August 4, 2025

AeroBarrier Technology Development

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UC Davis and Aeroseal

Presentation Overview

Conceptualization of Envelope Sealing Process

- Seal Rate Analysis
- Transport Efficiency
- Sealing Simulation Tool

Dedicated Test Facility

- Sealing Rate Comparison
- Separation of Effects Impacting Seal Rate

New Technology Developments

- Smaller, Lighter, Faster System
- Non-Electric Heat
- Airless Atomization

New Applications

- Ceiling Plenum Sealing
- Underfloor Sealing

Envelope Sealing Process

- Pressurize Building with a Fan
  - Blower Door on Steroids
- Inject Aerosolized Sealant
  - Air carries sealant to Leaks
- Track Sealing Process
  - Feedback to Technician
  - Documentation for Builder (or homeowner)

aeroseal ENVELOPE

ENVELOPE SEALING REPORT

Envelope Sealing Performed For:

DALE | ROADHOUSE HOMES
2747 EAST 25TH AVENUE
VANCOUVER, BC V5R1H6

DATE: 2/1/2019
BUILDING TYPE: SINGLE FAMILY RESIDENCE

Envelope Sealing Results:

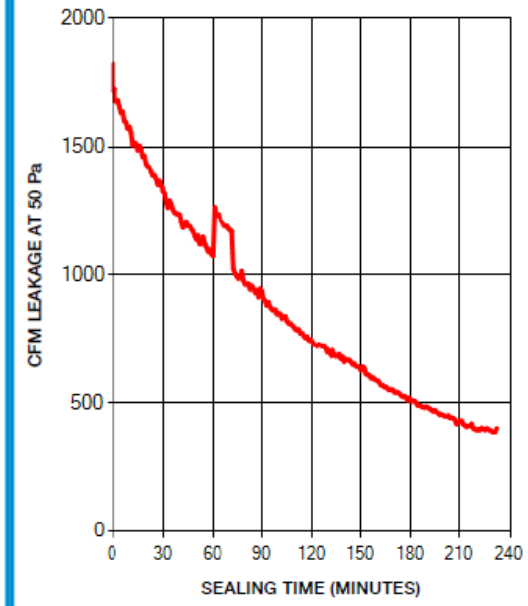
When we arrived,
YOUR HOME HAD:
1825.0 CFM of Leakage, equivalent to a
219.7 Square Inch Hole or 4.74 Air Changes per Hour
*(for your **2401** square-foot structure enclosing a volume of **23103** cubic feet).*

After we finished,
YOUR HOME HAS:
403.1 CFM of Leakage, equivalent to a
48.5 Square Inch Hole or 1.05 Air Changes per Hour

This corresponds to a 77.9% Reduction in Envelope Leakage.

Note: Envelope leakage and air-change results are calculated at a standard pressure of 50 Pa.

Elapsed Sealing Progress:



Envelope Sealing Performed By:

PACIFIC AEROBARRIER SYSTEMS
UNIT 152 - 628 E. KENT AVENUE S.
VANCOUVER, BC V5X 0B2
604.222.2100
INFO@PACIFICAEROBARRIER.COM

AEROBARRIER CASE ID: 8016
SYSTEM DESCRIPTION: HOME ENVELOPE
AIR SEAL DESCRIPTION: ENVELOPE SEALING
HARDWARE: AEROBARRIER

Conceptualization of Envelope Sealing Process

Seal Rate Analysis

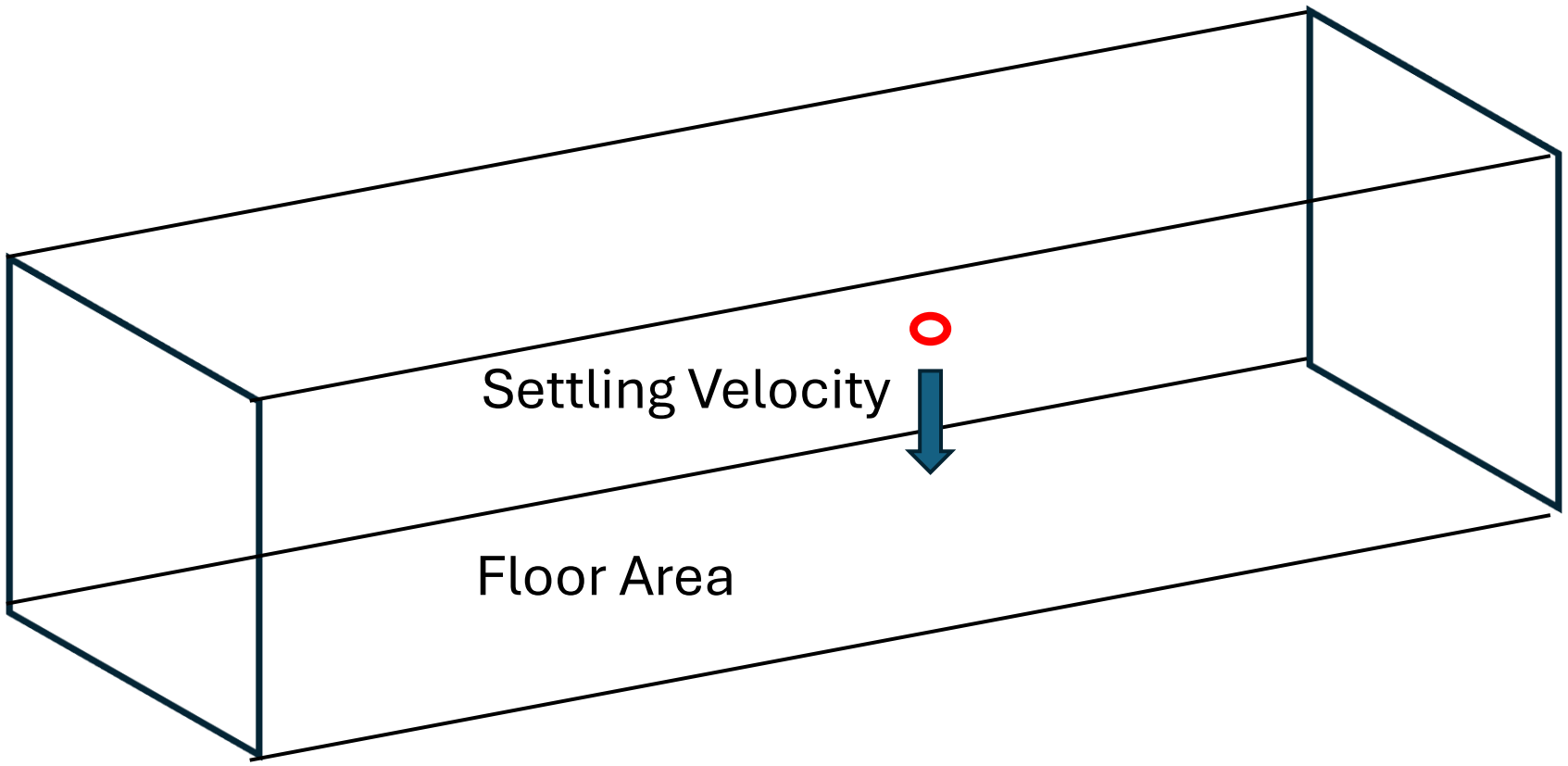
$$Seal\ Rate\ \left[\frac{in^2}{min}\right] = \frac{InjRate\ [\frac{gm}{min}] * \eta_{trans}\ [-] * \eta_{dep}\ [-]}{SealDensity[gm/in^2]}$$

where:

$InjRate$	is max sealant injection (limited by psychrometrics)
η_{trans}	is Transport Efficiency (fraction getting to leaks)
η_{dep}	is Deposition Efficiency (fraction depositing in leaks)
$SealDensity$	is sealant required to seal a given size leak

Conceptualization of Envelope Sealing Process

Transport Efficiency



Conceptualization of Envelope Sealing Process

Transport Efficiency

Basically a race between getting to the leaks before falling to the floor

$$\eta_{trans}\,[-] = \frac{FanFlow\,[cfm]}{FanFlow\,[cfm] + V_{settling}\left[\frac{ft}{min}\right] * FloorArea\,[ft^2]}$$

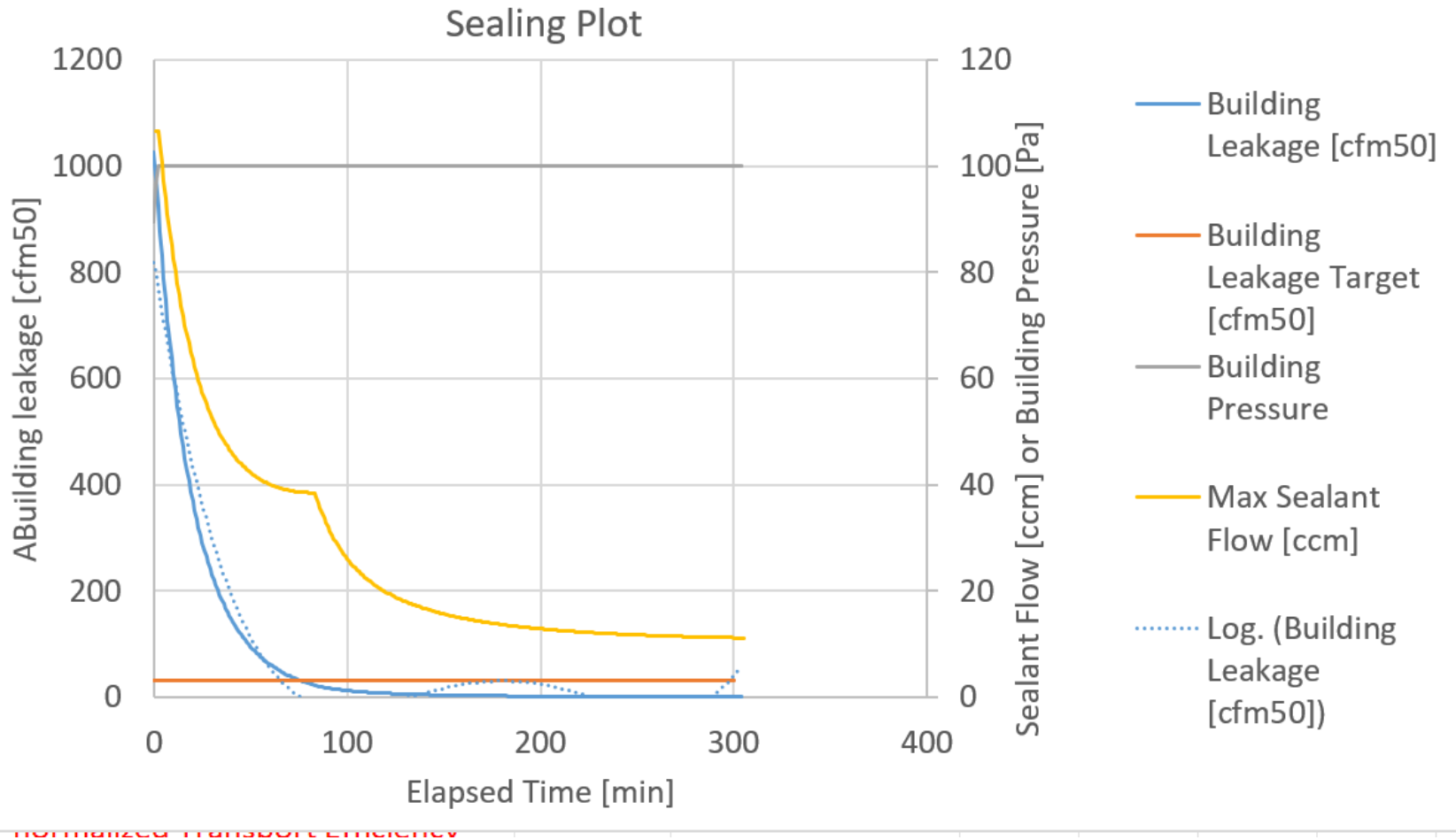
where:

$V_{settling}$ is Settling Velocity (like terminal velocity), a strong function of particle size

Conceptualization of Envelope Sealing Process

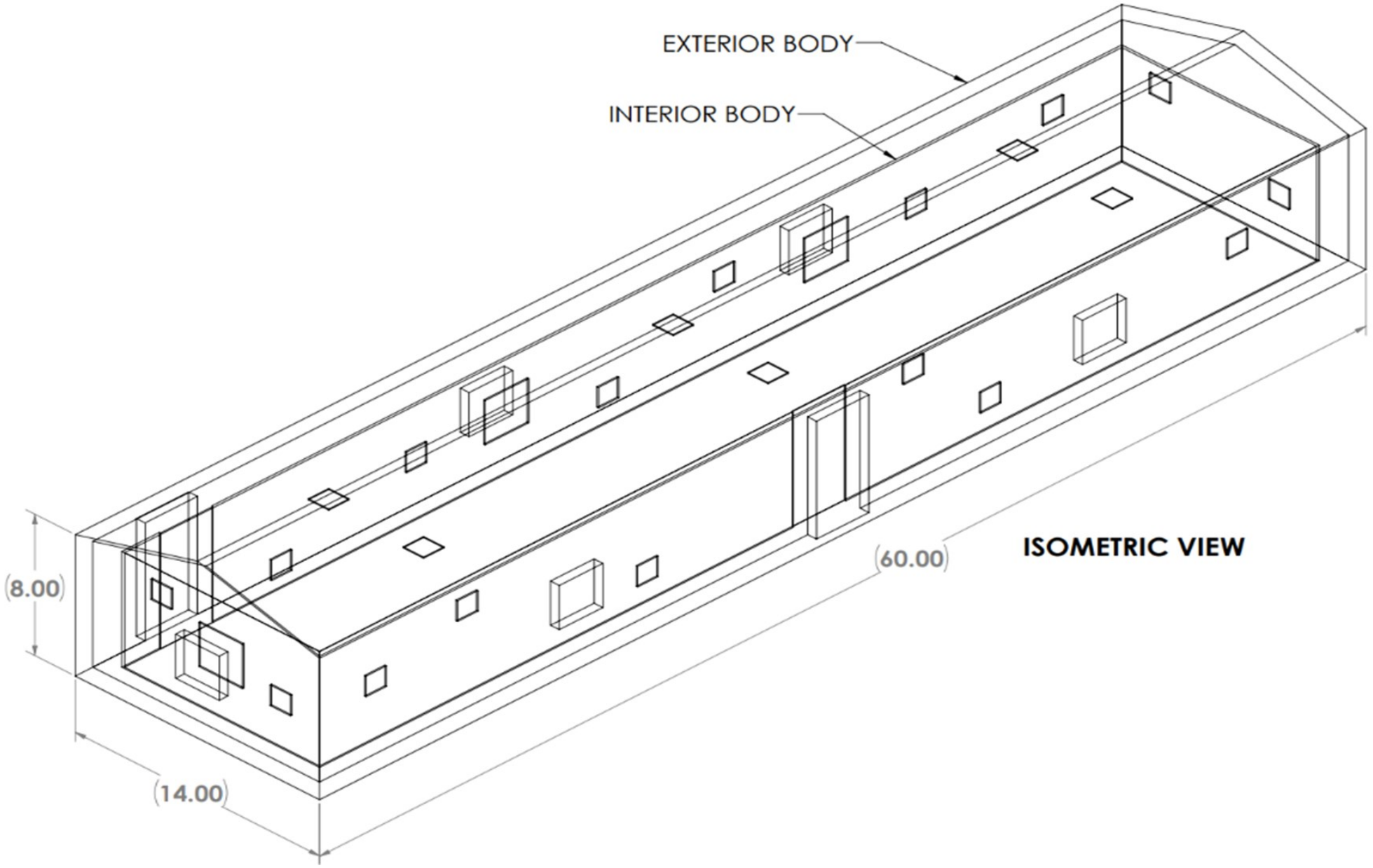
Sealing Simulation Tool

Aerobarrier Sealing Simulation Inputs and Results		
Building Floor Area	**700**	ft²
Ceiling Height [ft]	8	ft
Initial Leakage [ACH50]	**11**	ACH50
Seal Thickness	**0.073**	in
Sealing Pressure	**100**	Pa
Particle Size	**12**	microns
Maximum Fan Flow	**1500**	cfm
Depostion Efficiency [-]	**60%**	%
Heat Added	**1,500**	W
Heat Type	**1**	**Electric**
Outside Temperature	76	°F
Outside Rel Humidity	70%	%
Max Sealant Injection	**500**	ccm
Percent Solids	20%	%
Altitude	1,000	ft
Sealed Fraction Target	97%	%
Number of Sealant Injector	**2**	Used for leng
Height of injectors	**5**	Used for leng

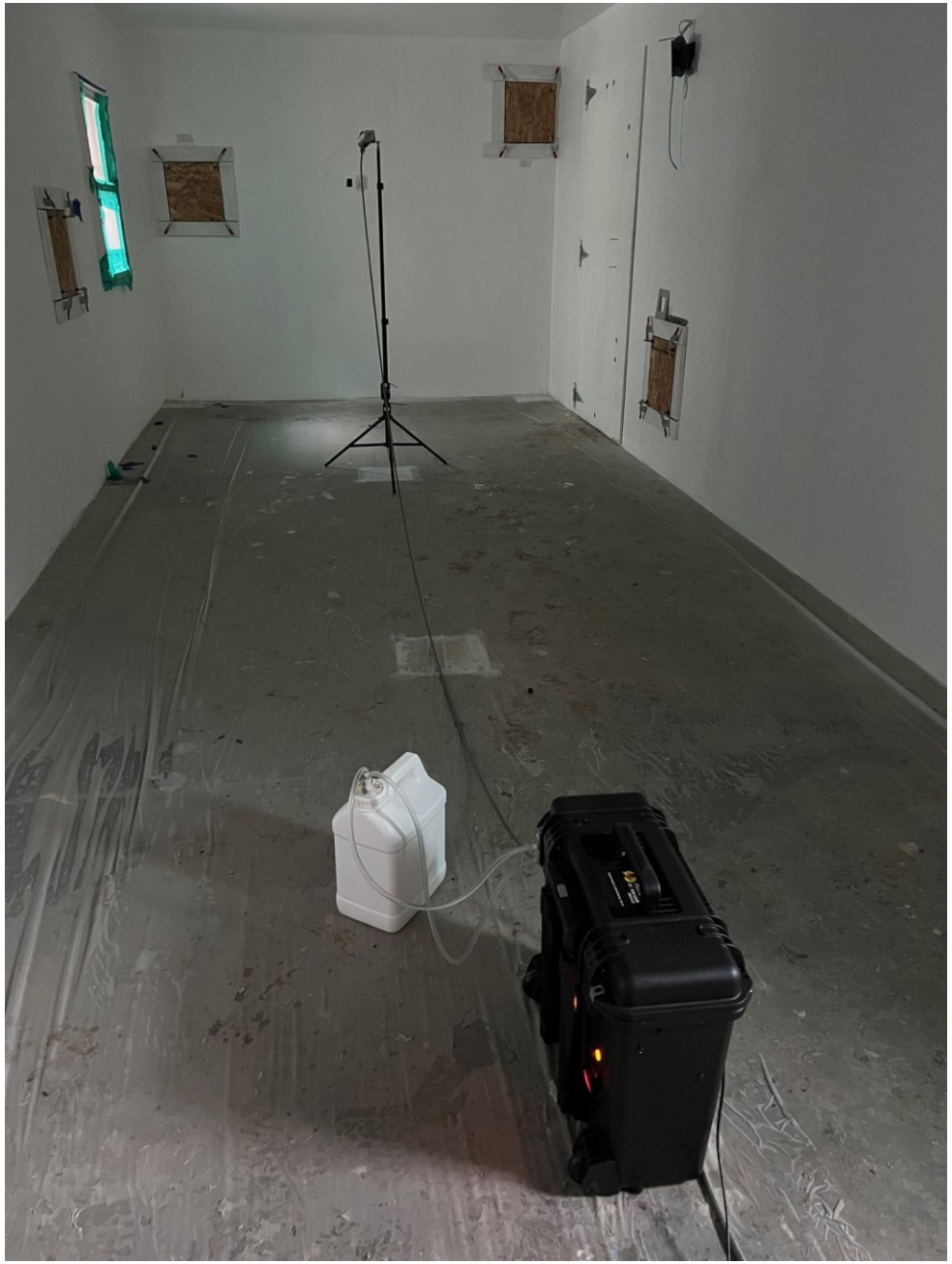


Dedicated Test Facility

Dedicated Test Facility

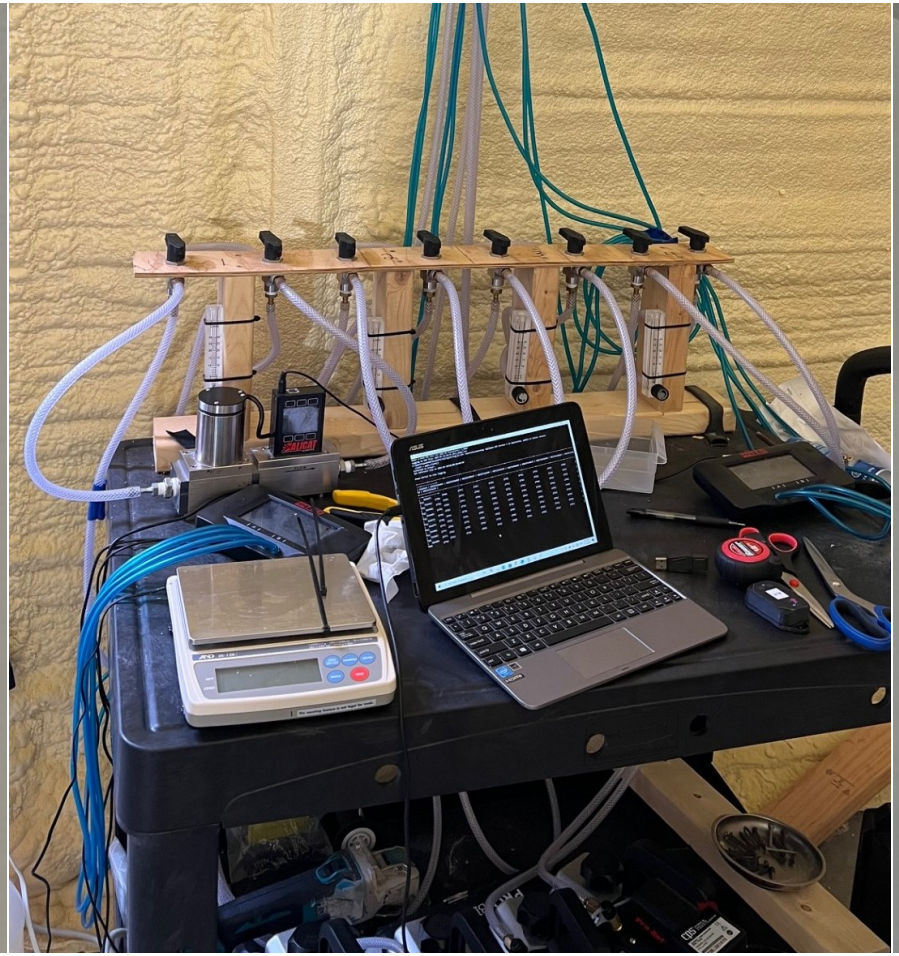


Dedicated Test Facility



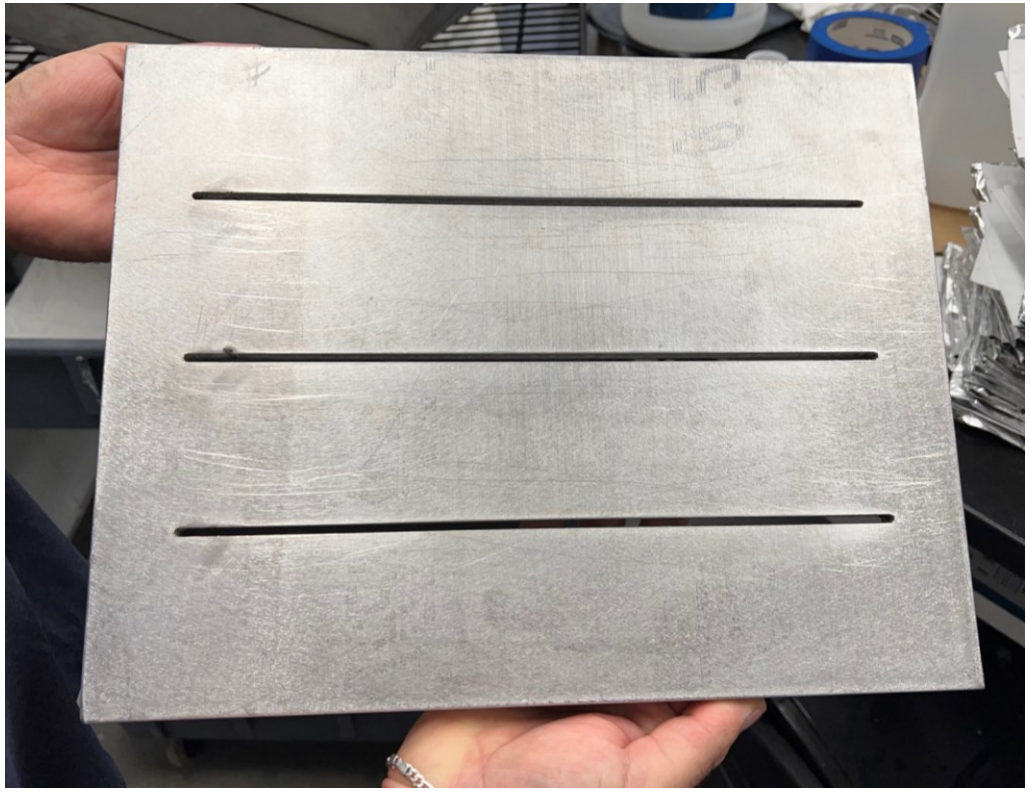
Dedicated Test Facility

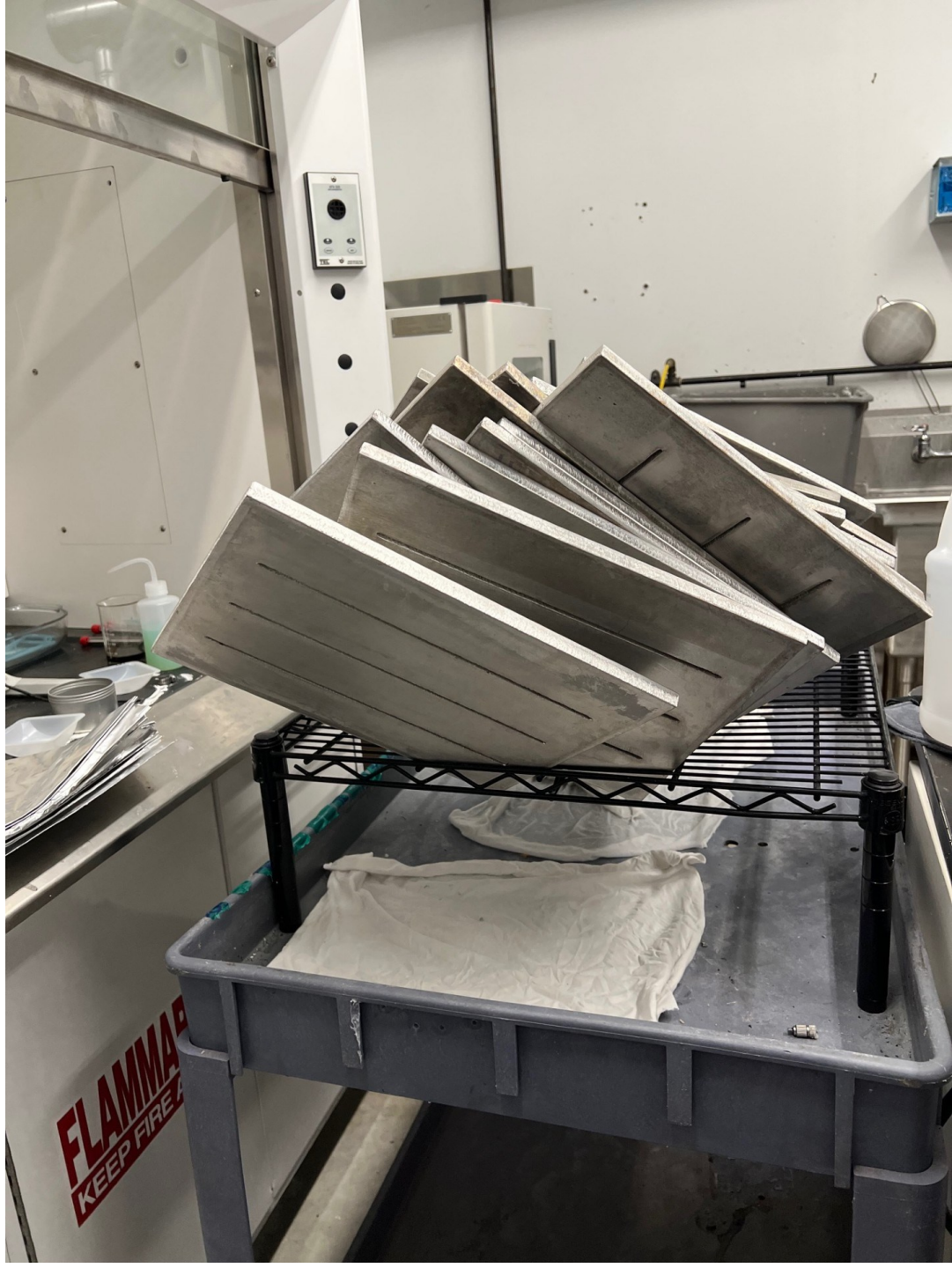
- Uses concentration measurement boxes to determine Transport Efficiency at FOUR different locations



Dedicated Test Facility

- Uses re-usable leakage plates to assure the same conditions for all tests





Dedicated Test Facility

- Uses scale to weigh plates before and after sealing to determine SealDensity
- Uses 2nd scale to weigh total sealant injected
  - Facilitates calculation of sealant use efficiency
  - Facilitates calculation of Deposition Efficiency

New Technology Developments

Non-Electric Heat =

Smaller, Lighter, Faster System

- 220 V Fan
- Large heavy Compressor/Generator
- Compressed Air lines running into house

- Non-Electric Heat
- 110 V Fan
- 35% less weight

New Technology Developments

Non-Electric Heat + Airless Atomization =
Smaller, Lighter, Faster System

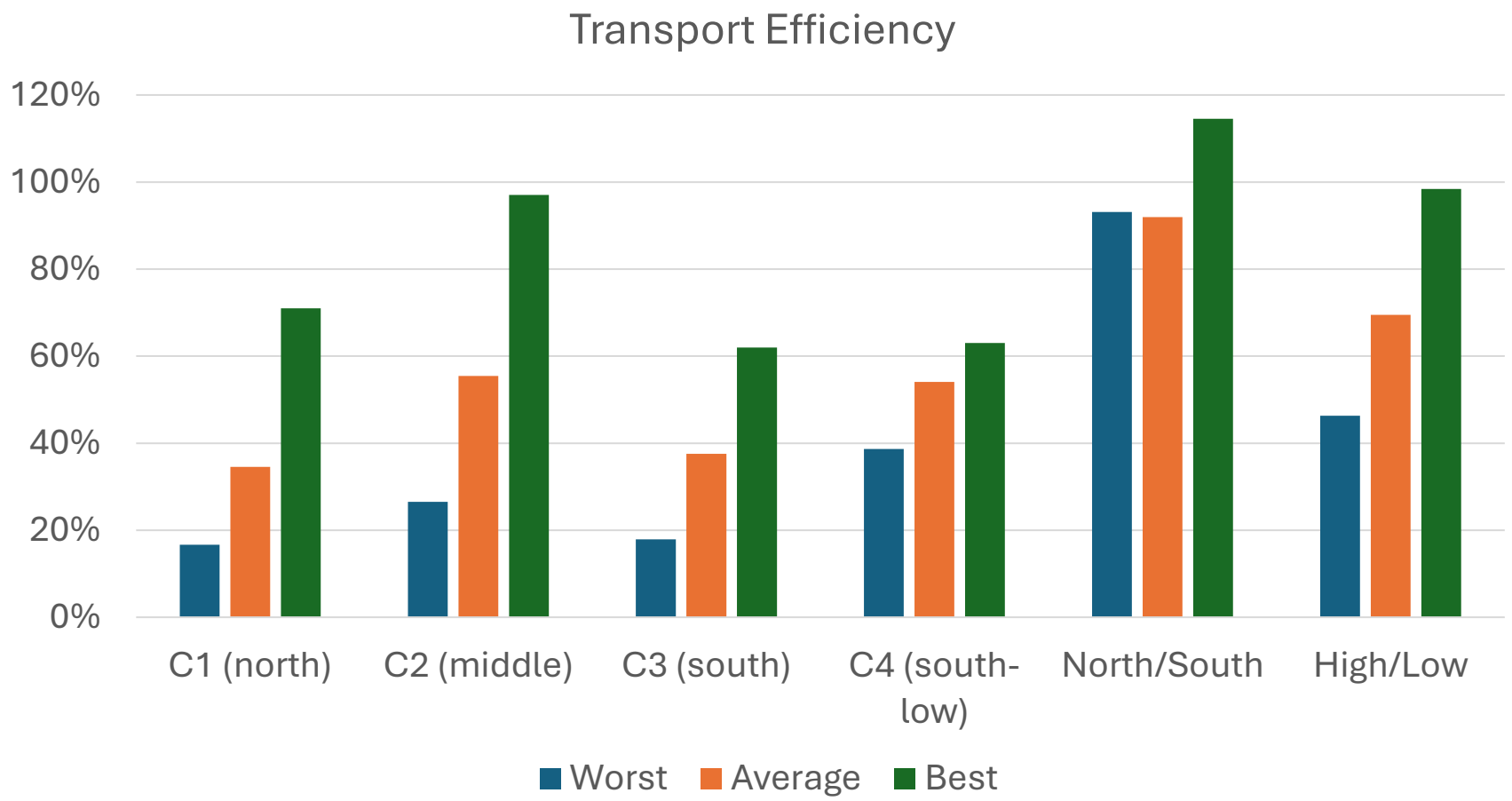
- Non-Electric Heat
- 110 V Fan
- 35% less weight

- Airless Atomization - No Compressed Air
- Battery-powered sealing stations
- Another 50% weight and volume reduction

Dedicated Test Facility Application

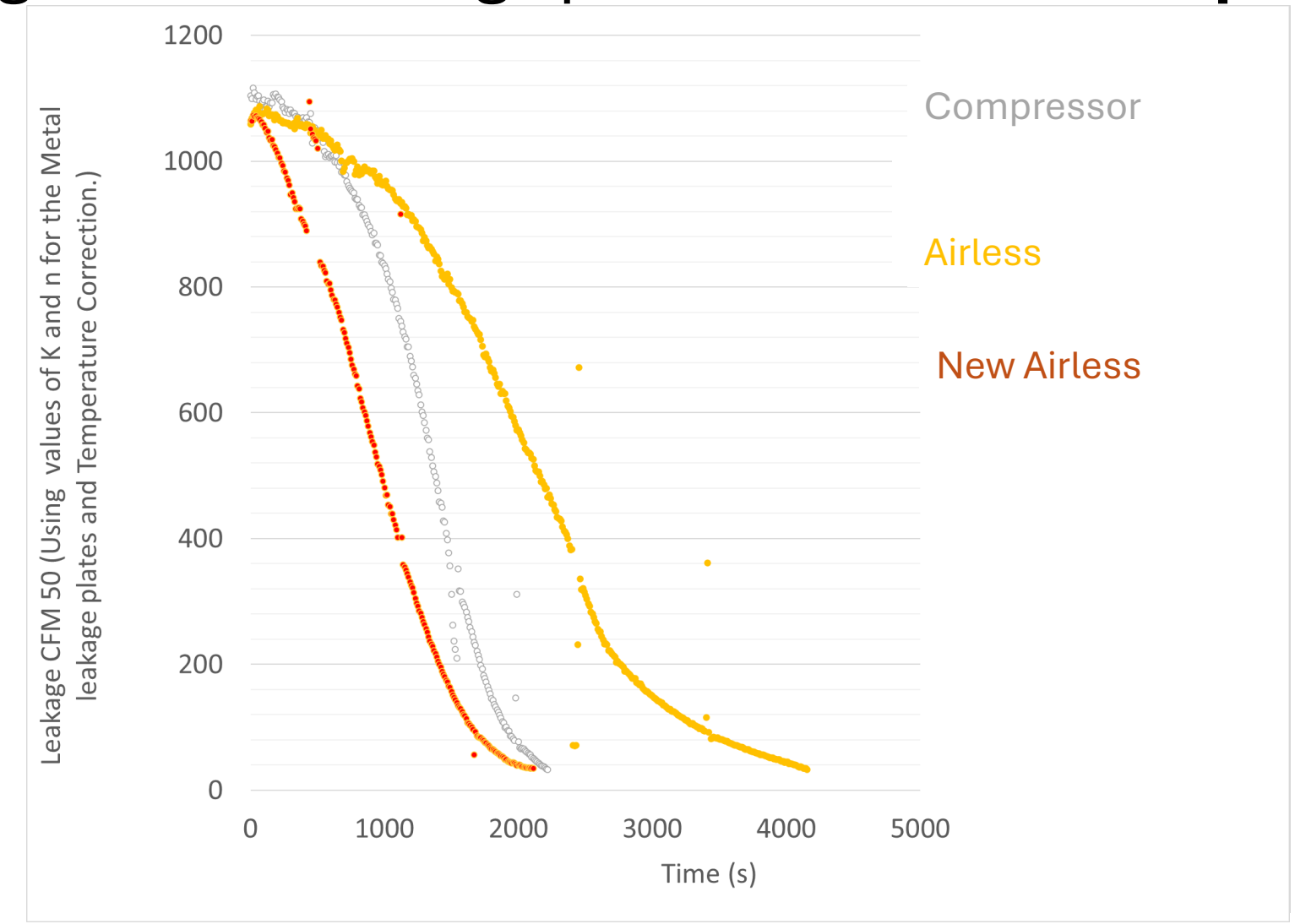
Quantifying Transport Efficiency

$$\eta_{trans}\,[-] = \frac{Leak - Site\ Concentration\ [ppm]}{Input\ Concentration\ [ppm]}$$



Dedicated Test Facility Application

- Getting **Airless** sealing speeds to match **Compressor Systems**

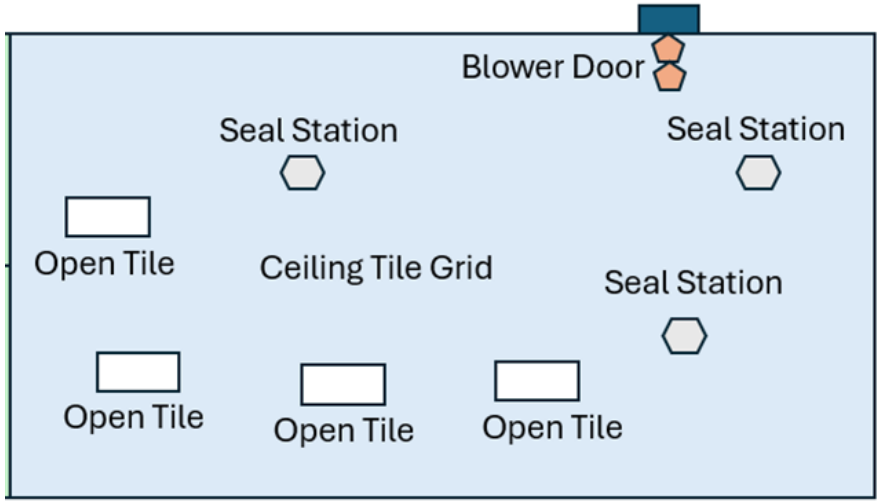


Field Testing Airless System

- Saves 20 mins on set-up and clean-up
- Has had **longer injection times** versus **Compressed Air**
- Last week **AIRLESS** showed **shorter injection times** versus **Compressed Air,** based upon innovations tested in the lab

New Applications

Ceiling Plenum Sealing



PROTOCOL

- Preparation
  - Applied spray foam to patch large existing openings between ceiling plenum and adjacent ceiling plenum (i.e. gaps in corrugated roof deck)
  - Positioned 3 mobile sealant injection stations in the ceiling plenum nearest the perimeter walls
  - Opened ceiling tiles furthest from the sealing stations to ensure air penetration from the blower door into the ceiling plenum
- Injection performed during normal operating hours in an occupied office building
  - Used an additional blower door to pressurize an adjacent room to limit sealant infiltration into the rest of the facility

New Applications

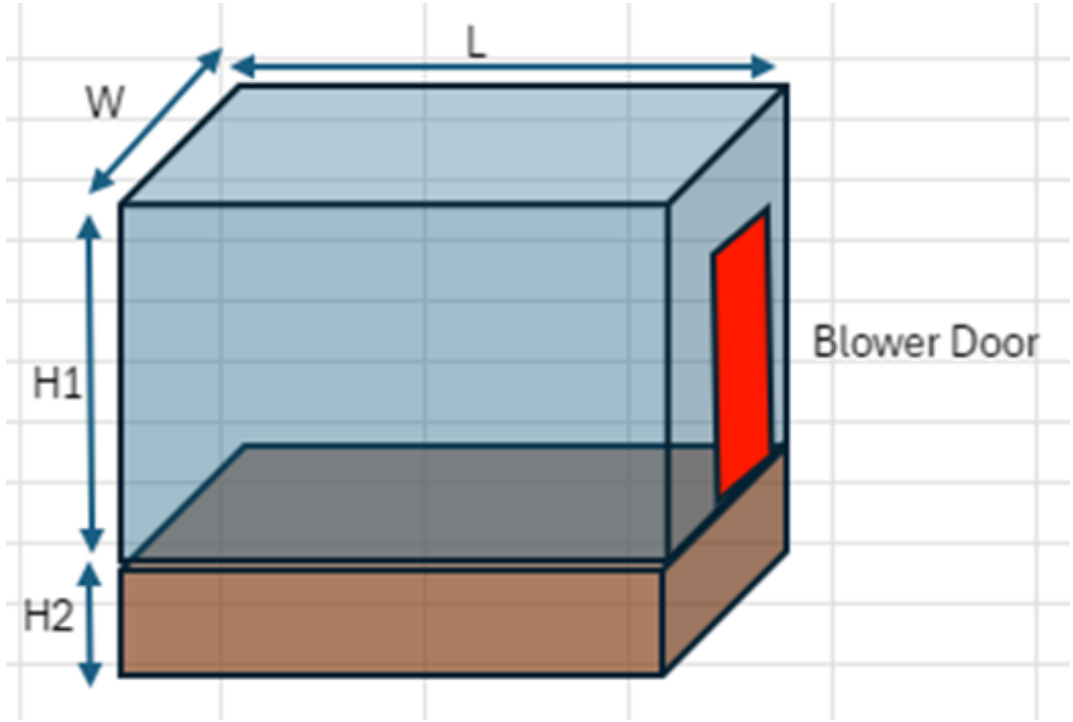
Ceiling Plenum Sealing

Results

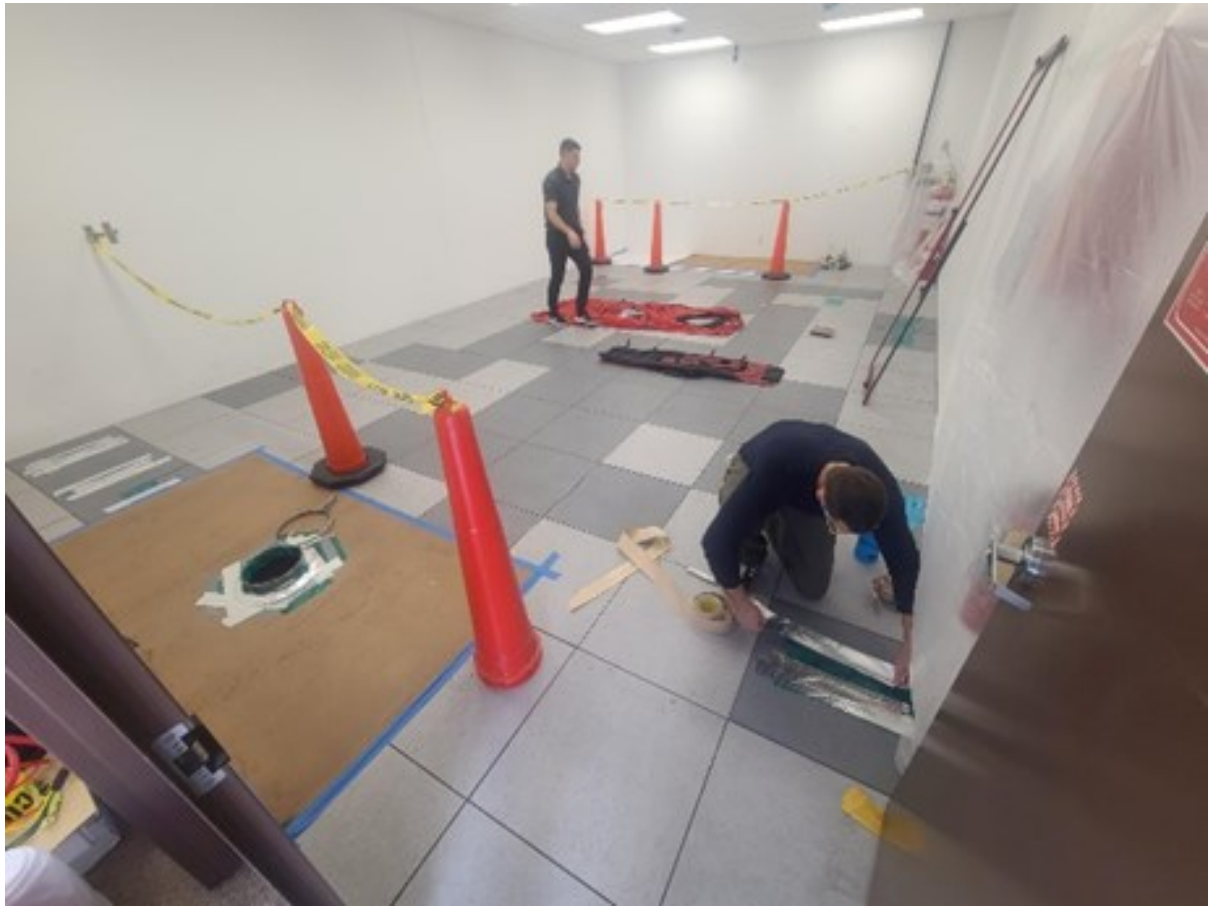
- Sealed approximately 300 cfm50
- Stopped prematurely due to some fogging of occupied space
- Should be performed during unoccupied hours
  - Not enough fogging to cause deposition, but enough to cause complaints

New Applications

Underfloor Air Distribution Sealing



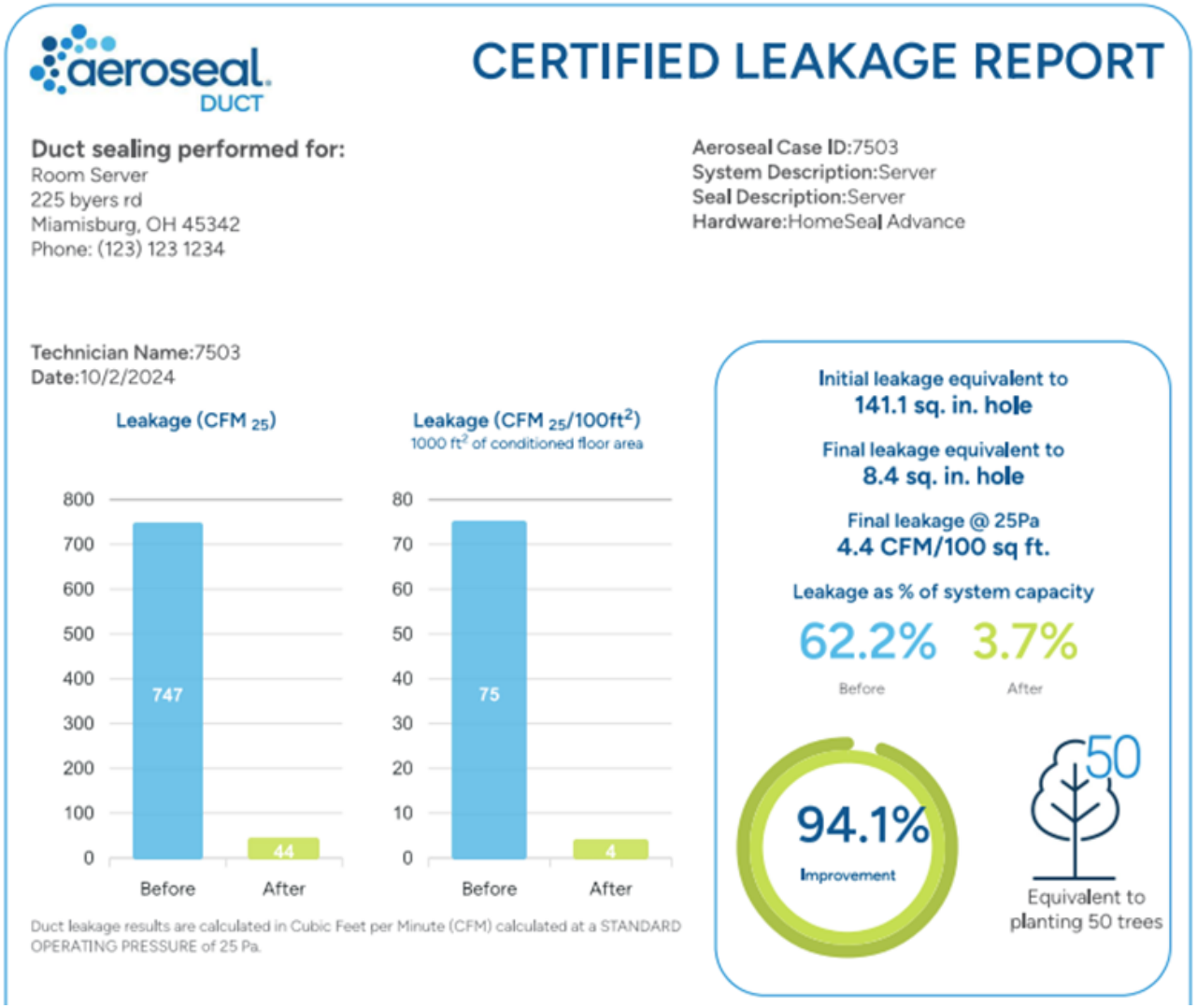
Parameter	Value
Envelope Height (H1)	9.9 ft
Subfloor Height (H2)	1 ft
Envelope Width (W)	18.2 ft
Envelope Length (L)	31.3 ft
Envelope Volume (L x W x H1)	5,630 cubic feet



New Applications

Underfloor Air Distribution Sealing

Parameter	Value
Envelope Pre-seal Leakage	6.3 ACH50
Envelope Post-seal Leakage	4.9 ACH50
Subfloor Initial Leakage	747 CFM25
Subfloor Final Leakage	75 CFM25



Presentation Take-Aways

Facility for Precise Measurement of Aerosol Envelope Sealing Technologies

- Separates out factors influencing performance

Airless Envelope Sealing is the Future

- Surpassed current Air-Assist atomization in lab and field
- Dramatically reduces equipment weight and volume
- Reduces set-up and break-down time requirements

New Applications

- Continue to find new applications for the technology