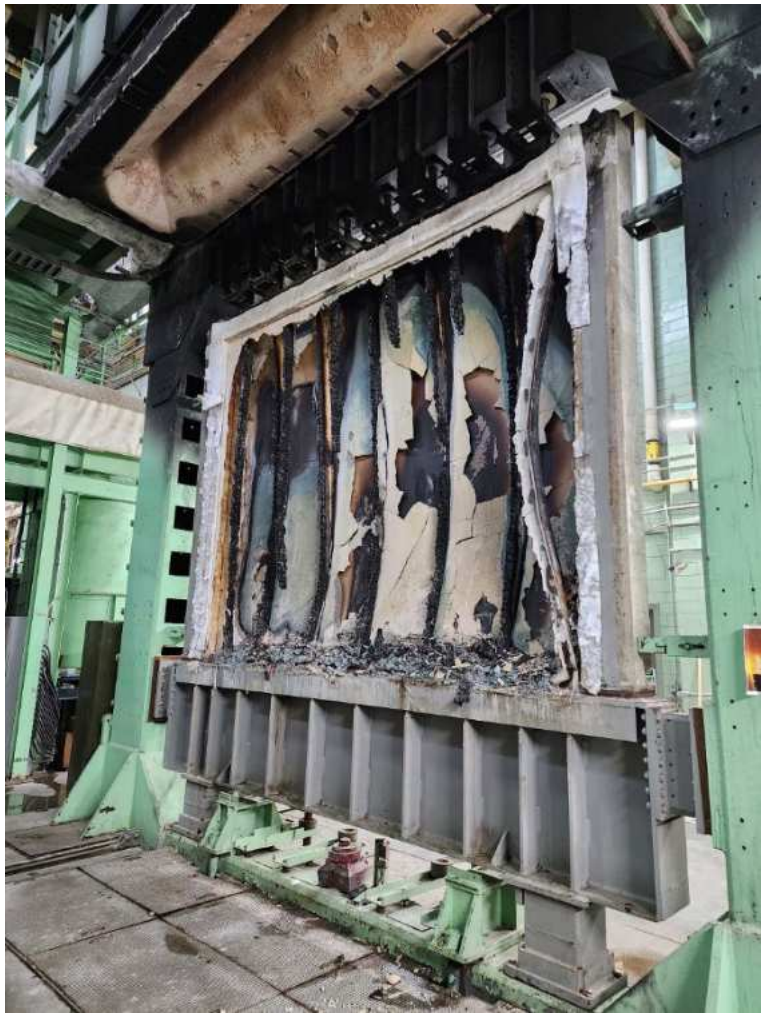
- Drywall 5/8” type X
- Drywall 1/2”
- **SBPO membrane**
- Wood stud (2”x4”), 24”o.c. with batt insulation 100mm
- Air cavity
- Wood stud (2”x4”), 24”o.c. with batt insulation 100mm
- **SBPO membrane**
- Drywall 1/2”
- Drywall 5/8” type X

Tested as a load bearing structure under the load of 96.3 kN

Fire Test Specimens



Fire Test Results



Fire Test Results

Specimen with **sealed SBPO** air barrier :

- Structural failure after **75 minutes**

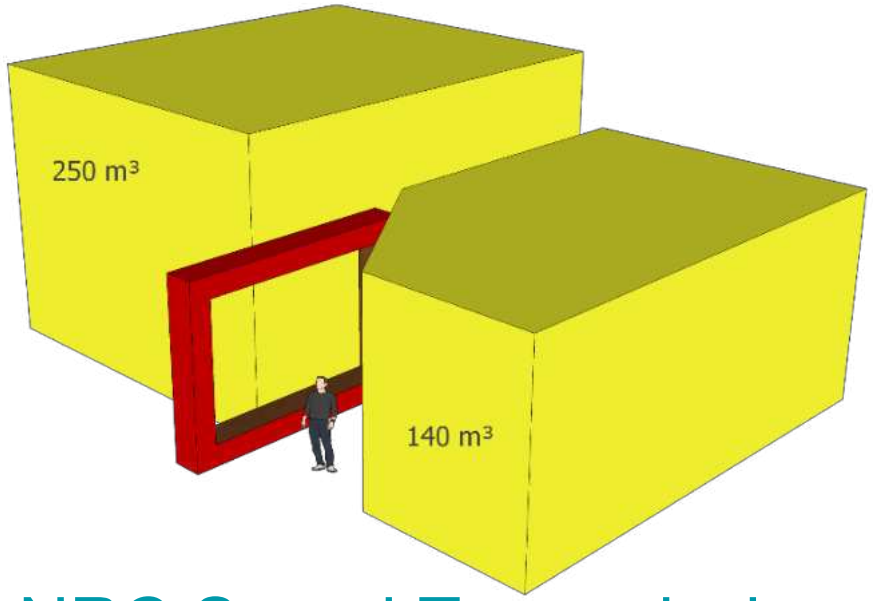
Specimen with **unsealed SBPO** air barrier

- Structural failure after **72 minutes**

Acoustic Evaluation

Acoustic Test Protocol, Test Facility

- The acoustic testing was done in accordance with the test protocol of the **ASTM E90-09 (2016)** Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- And the Sound Transmission Class (STC) was determined in accordance with **ASTM E413-22** Classification for Rating Sound Insulation



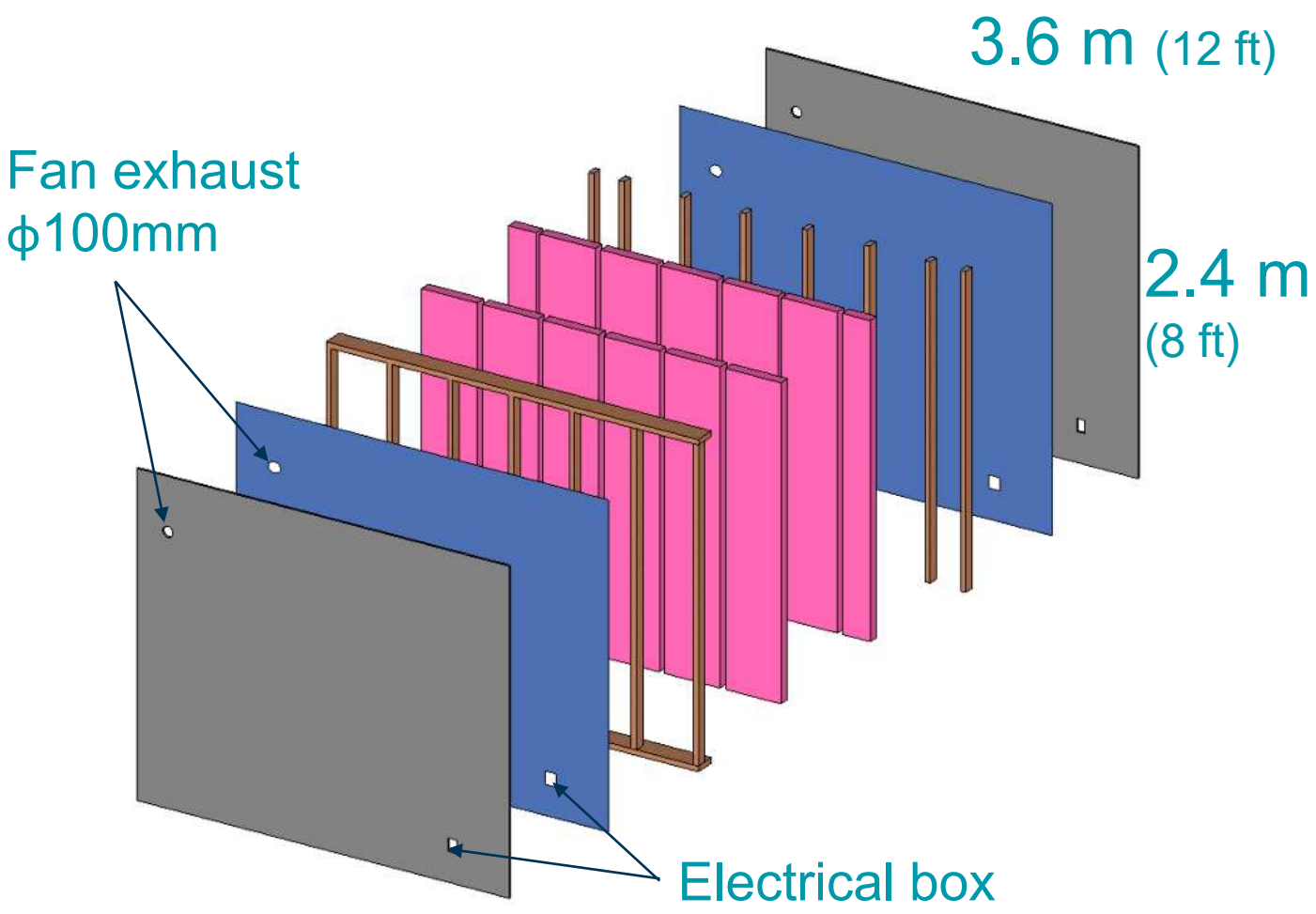
NRC Sound Transmission Wall Facility

List of Specimens for Acoustic Evaluation

1) Specimen with two layers of **spun-bonded PO membrane** used as an air barrier with **unsealed** electric box and stapled in the field and at the perimeter

2) Specimen with two layers of **spun-bonded PO membrane** used as an air barrier with **sealed** electric box and stapled at the perimeter only

Acoustic Test Specimens



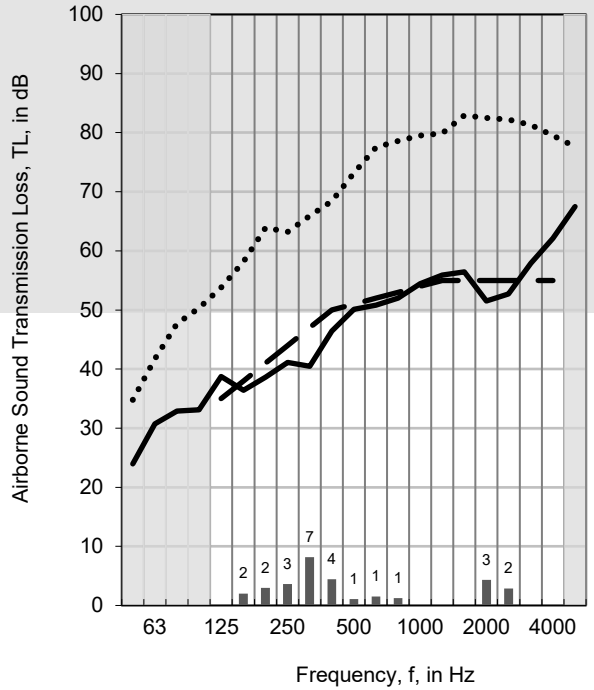
- Drywall 5/8” type X
- Drywall 1/2”
- **SBPO membrane**
- Wood stud (2”x4”), 24”o.c. with batt insulation 100mm
- Air cavity
- Wood stud (2”x4”), 24”o.c. with batt insulation 100mm
- **SBPO membrane**
- Drywall 1/2”
- Drywall 5/8” type X

Acoustic Test Specimens

Acoustic Test Results

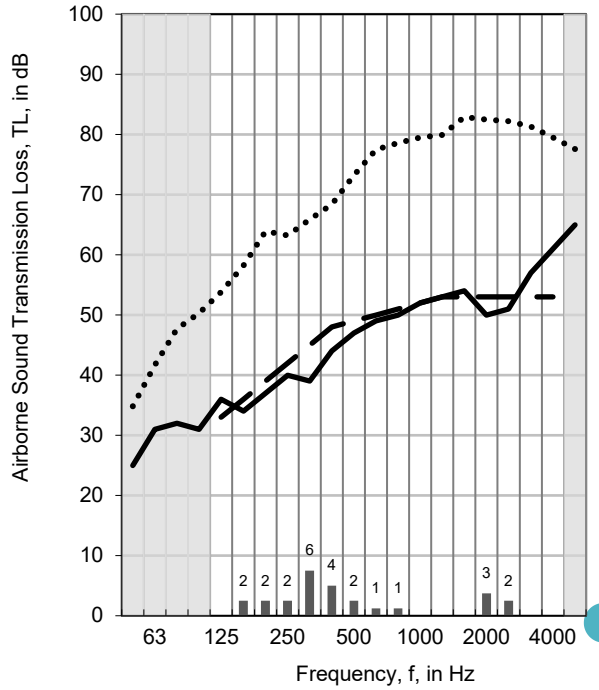
Specimen with **sealed SBPO** air barrier

- **STC 51**



Specimen with **unsealed SBPO** air barrier

- **STC 49**



* STC: Sound Transmission Class

Conclusions I

- Difference in positive vs. negative pressure test due to **valving** and/or **ballooning**
- The airtightness of airtight drywall approach (ADA), is initially acceptably low, but is unpredictable over time (occupant behaviour)
- Polyethylene (PE) sheets and spun-bonded polyolefin (SBPO) **membranes**: well within the test facility uncertainty (**zero air leakage**)
- Penetrations increase air flow rate very **slightly**

Conclusions II

- Use of SBPO membrane is more appropriate than PE-sheet (undesired moisture accumulation within wall assembly)
- Construction openings (cuts in air barrier to simplify between unit communication) **should be avoided**.
- If they are necessary, care must be taken to ensure they are **properly sealed** at the end of the construction -> increased on-site quality assurance requirements on crews and crew chiefs.
- Air barrier with one sheet (between wood stud rows in combination with air cavity) should be avoided

Conclusions III

- Effect of sealant on fire and acoustic performance: **Sealed SBPO** specimen perform slightly **better**

	Sealed membrane	Unsealed membrane
Fire rating, min	75 min	72 min
Acoustic rating	STC 51	STC 49

THANK YOU

Michal Bartko• Research Officer • Michal.Bartko@nrc-cnrc.gc.ca


2023-02-01 10:47:11
6-WAL-EAST


2023-02-01 10:47:11
7-WAL-EXT

Session 7
POLL


Ben Miller
Vice President, Operations, Big Block Construction
Neil Hawkins, Development Manager, Avalon Master Builder
Haitao Yu
Lead, Research & Development, Landmark Group
Sam Zirnhelt
Owner, Zirnhelt Timber Frames
Sean Mason
Founder, Sean Mason Homes

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building communities at full throttle

GOTTA KEEP 'EM SEPARATED Compartmentalization for Multi-Family:

LESSONS IN MODULAR INTEGRATION

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building communities at full throttle

Achieving Consistent Airtightness with Modular Stacked Townhomes

- Decades of building high-performance modules in factory yields consistent airtightness of **~1.0 - 1.5 ACH@50Pa**
- Improving processes for Net Zero MURB standards has increased results to **~0.5 - 1.0 ACH@50Pa**

(and as low as **0.47 ACH@50Pa** unguarded)






Willowview Heights, Saskatoon, SK (2020)

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Compartmentalization in Modular Apartment Buildings

Building ahead of Net Zero Ready standards for Part 3

- modest geometry, exterior finished on site
- AIRTIGHTNESS: **0.87 ACH @50Pa**
- consumes **48% less heating energy**
  = nearly **$450/month savings** in energy bills
  compared to code-built equivalent

Horse Dance Lodge, Regina, SK (2023)

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Beyond Compliance: Increasing Recognition of Modular

Streamlining Approvals for Modular MURBs

Municipal policies do not recognize factory certification for volumetric modular MURBS.

Proposed solution:

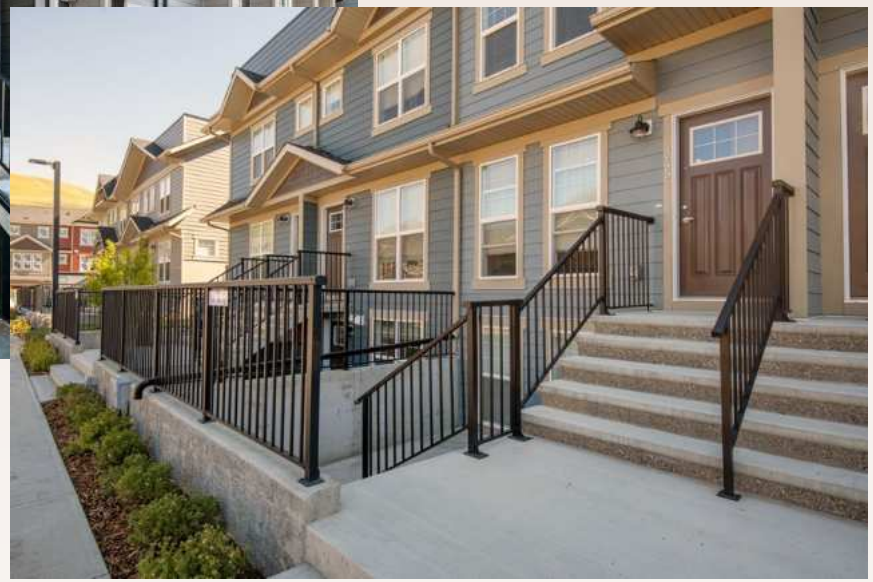
Municipalities interested in accelerating housing starts can recognize factory certification for modular MURBs.

2024 Net Zero Leadership Summit

CHBA Net Zero Home MURB Pilot - Avalon

Avalon Master Builder
June 2024

vs. Stacked Multifamily Townhomes

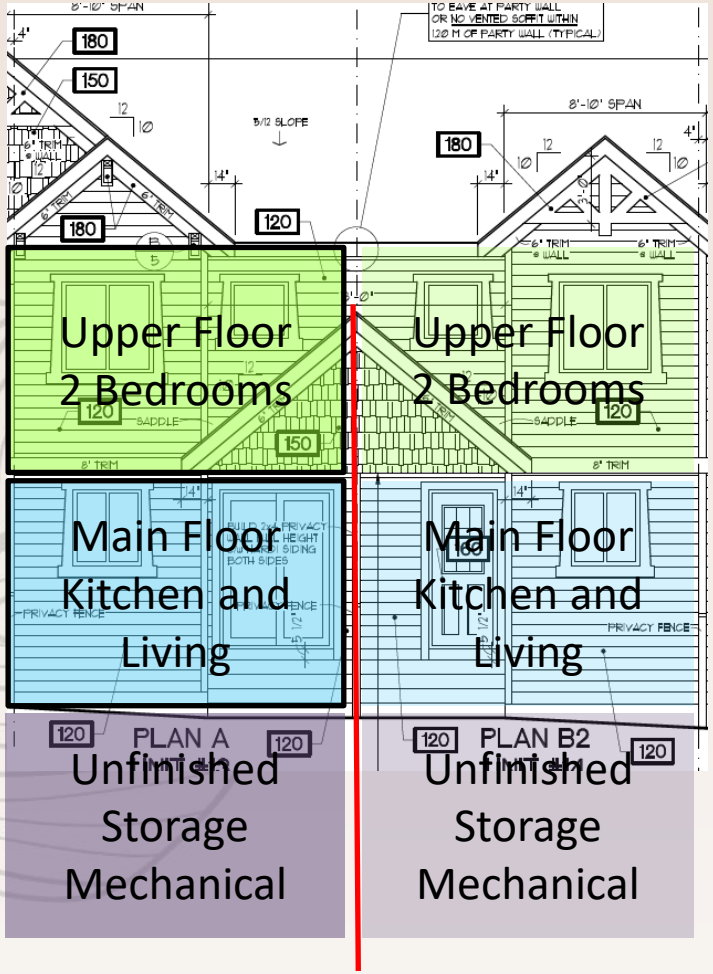


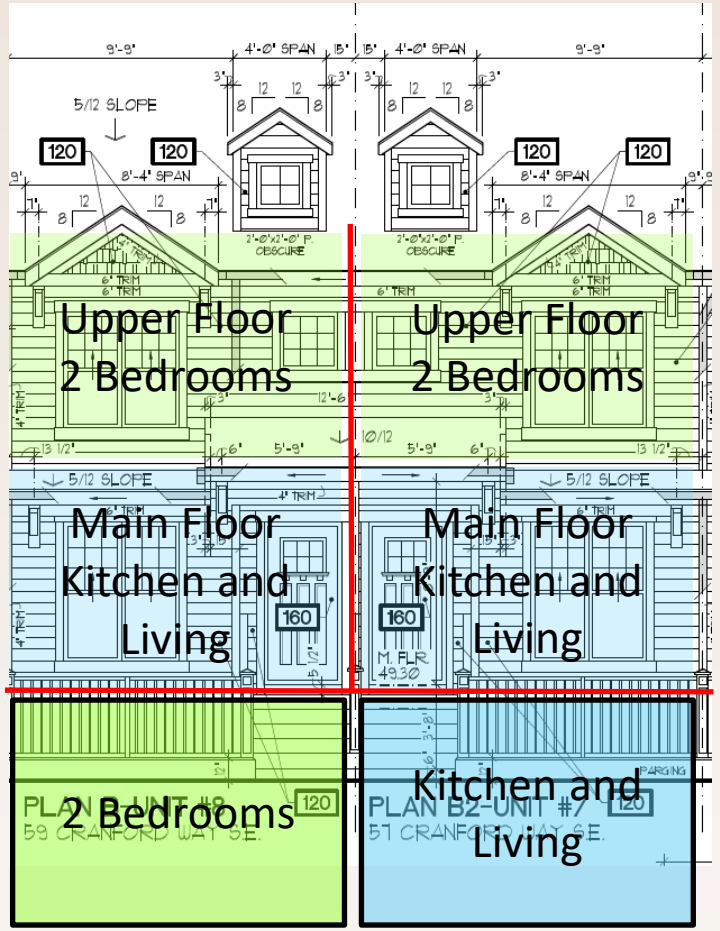
Units Below

Units Behind

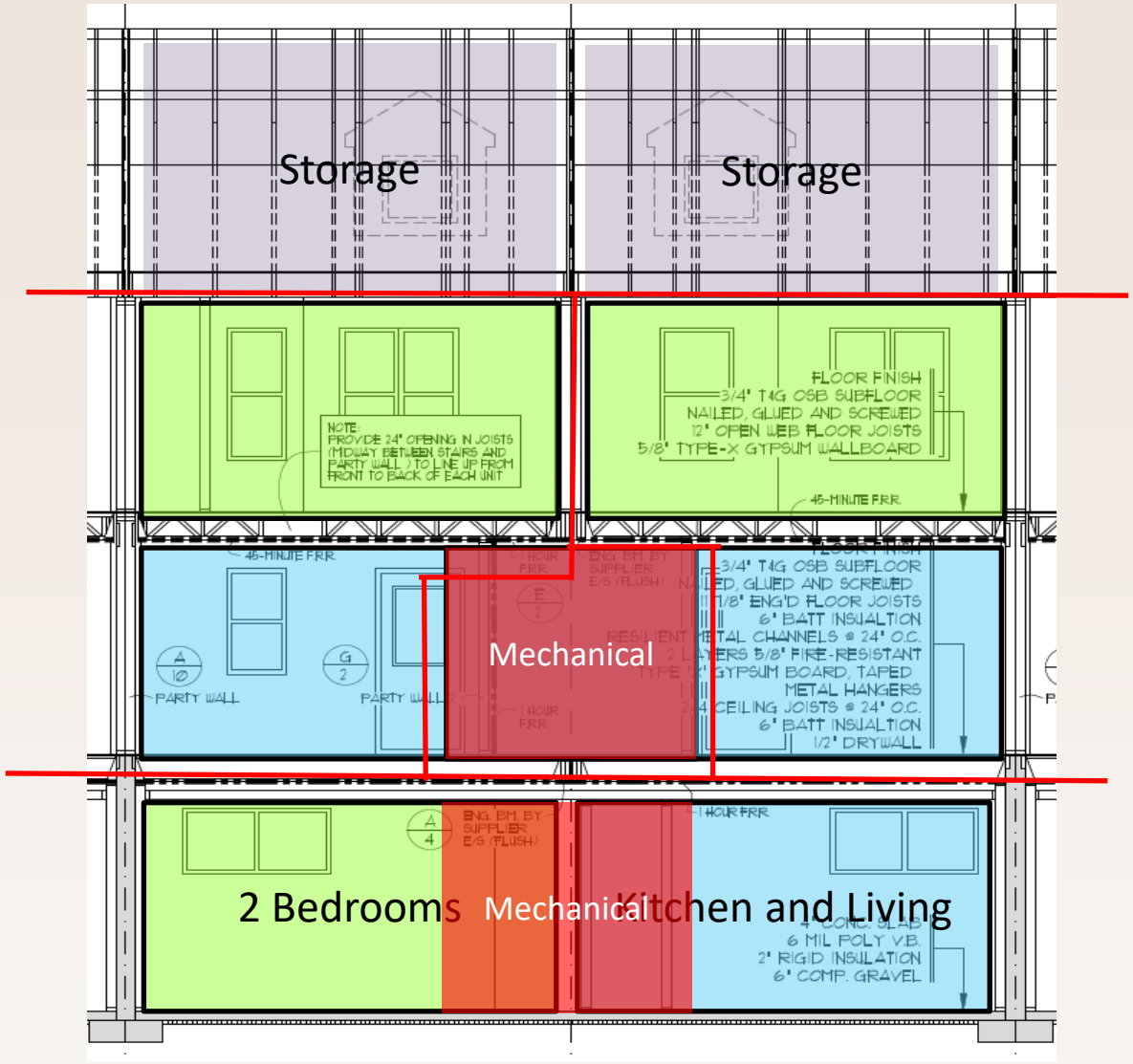
Units Above

Introduction of the Stacked Town



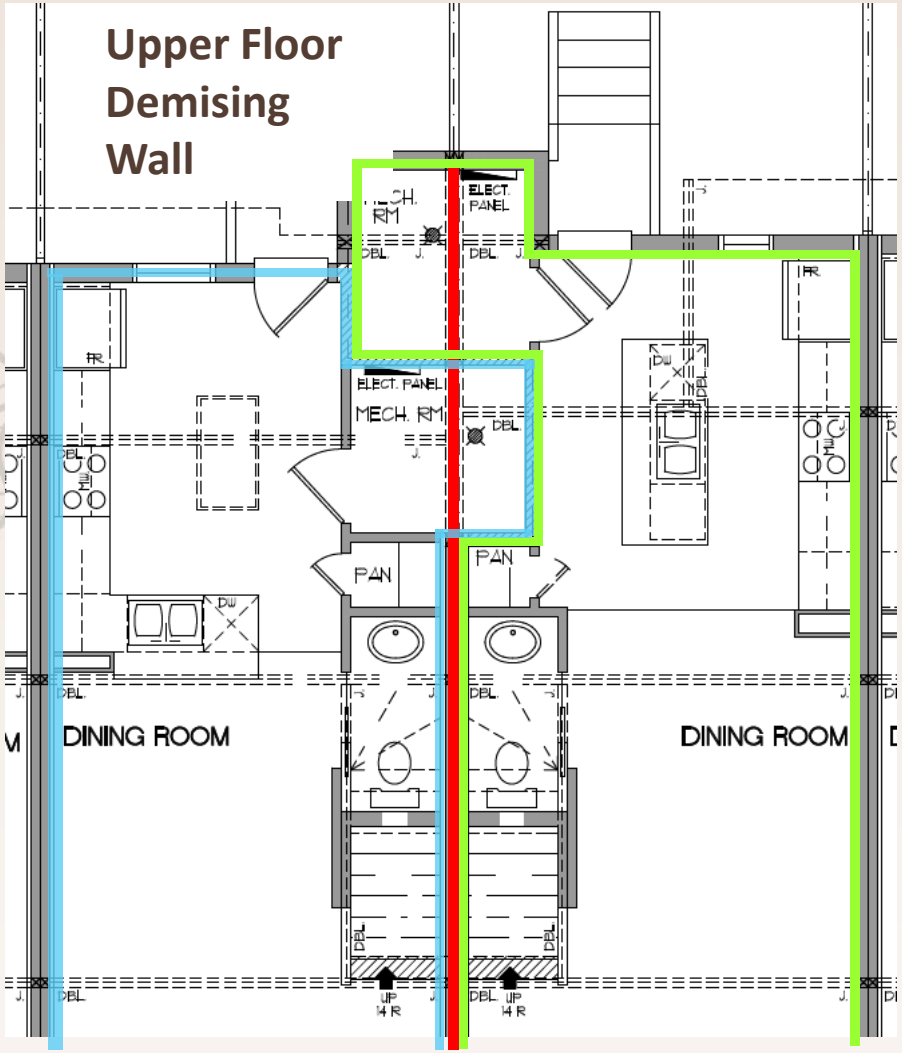


Unit Compartments



Unit Compartments

Main Floor
Air Barrier Left

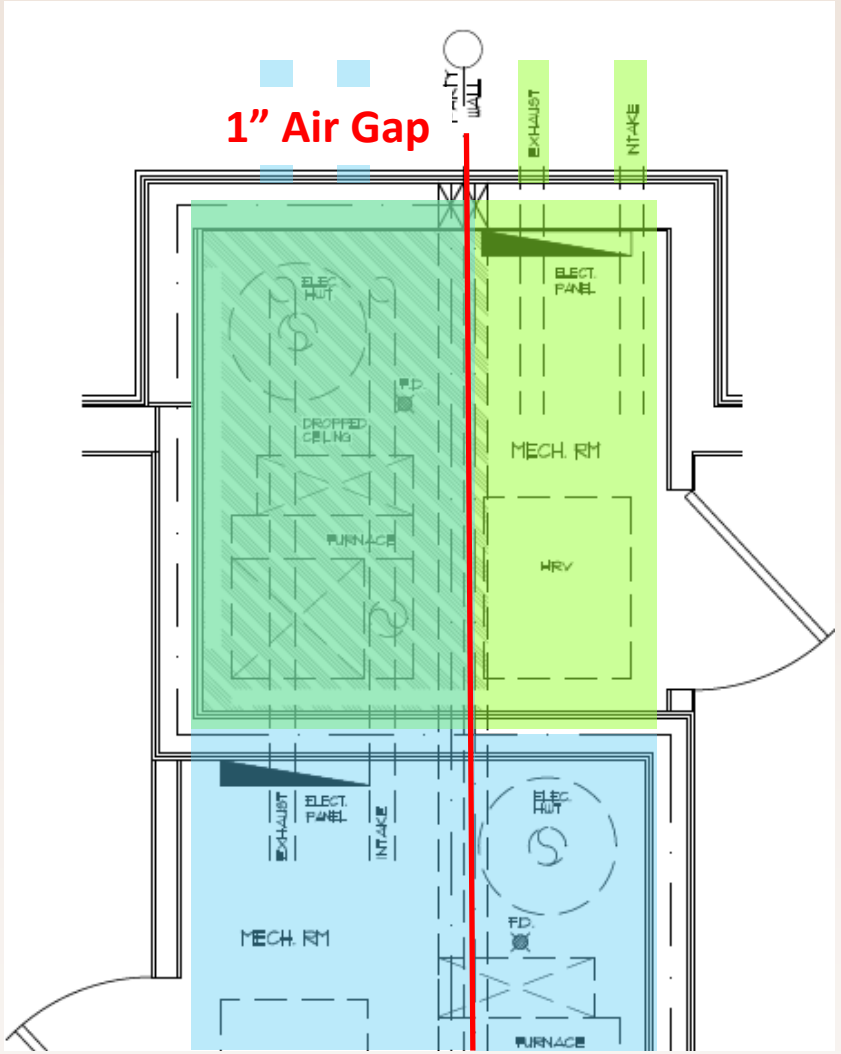


Main Floor
Air Barrier Right

avalon | 4

Unit Compartments

Main Floor Left Compartment



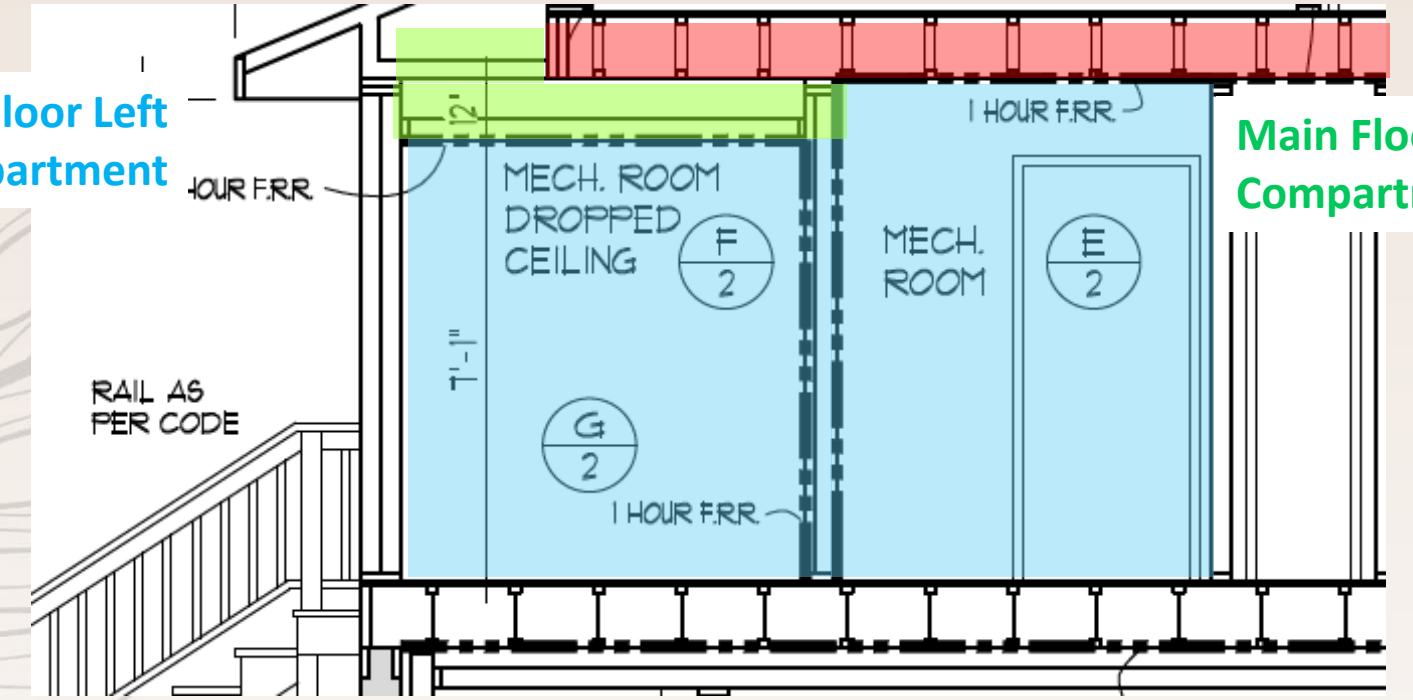
Main Floor Right Compartment

Unit Compartments

1” Air Gap

Main Floor Left Compartment

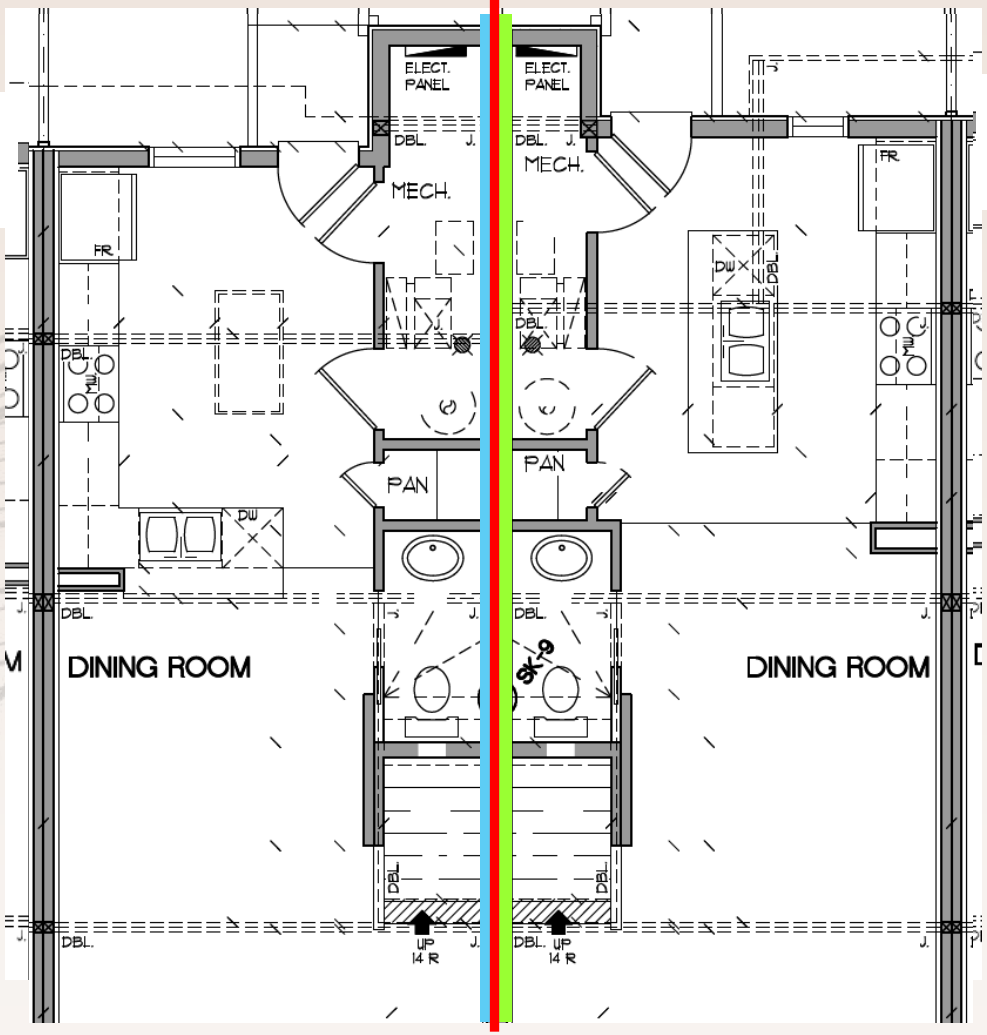
Main Floor Right Compartment



Simplify the Compartments

1” Air Gap

Main Floor Left Air Barrier



Main Floor Right Air Barrier

avalon | 4M

NET ZERO READY MURBS

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LANDMARK HOMES
it's what's inside

PROJECT LOCATION: Edmonton, AB

NET ZERO ENERGY ADVISOR: Cooper Le, 4 Elements

 # NET ZERO UNITS: 11

CLIMATE ZONE: 7a

STATUS: Occupied 2022

OWNERSHIP TYPE: Rental

PROFILE #3

Unit Types:

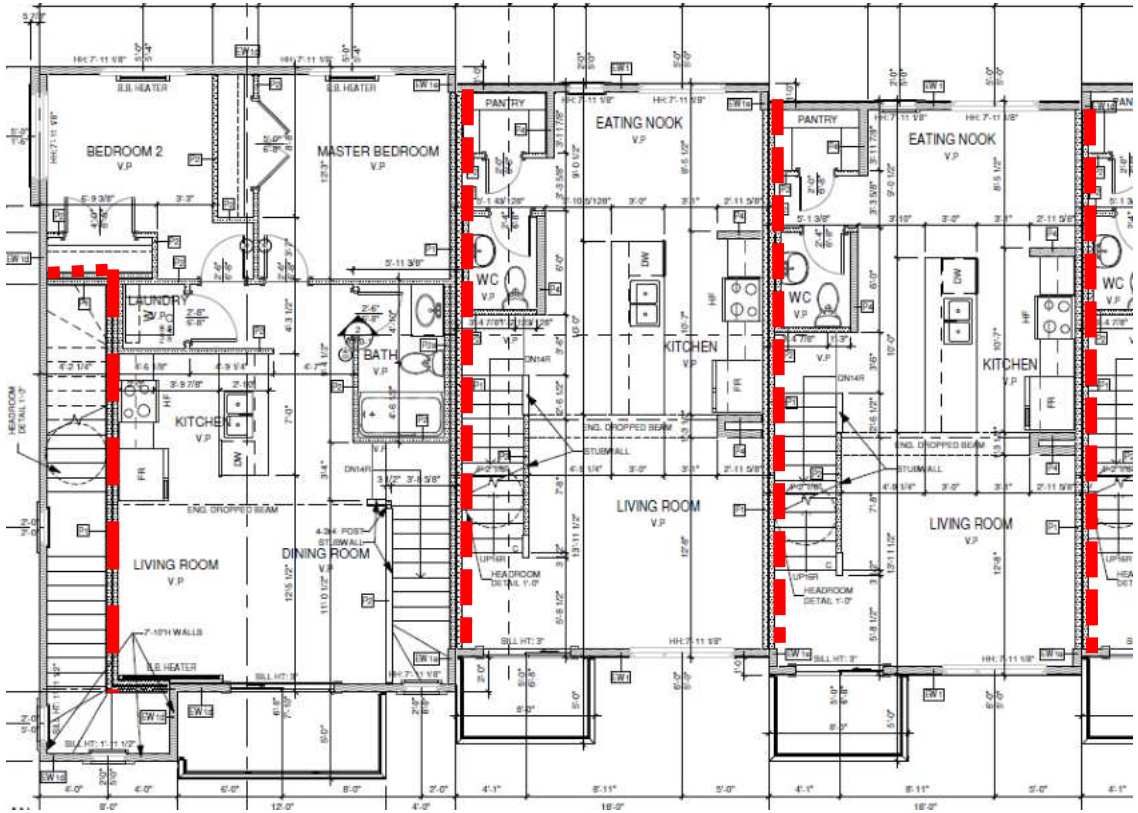
- 7 Townhome mid-unit: 18' x 35', 1,818 SF
- 2 Stacked Lower Mid-Unit: 24' x 35', 1,194 SF
- 2 Stacked Upper End-Unit: 24' x 35', 1,291 SF

Operational Energy Intensity:

- Townhome mid-unit: 0.16 GJ/m^2 (45 kWh/m^2)
- Stacked Lower Mid-Unit: 0.067 GJ/m^2 (19 kWh/m^2)
- Stacked Upper End-Unit: 0.11 GJ/m^2 (32 kWh/m^2)

	Reference Units (GJ)					Net Zero Ready Units (GJ)					Improvement %
	Space heating	DWH Heating	HRV & Fans	Cooling	Total	Space heating	DWH Heating	HRV & Fans	Cooling	Total	
Townhome Mid-Unit	44.2	13.0	2.5	2.4	62.1	8.5	11.1	1.1	6.9	27.6	56%
Stacked Lower Unit	20.5	10.0	1.1	1.9	33.5	4.6	1.3	0.3	1.1	7.4	78%
Stacked Upper Unit	36.3	10.0	1.2	2.0	49.4	10.6	1.4	0.2	1.4	13.7	72%

Lessons Learned #1: Air-tightness of Stacked Lower Units

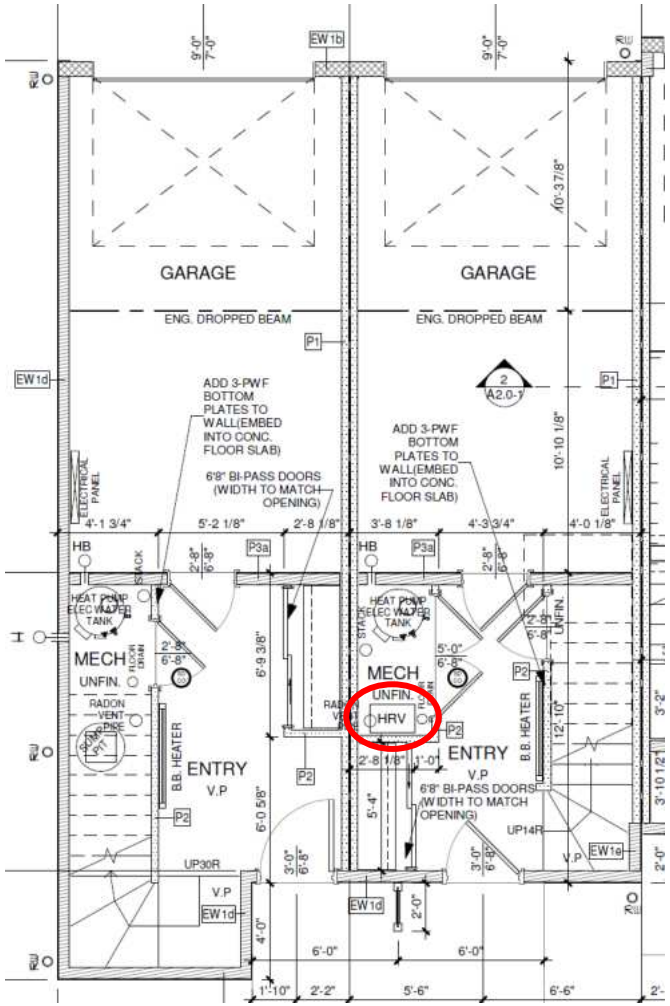


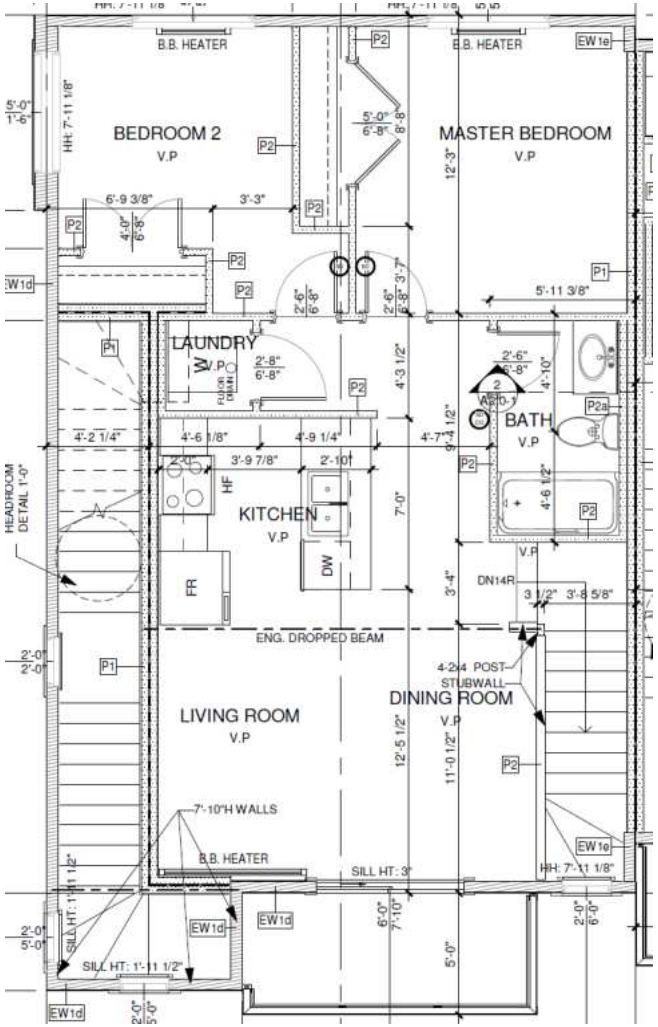
Compartmentilization

Unit Type	Volume	Exposed Surface Area	Party Surface Area	Total Surface Area	GUARDED ACH (CFM50*60/ Volume)		UNGUARDED ACH (CFM50*60/ Volume)
MURB Upper	10,820.50	2630.50	1,136.50	3767.00	1.18		2.28
MURB Lower	8,606.20	1385.20	1,149.00	2534.20	2.09	*	3.42
Mid	13,626.30	2235.80	1,439.90	3675.70	1.41		1.98
Mid	13,626.30	2235.80	1,439.90	3675.70	1.70		2.32
Mid	13,626.30	2235.80	1,439.90	3675.70	1.23		2.09
Mid	13,626.30	2235.80	1,439.90	3675.70	1.47		1.99
Mid	13,626.30	2235.80	1,439.90	3675.70	1.47		2.10
Mid	13,626.30	2235.80	1,439.90	3675.70	1.36		1.90
Mid	13,626.30	2235.80	1,439.90	3675.70	2.13		2.58
MURB Lower	8,606.20	1385.20	1,149.00	2534.20	2.98	*	2.84
MURB Upper	10,820.50	2630.50	1,136.50	3767.00	0.99		2.00
Building Tota	**134,237.50**	**23682.00**			**1.59**		**2.27**

LANDMARK HOMES
it's what's inside

Lessons Learned:
Air-tightness of Stacked Lower Units





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ZIRNHELT TIMBER FRAMES

Net Zero MURB
WLFN, BC

GOTTA KEEP 'EM SEPARATED. Compartmentalization for Multi-Family.

- No structural penetrations, continuous air and moisture barriers, smart membranes
- **Challenges:**
- moisture management
- odours
- sound


CANADIAN HOME BUILDERS' ASSOCIATION
netzero home
LEADERSHIPSUMMIT
Questions?

CANADIAN HOME BUILDERS' ASSOCIATION
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LEADERSHIP SUMMIT

Networking Break

in the Demo Hub. (Whistler Ballroom)
Be back by 3:00 pm.