Enabling Decarbonization through Air Sealing

Maggie McCarey
Bill Shadid
Tom Holmes

Presented at 2024 NESEA Building Energy Boston
3.20.24

Today's Speakers

Maggie McCarey

- Head of Policy and Market Development
- 15 years of energy efficiency and building decarbonization policy
- Former MA DOER Energy Efficiency Director

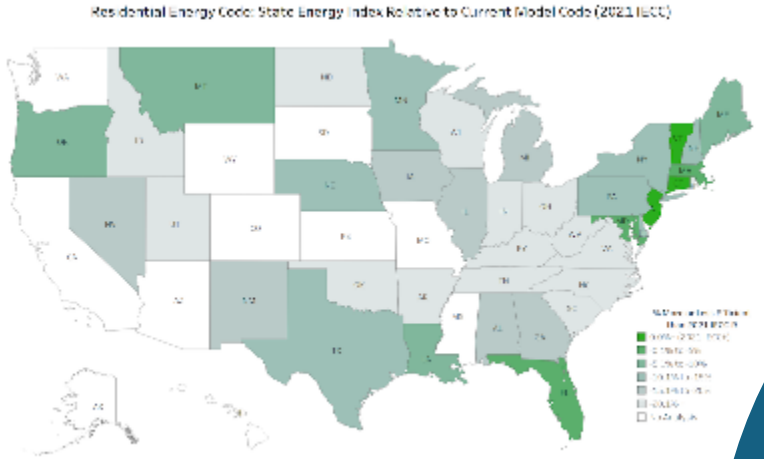
Bill Shadid

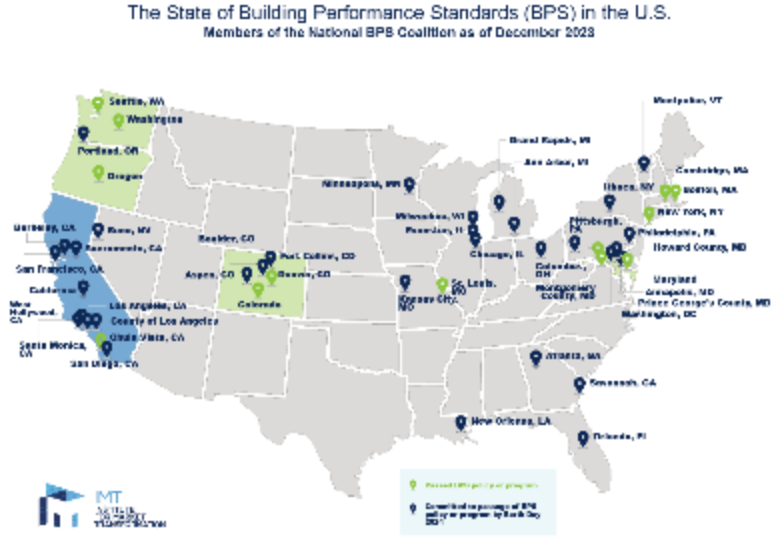
- Strategic Marketing
- Over 25 years in the building industry
- 16+ years in sustainable building technologies
- 9+ years as a sustainable architect

Tom Holmes

- Northeast Commercial Business Manager
- 20+ Years Designing & Implementing Building Performance Projects
- Specialist in Existing Building Envelope & Ventilation

State of the Market: Why Sealing?



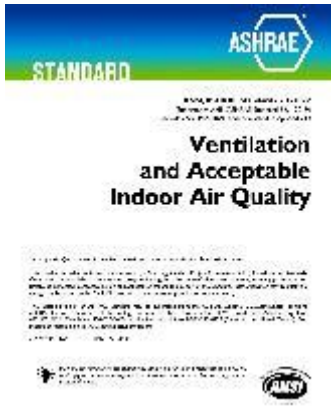


Codes

Building Performance Standards

Building Performance and IAQ

Incentives: Tax credits and rebates



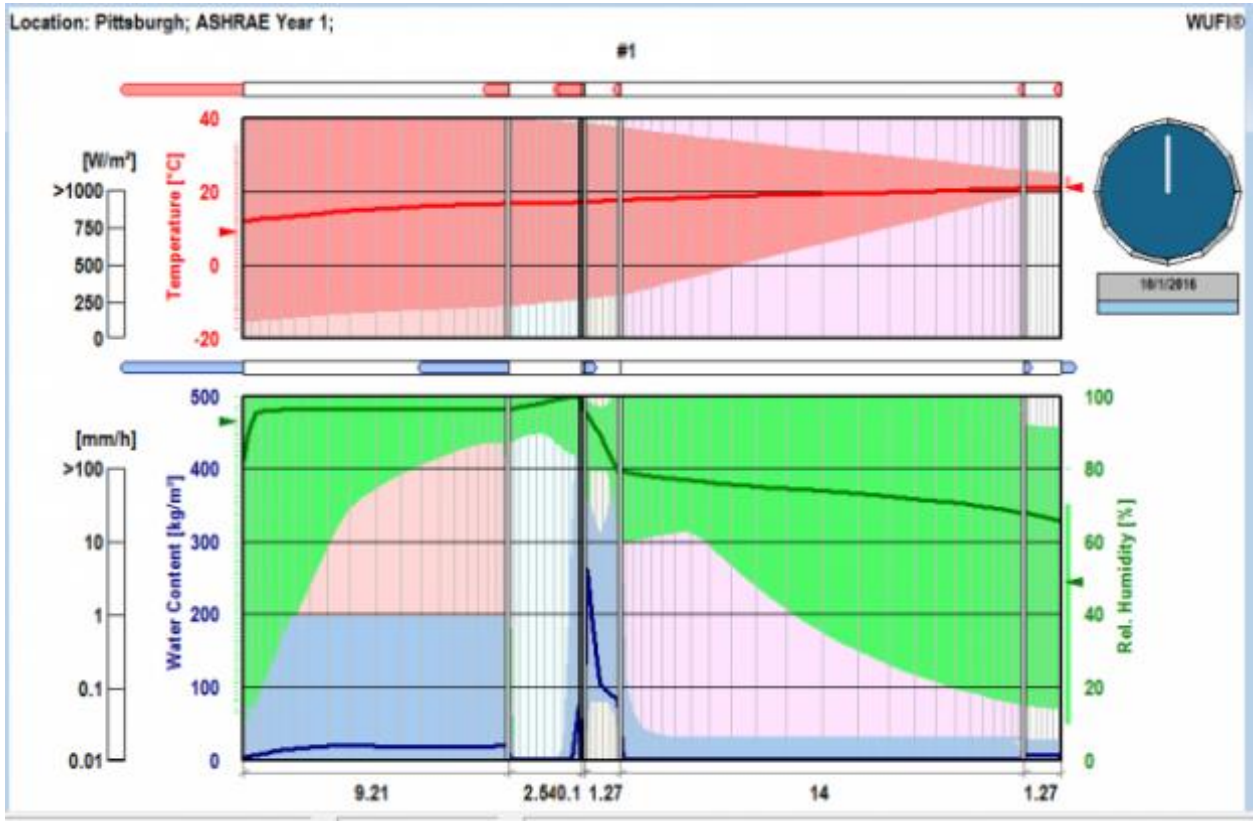
Multifamily Envelope Air Sealing: New Construction

Air Sealing is Even More Important in Highly Insulated Assemblies

The more insulation in an assembly,

The less the drying potential

The more air tight the assembly should be.



WUFI output courtesy of Green Building Advisor

Air Leakage Is A Large Contributor to Carbon Emissions From Housing

- The US DOE estimates that uncontrolled air leakage accounts for as much as 40% of energy use

- Air sealing the building envelope can greatly reduce the energy use and carbon emissions of the house

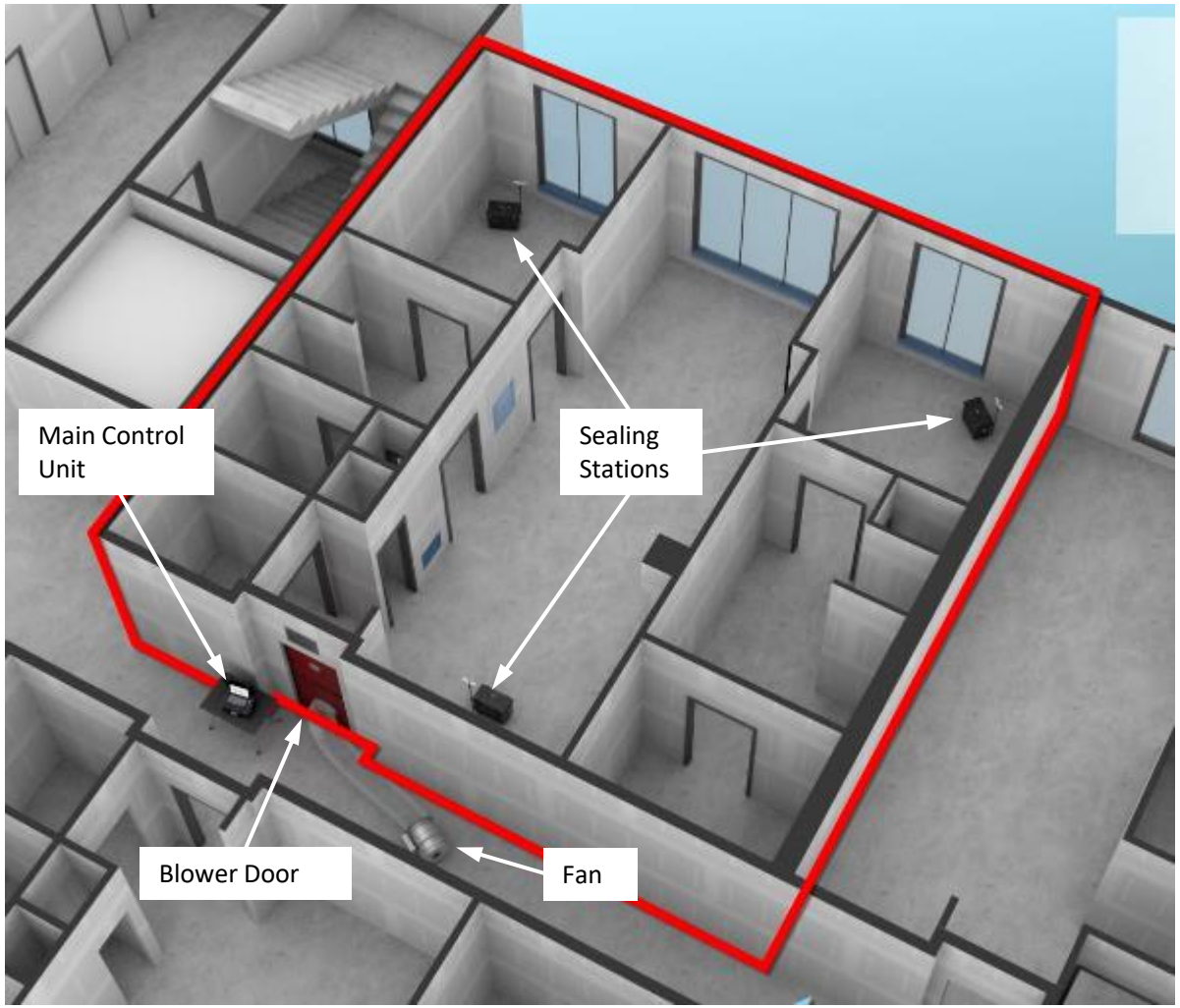
40%

Additional Benefits of Sealing the Multifamily Envelope (Ext & Party Walls)

- Help prevent moisture from entering the wall and attic systems
- Experience dramatic savings on home heating and cooling
- Enjoy a more comfortable home
- Diminish noise – from exterior & adjoining units
- Improve indoor air quality – from exterior & adjoining units
- Defend against insects and pests

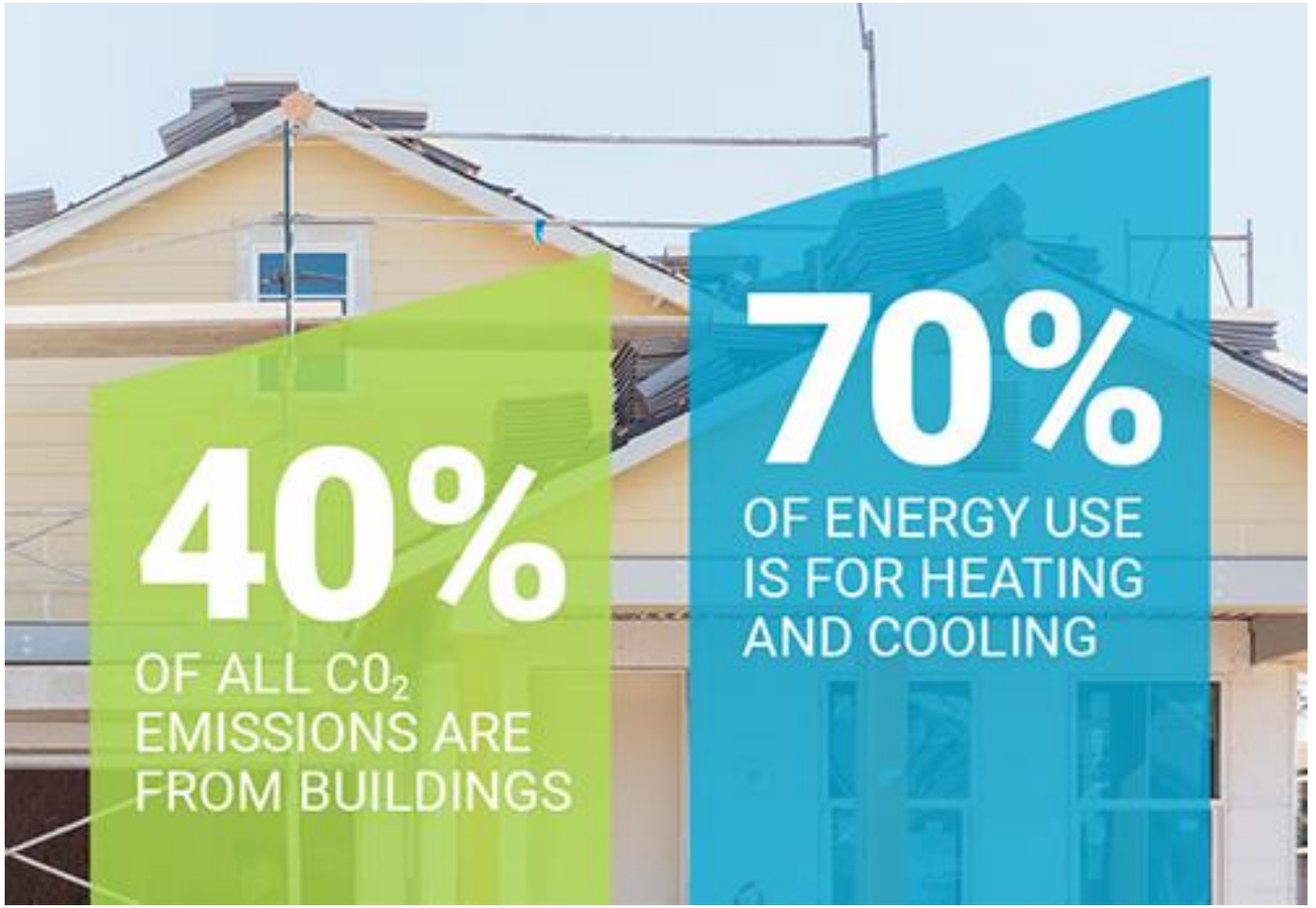
Air Sealing Methods Overview: Manual

Air Sealing Methods Overview: Automated & Blower Door Directed

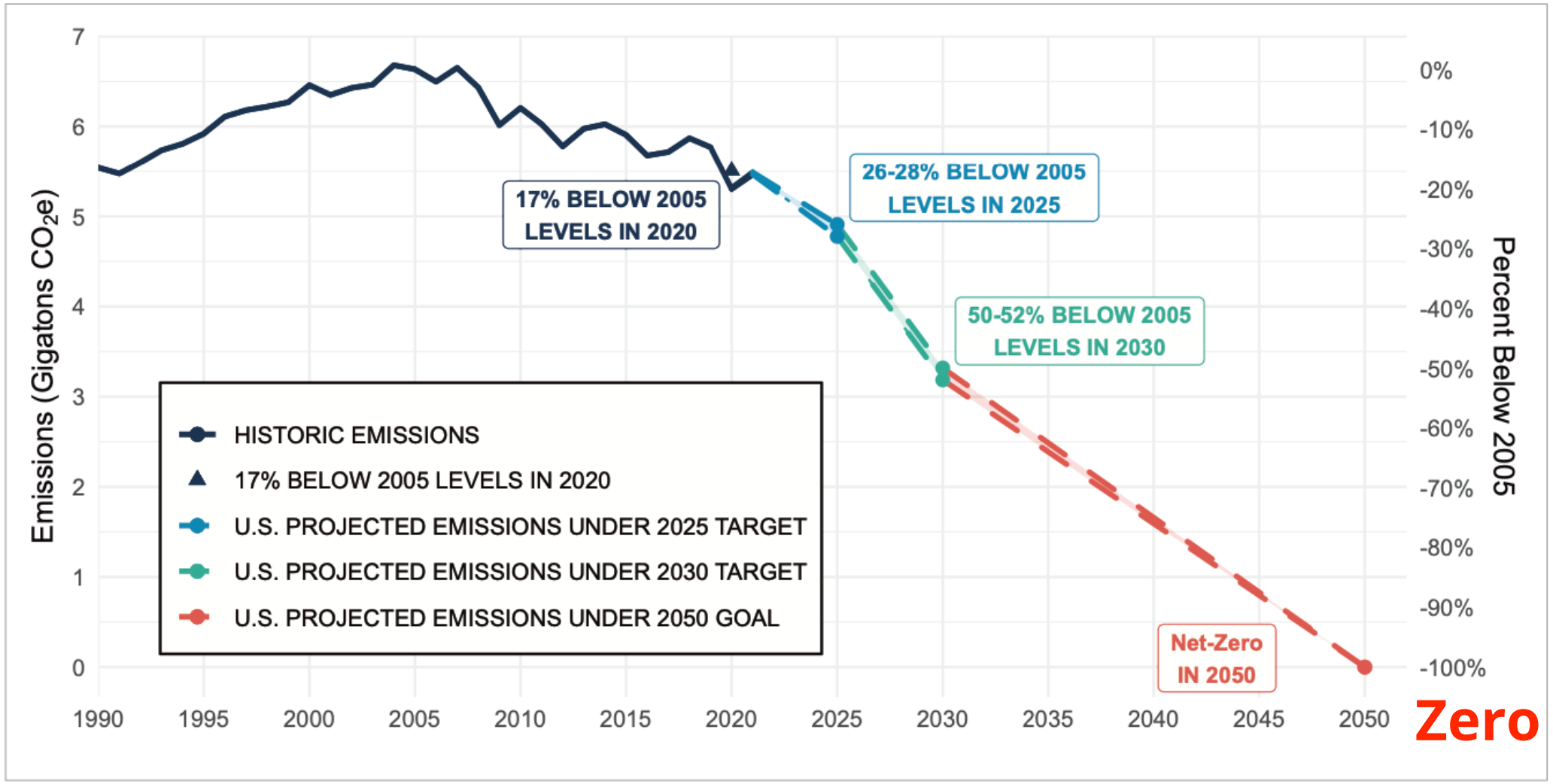


Computer Controlled Sealing Station Spraying Sealant

Carbon Impact of Housing



The New Imperative: Greenhouse Gas Emission Reductions



Zero by 2050

Types of Carbon Impact

'Upfront' Embodied Carbon

Manufacturing, transportation, and installation of construction materials

Operational Carbon

Building energy consumption

Operational Carbon Reduction Options: Reduce the Building's Energy Use

Less Energy Reduction → More Energy Reduction

High Efficiency Appliances

Attic Insulation

Wall Insulation

Air Sealing

HVAC

Windows & Doors

Basement Insulation

Exterior Insulation

Embodied Carbon Impacts of Envelope Improvements to Reduce Operational Carbon

Adds More Embodied Carbon

Adds Less Embodied Carbon

Rigid Foam Insulation

Insulated Sheathing

Windows & Doors

Natural Material Insulation

Spray Foam Insulation

Fiberglass Insulation

Air Sealing

Envelope Air Sealing: The Most Carbon Reduction Bang For The Buck

- Biggest impact on operational carbon
- With the lowest cost
- And the lowest embodied carbon impact

Carbon Assessment Tools Available

Embodied Carbon

- Building modelling software
- Inputs from product manufacturers
- Examples:

Operational Carbon

- Energy modelling software
- Fuel source emission factors
- Examples:

ekotrope

REM/Rate™

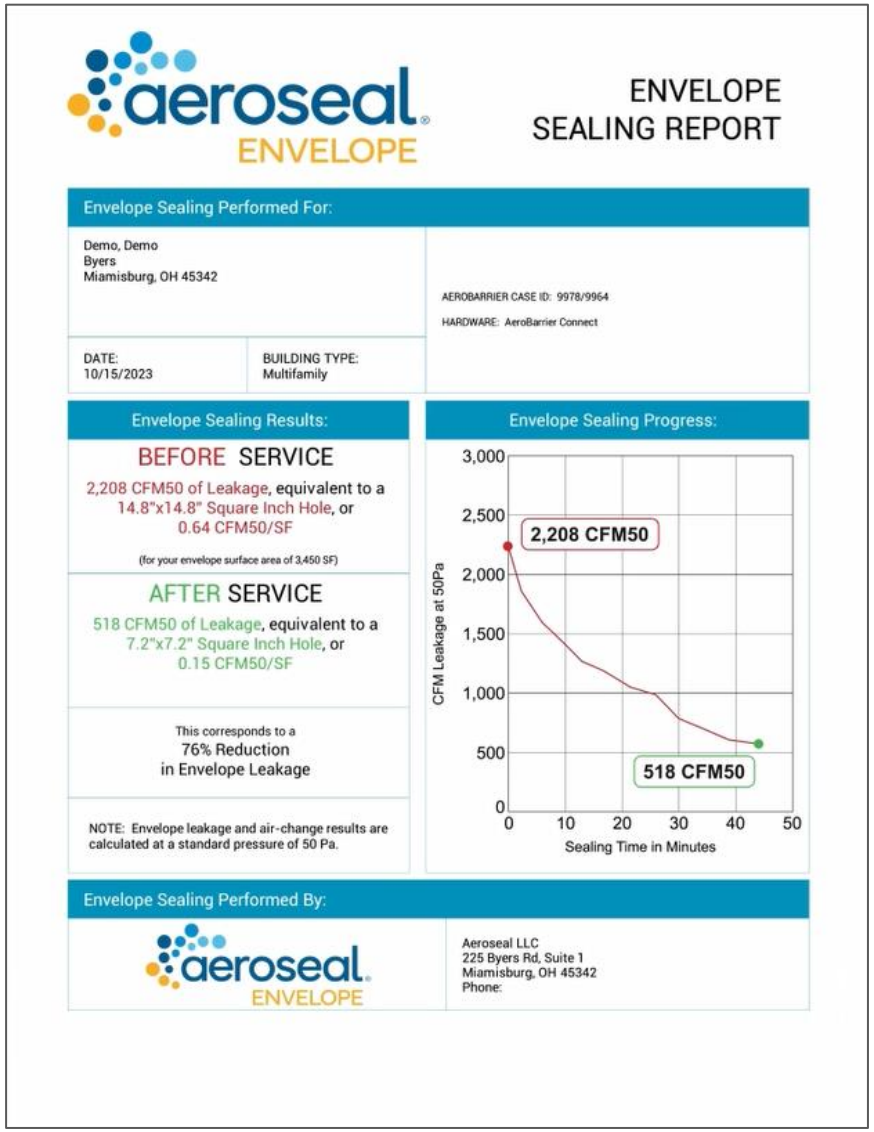
PHribbon

AeroBarrier Multifamily Air Sealing Overview Video

Watch AeroBarrier Multifamily Air Sealing Overview Video here

AeroBarrier Envelope Sealing Report

An Envelope Sealing Report is generated for every exterior envelope and multifamily unit sealed



aeroseal ENVELOPE

ENVELOPE SEALING REPORT

Envelope Sealing Performed For:

Demo, Demo
Byers
Miamisburg, OH 45342

AEROBARRIER CASE ID: 9978/9964
HARDWARE: AeroBarrier Connect

DATE: 10/15/2023

BUILDING TYPE: Multifamily

Envelope Sealing Results:

BEFORE SERVICE

2,208 CFM50 of Leakage, equivalent to a 14.8"x14.8" Square Inch Hole, or 0.64 CFM50/SF

(for your envelope surface area of 3,450 SF)

AFTER SERVICE

518 CFM50 of Leakage, equivalent to a 7.2"x7.2" Square Inch Hole, or 0.15 CFM50/SF

This corresponds to a 76% Reduction in Envelope Leakage

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

Envelope Sealing Progress:

Envelope Sealing Performed By:

aeroseal ENVELOPE

Aeroseal LLC
225 Byers Rd, Suite 1
Miamisburg, OH 45342
Phone:

AeroBarrier Air Leak Sealing Examples

After AeroBarrier sealing examples showing incremental sealing vs. other methods

Around electrical box

Joint in wood subfloor above basement

Around exterior door

Case Study: Multifamily Passive House Harvard University Student Housing

Details for 2 Projects:

- Harvard University Student Housing apartments
- Renovate historic structures to passive house standard
- 13 Kirkland Place, Cambridge, built 1856 – 4 units
- 5 Sacramento St, Cambridge, built 1891 – 7 units
- Historic status prevented exterior changes
- Insulation and air sealing done from the inside
- Goal was to meet Phius certification standards
- Installer = New England Air Barrier

Results with AeroBarrier:

- AeroBarrier enables achieving passive house air sealing requirements

Case Study: Multifamily Avalon Bay Brighton

Project Details:

- Avalon Brighton Apartments
- Boston, MA
- 180 units
- Natural gas supply issues forced use of electric heat pumps
- AeroBarrier used for compartmentalization of all units

Results with AeroBarrier:

- Exterior envelope sealed during compartmentalization
- Before AeroBarrier = 6-8 ACH50
- After AeroBarrier = all units below 3 ACH50, average = 2.63 ACH50

Case Study: Multifamily Passive House 153rd Street Apartments

Project Details:

- 153rd Street Apartments
- Upper West Side, Manhattan, New York, NY
- 32 units
- AeroBarrier used for compartmentalization

Situation Before AeroBarrier:

- Apartments mostly complete and unable to achieve passive house requirement for air tightness between units (compartmentalization)
- Significant time and $ spent in prior attempts to achieve air sealing requirement
- Build was not able to progress to completion

Case Study: Multifamily Passive House 153rd Street Apartments

Project Results:

- Passive house compartmentalization requirements were achieved
- 32 apartments were sealed in 8 days
- Project was able to move to completion and occupancy

"It was blowing people's minds – mostly because monitoring compartmentalization in a multi-family building under construction is typically a very difficult, time consuming task. The level of coordination and commitment you need to get from all contractors on the job is as critical as it is nearly impossible to achieve. With AeroBarrier, it's simply not a problem." Chris Benedict, Architect

Case Study: Multifamily Passive House
Pax Futura Apartments

Project Details:

- Multifamily apartments
- Seattle, WA
- Seattle's first Passive House apartments
- 32 studio & 1 BR units
- AeroBarrier used for compartmentalization on Level 1
- Installer = Ekovate

Results:

- Before AeroBarrier = 3.6 ACH50
- After AeroBarrier = 0.21 ACH50
- 94% reduction in air leakage

Case Study: Multifamily Passive House
Pax Futura Apartments

AeroBarrier Sealant at Bottom of Party Wall

AeroBarrier Sealant at Exterior Wall

Case Study: Multifamily Net Zero Soleil Lofts Apartments

Project Details:

- Multifamily – Net Zero Energy
- Soleil Lofts, The Wasatch Group
- Herriman, UT
- 600 units, solar, all electric
- AeroBarrier used for compartmentalization

Case Study: Multifamily Net Zero Soleil Lofts Apartments

Needed to cut energy consumption in half to meet performance targets and modeling showed air sealing was the best option

Mechanical Changes:

- 3-bedroom units were modeled to get a 3.5-ton gas furnace.

- Goal was to reduce mechanical equipment costs if possible

"We looked at other energy efficiency measures, including lighting and appliances, but energy modeling showed us they aren't as cost-effective as air sealing." The Wasatch Group

Case Study: Multifamily Net Zero Soleil Lofts Apartments

Project Results:

- 3 bedroom units were planned to have a 3.5 ton gas furnace
- Sealed with AeroBarrier to 1ACH50
- Now able to use 1.5 ton VRF electrical heating/cooling system
- 50% reduction in HVAC costs
- Energy use reduction of 50% supported use of PV solar to achieve Net Zero
- Utility rebates totaled substantially more than the cost of AeroBarrier
- Largest Net Zero project in Utah

Case Study: Multifamily Energy Star (River Glen Apartments (sealed after finishes)

Project Details:

- Multifamily – Energy Star & 3 ACH50
- River Glen Apartments, Signature Const.
- Rochester, MN
- 208 units, Low Income Housing
- 160 units 100% finished, 48 unfinished

Customer Pain Points:

- Mostly complete affordable housing project couldn't meet air tightness requirement and allow occupancy of apartments
- Poor windows and mechanical dampers
- 40+ families in temporary hotel housing

Case Study: Multifamily Energy Star (River Glen Apartments (sealed after finishes)

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Case Study: Multifamily Energy Star (River Glen Apartments (sealed after finishes)

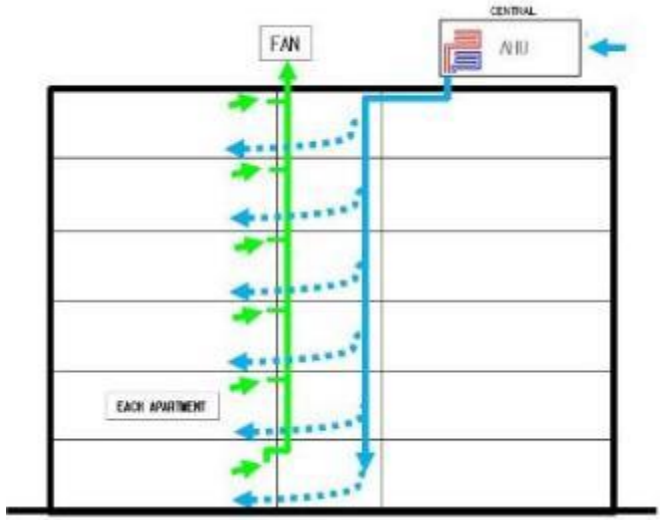
Project Results:

- Pre air sealing = 6.5 ACH50 average/unit
- Post air sealing = 1-1.5 ACH50 per unit
- Air tightness requirements met and families able to move out of hotel and into apartments
- Air sealing helped qualify for 45L on 50% of the units
- Now AeroBarrier is mandatory for Signature Construction in states requiring an ACH50 of 5 or less
- Signature Construction builds in 15 states

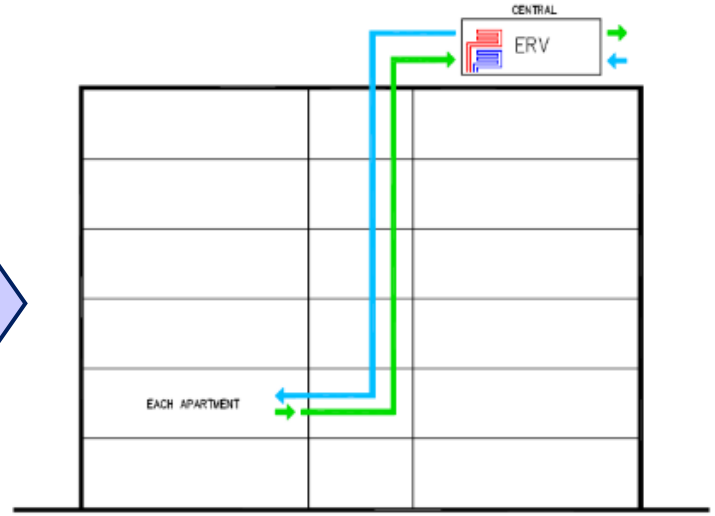
Multifamily Duct Sealing: High Performance Buildings

System Types

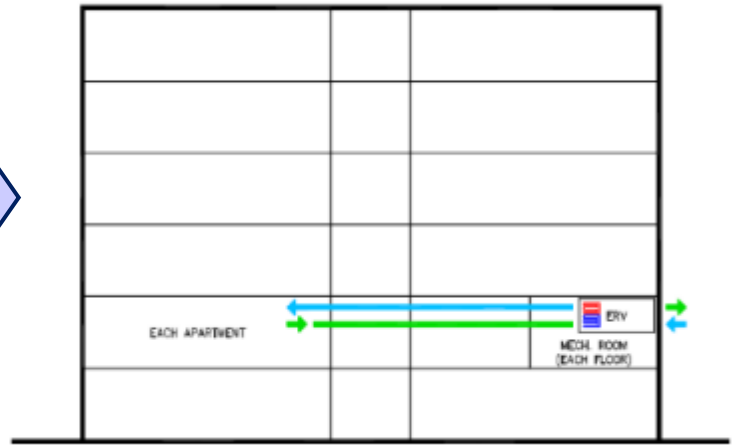
"Old Code" Central



Rooftop ERV

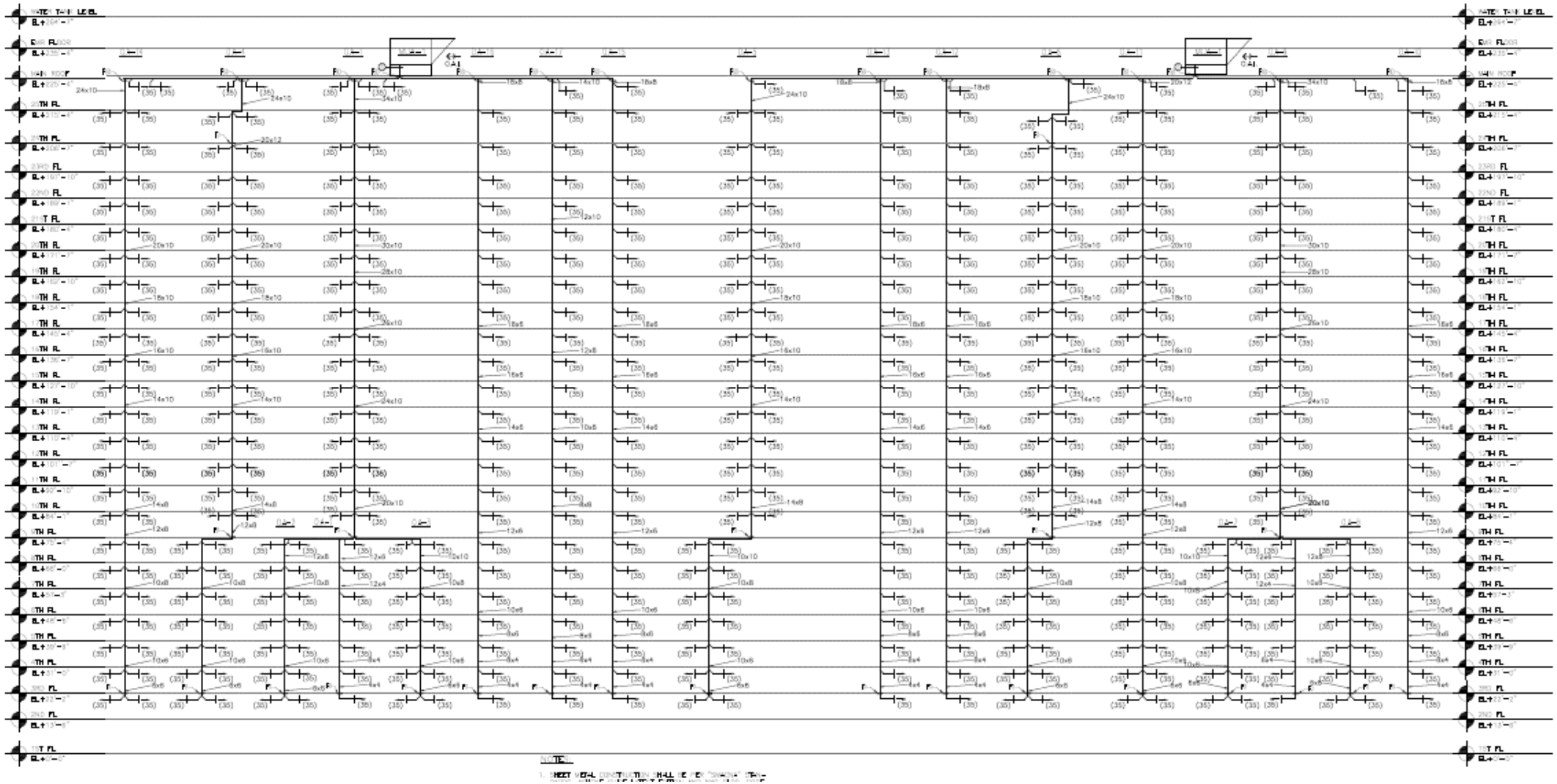


Floor by Floor

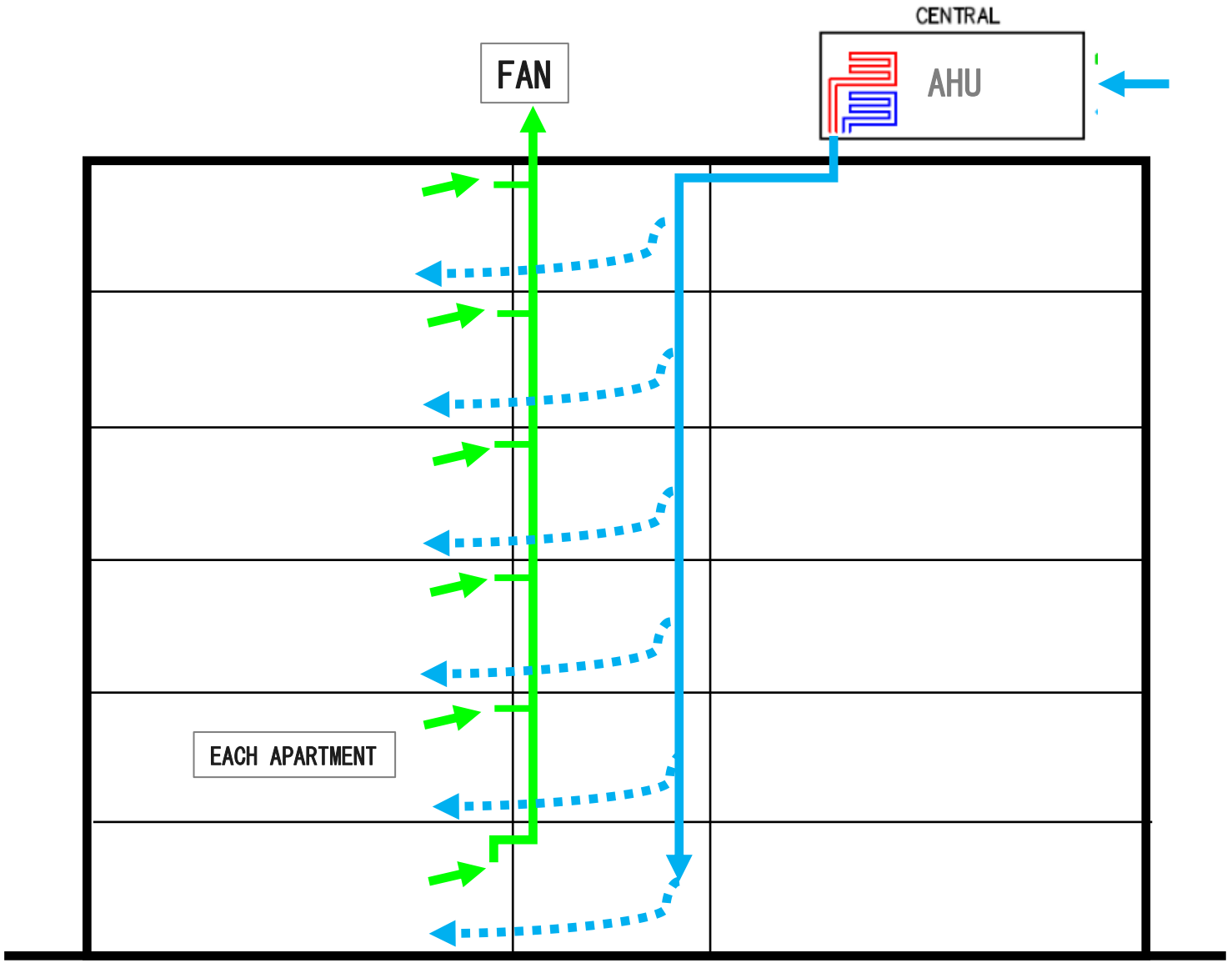


Unit Level

“Old Code” Central (Converted to ERV)



“Traditional” Rooftop Exhaust Only - Schematic



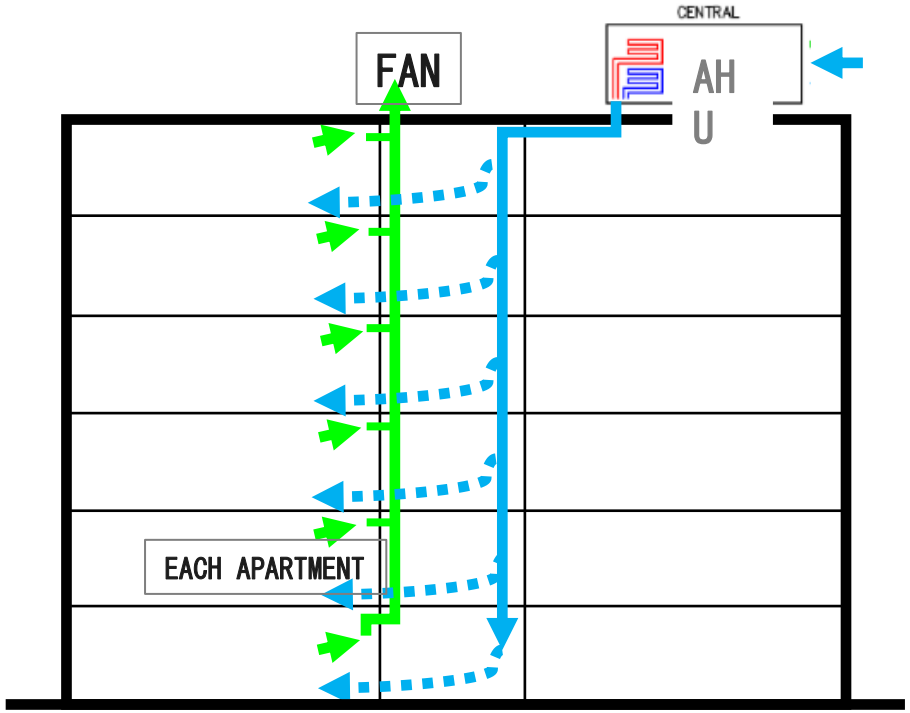
“Traditional” Rooftop Exhaust Only – Make it Work

Pros

- It’s What We Got

Cons

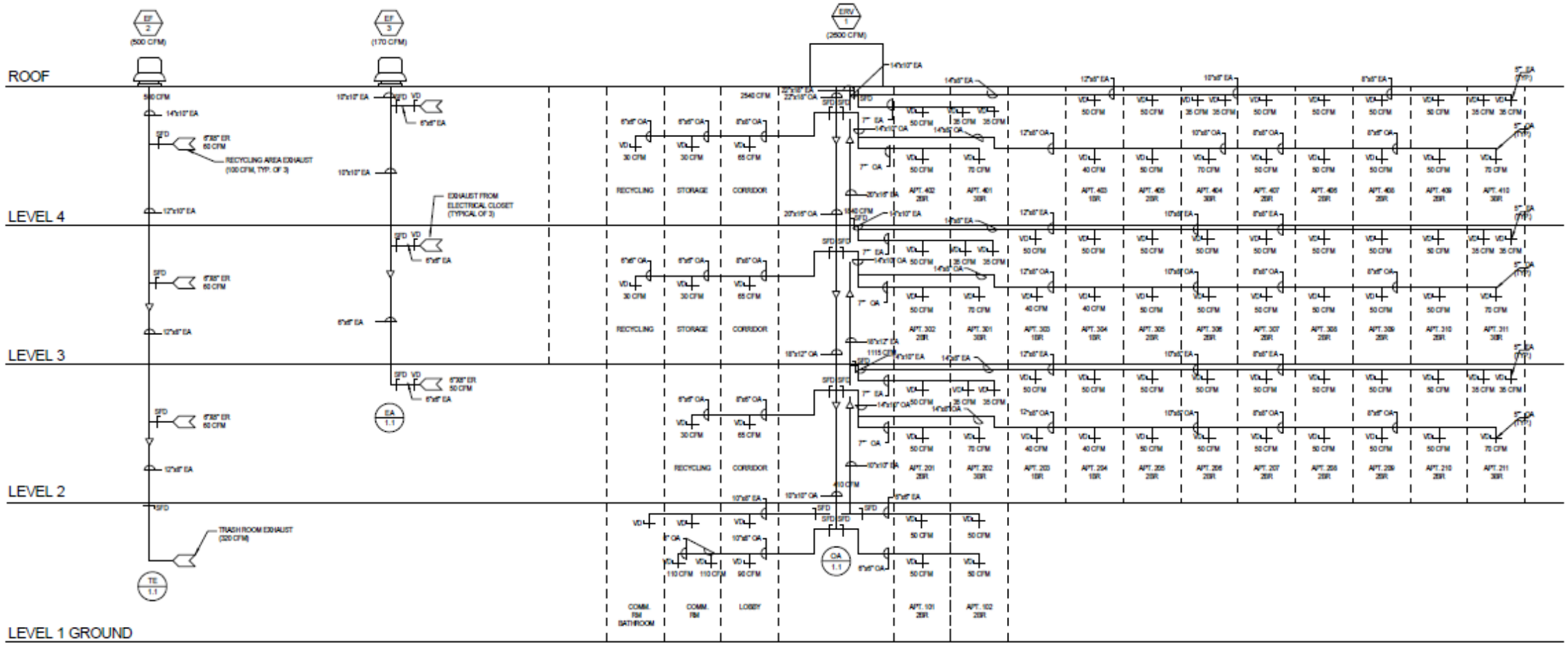
- 100% “Lost Air” Energy Penalty - $$$
- NO DIRECT MAKE UP FRESH AIR
- Ducts Leak, are Blocked or filled with Mold
- Rarely in Balance
- Rarely EVER Work!



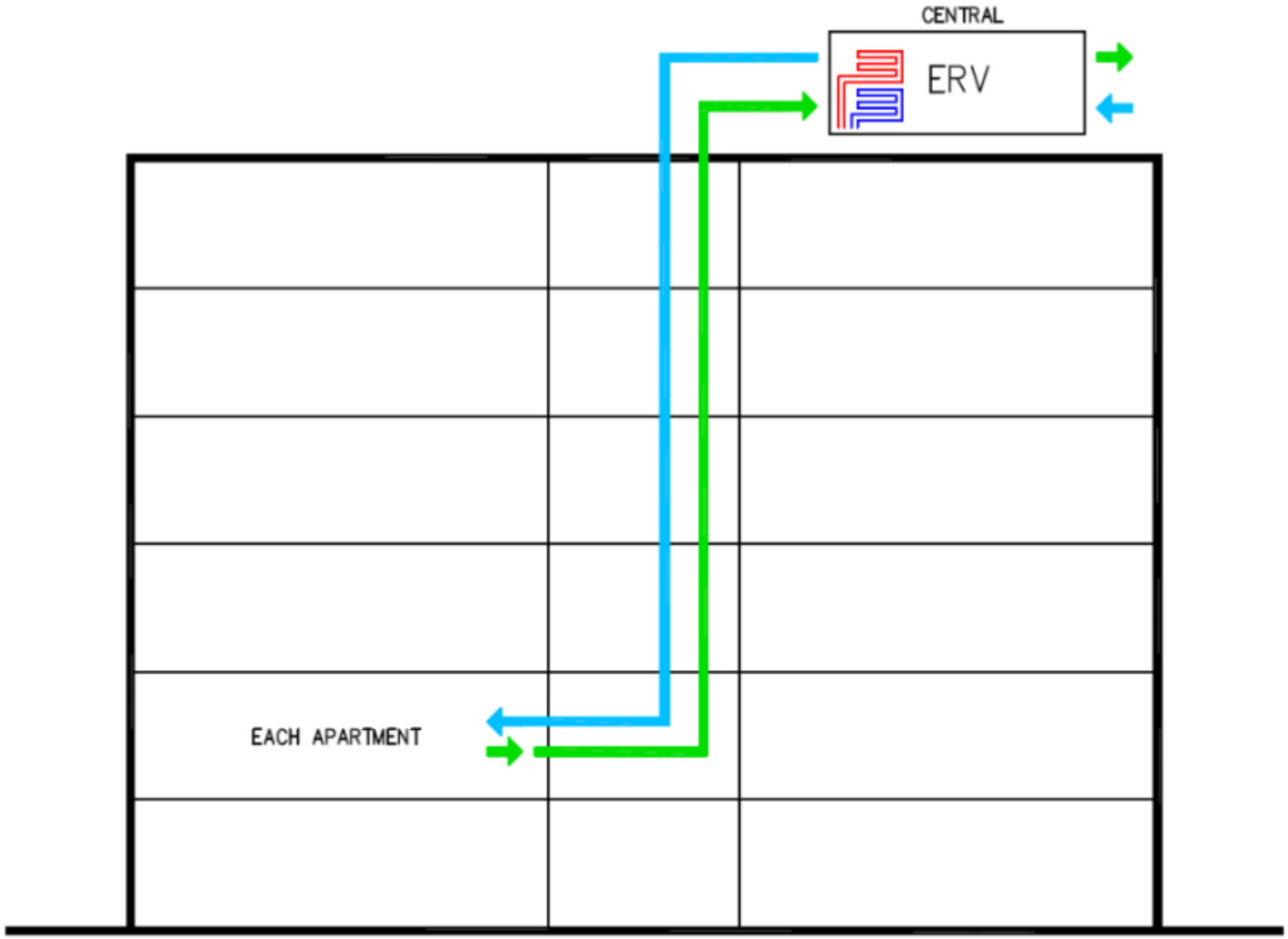
Making them WORK

- Seal the “Big Gaps” (10%-15% leakage max)
- Set Design Flows *at least* 50% above minimum thresholds – “gauge” more than measure flows
- Expect that vents will need periodic cleaning/ maintenance
- Can Repair Line By Line

Rooftop ERV with Direct OA Supply



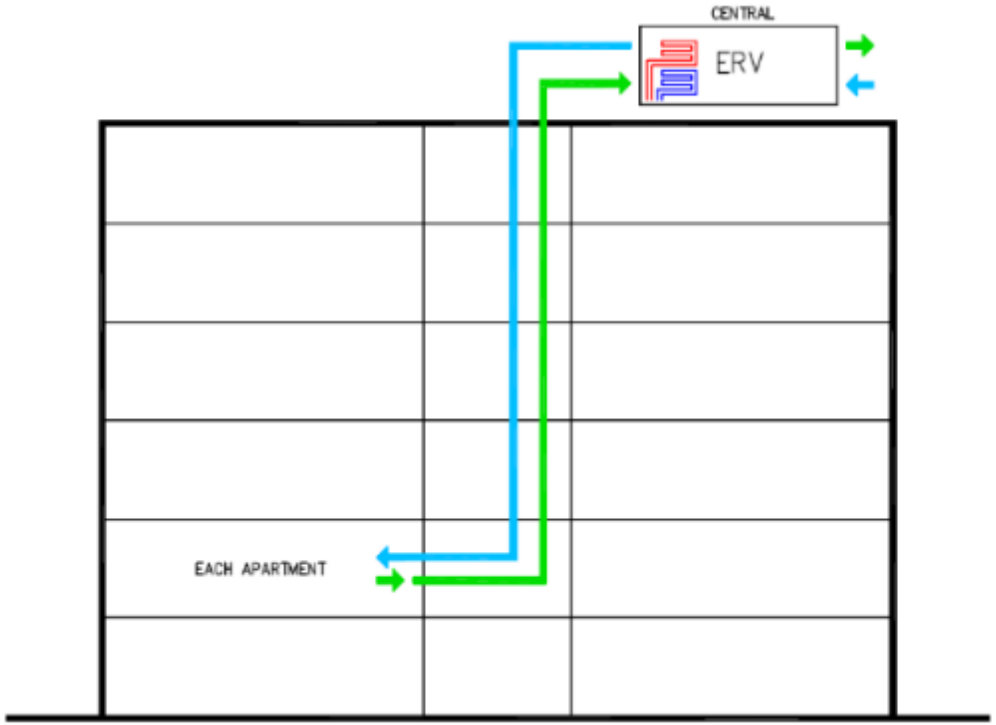
Central Rooftop ERV - Schematic



Central ERV – Make it Work

Pros

- Centralized Equipment
- Energy Recovery Reduces Energy Penalty $$
- *Modern Systems* Provide Unit-Level Make Up Air



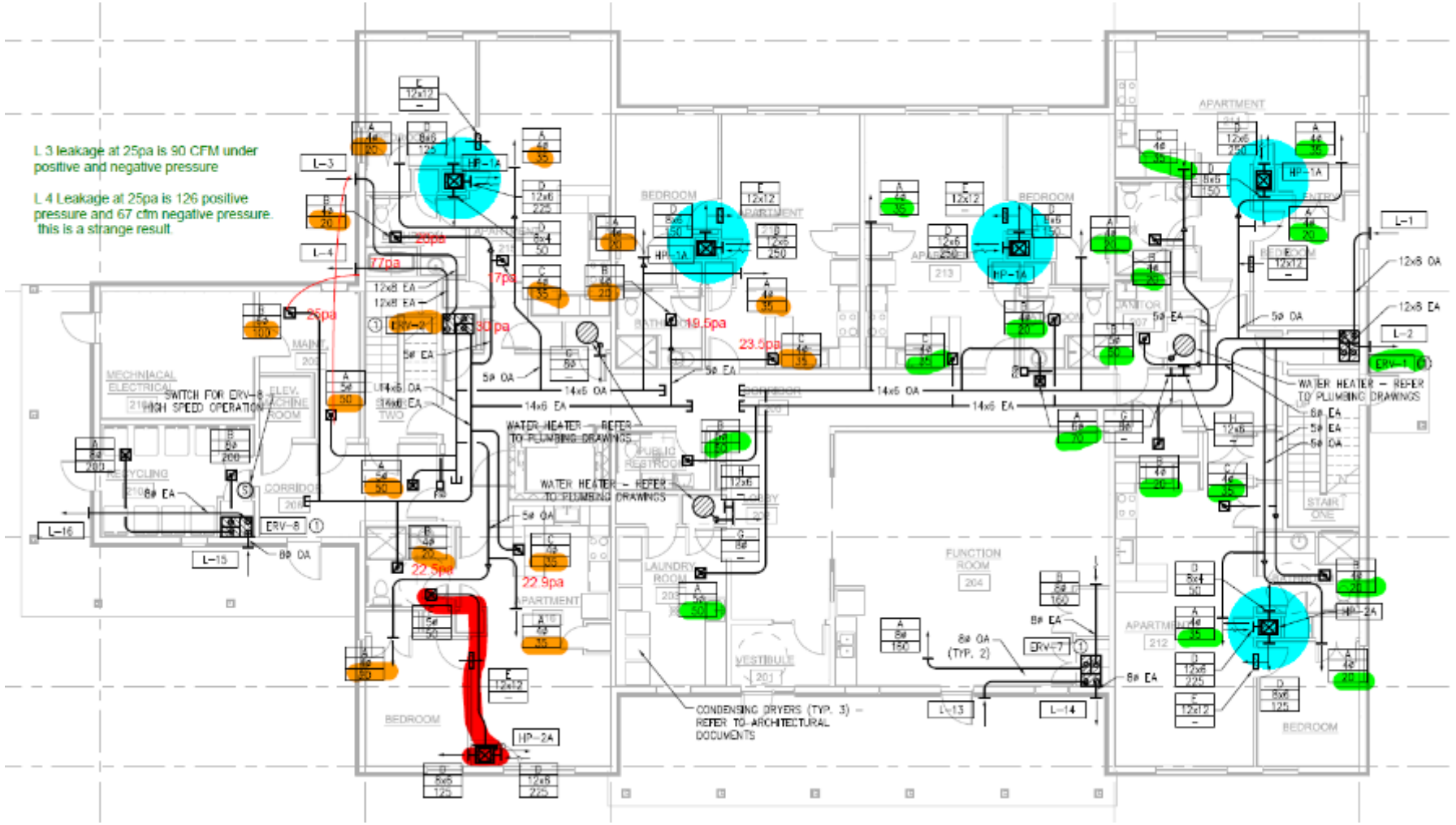
Cons

- "Old Code" Systems – NO MAKE UP AIR
- Ducts Must Be *Really* Tight
- Too Many Vent Connections Hurt Performance

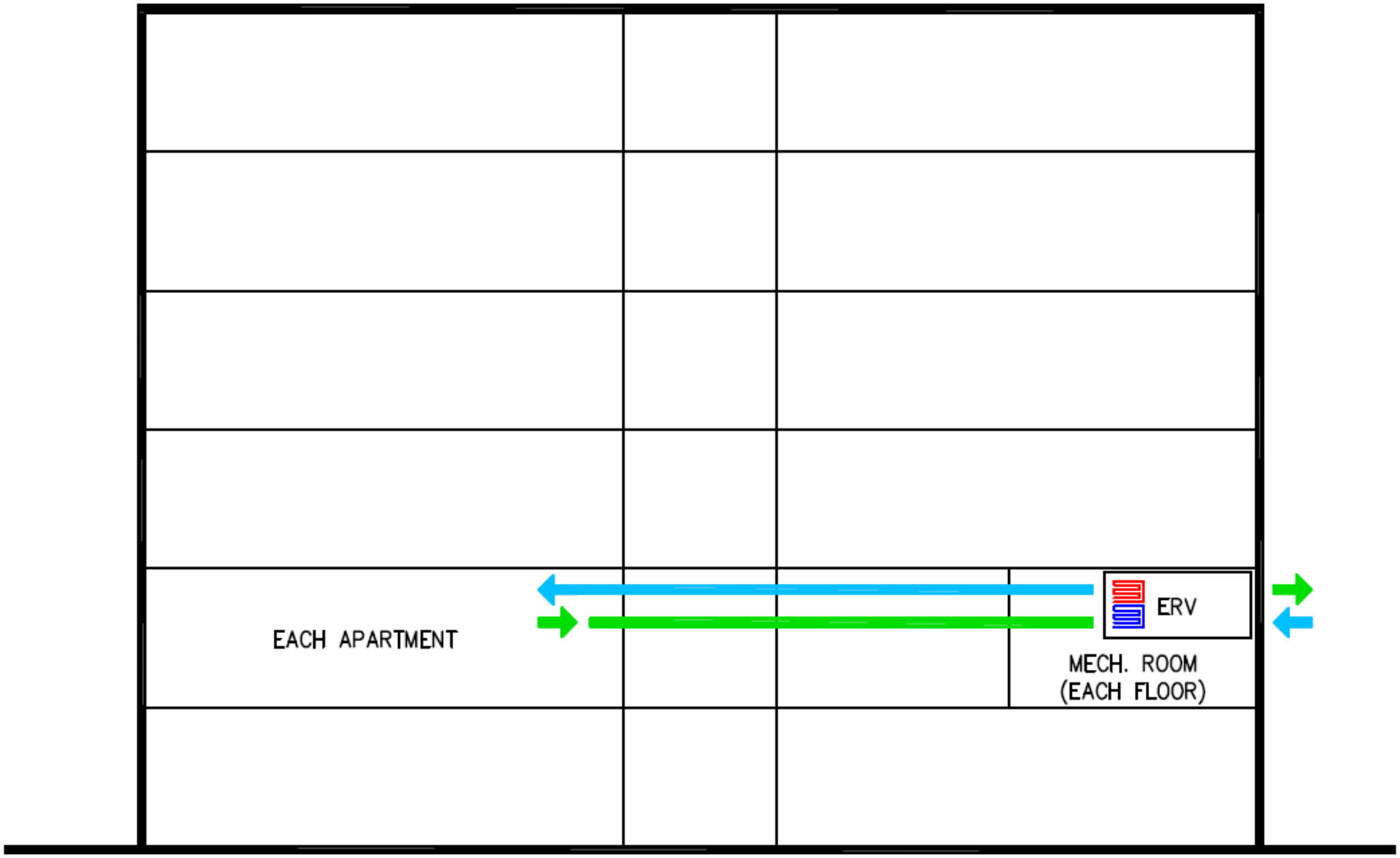
Making them WORK

- Really Tight Sheet Metal Ducts (2%-3% leakage max)
- Set Design Flows *at least* 20% above minimum thresholds – flows WILL fade farther from the fans (min 35-40 for kitchens; min 30 for bathrooms)
- Expect that vents will need periodic cleaning/ maintenance

Floor-by-Floor ERV



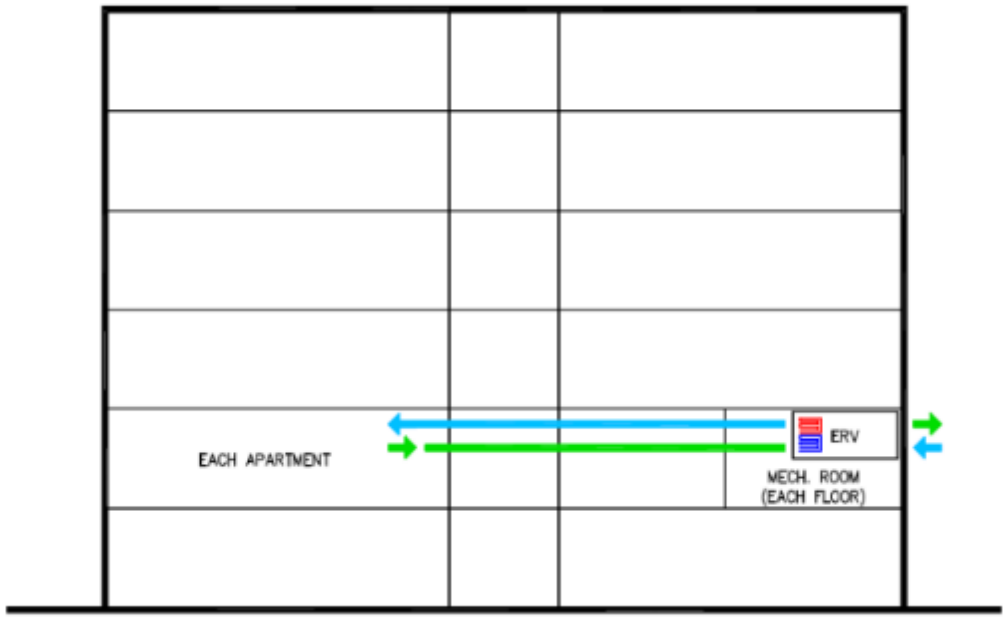
Floor-by-Floor Ventilation – Schematic



Floor-by-Floor ERV – Make it Work

Pros

- Energy Recovery Reduces Energy Penalty $$
- Eliminates Stack Effect, No Riser Shafts
- Better Building Compartmentalization



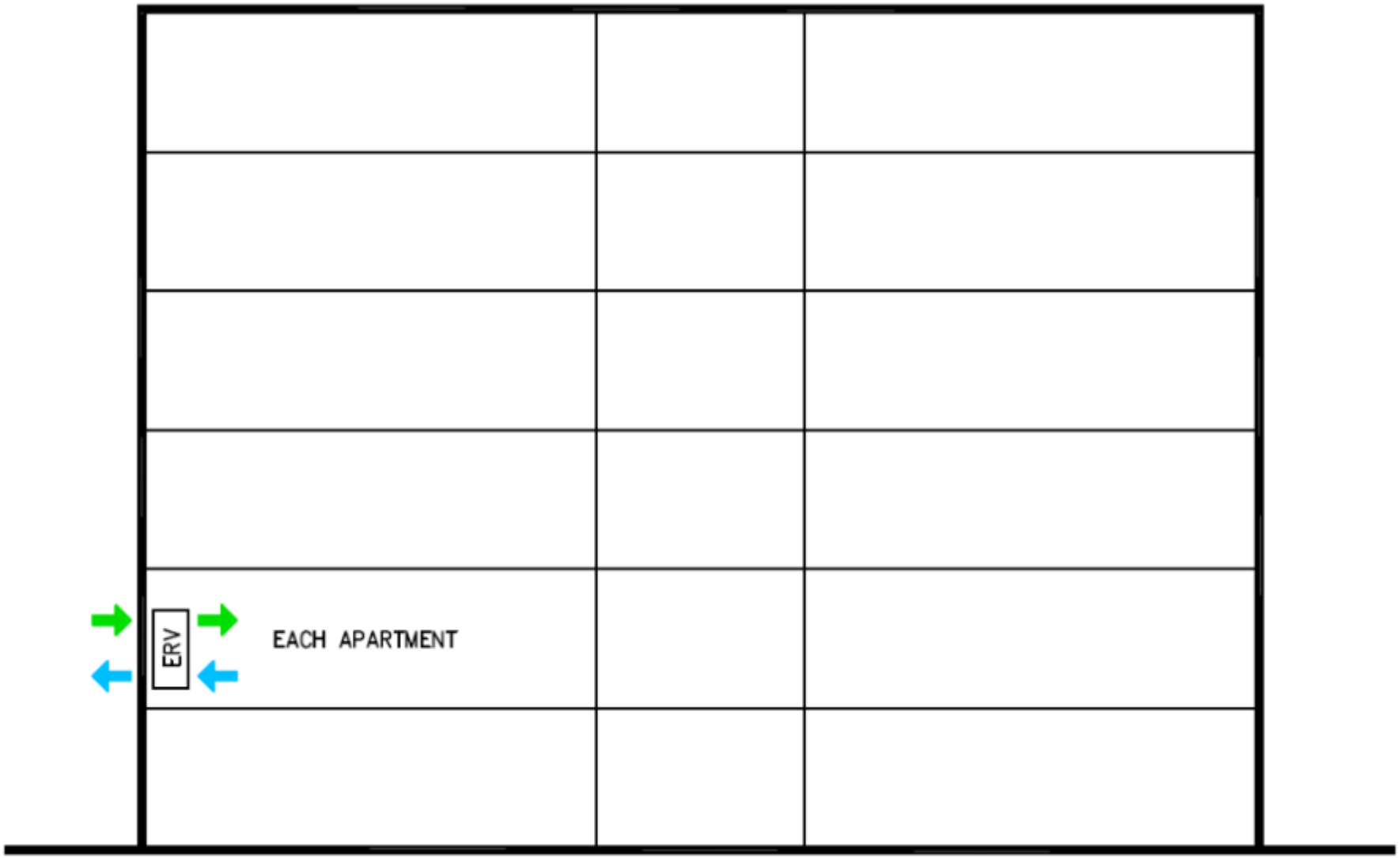
Cons

- Mechanical Spaces on Every Floor (Noise)
- Requires Corridor Ceiling Space for Ducts
- More Machines that Require Maintenance

Making them WORK

- Tight Sheet Metal Ducts (5% leakage max)
- Set Design Flows *at least* 20% above minimum thresholds
- Expect that vents will need periodic cleaning/ maintenance

Unit Level Ventilation – Schematic



Unit Level Ventilation – Make it Work

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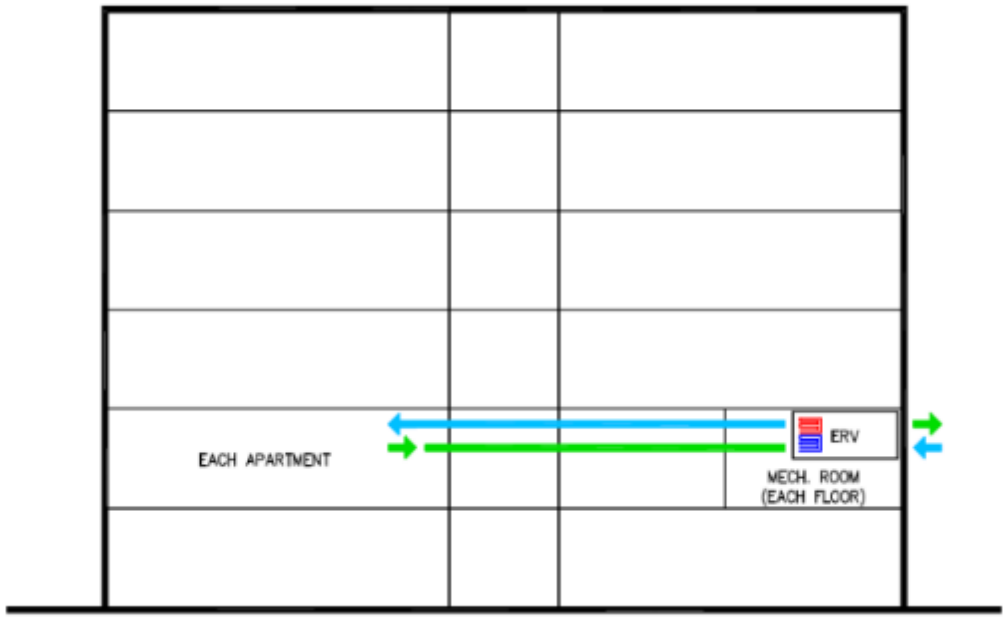


Making them WORK

- Tight Sheet Metal Ducts (5% leakage max)
- Set Design Flows *at least* 20% above minimum thresholds
- Expect that vents will need periodic cleaning/ maintenance

System Types: **Pros** & Cons

Pro	"Old Code" Exhaust Only		Modern Code with In-Unit Make Up Air		
	Central Exhaust Only	Central Exhaust Only ERV	Central with ERV	Floor-by-Floor	Unit Level
Already Installed in Existing Building	☑	☑			
Centralized Equipment	☑	☑	☑		
Mechanical Access from Common Spaces Only	☑	☑	☑	☑	
Up to 75% Energy Recovery		☑	☑	☑	☑
Direct Make Up Air to Apartments			☑	☑	☑
No Riser Shafts				☑	☑
Easier to Balance				☑	☑
Better Compartmentalization				☑	☑
No Fire/ Smoke Dampers					☑
Occupant Pays for Energy Use					☑
Occupant Controls Ventilation Directly					☑

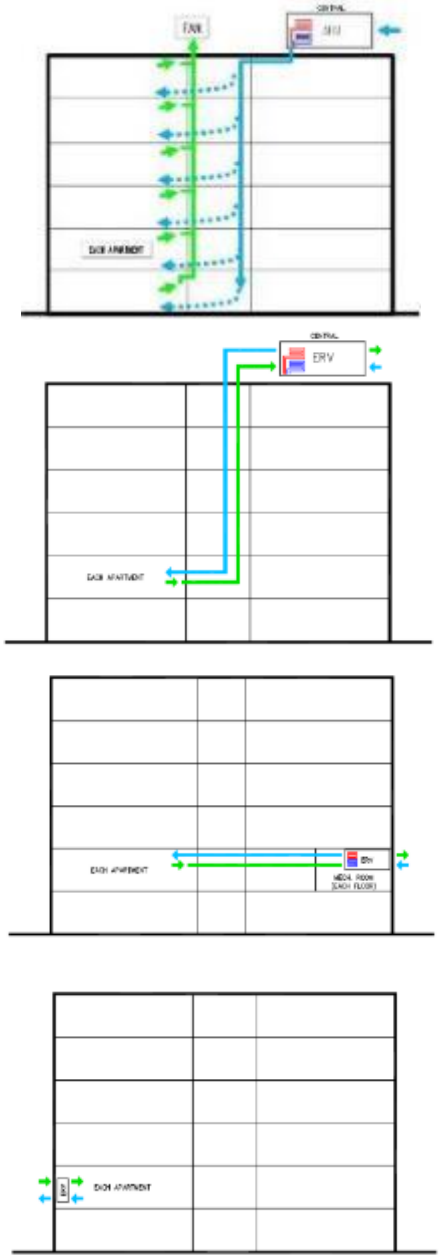
System Types: Pros & **Cons**

Con	"Old Code" Exhaust Only		Modern Code with In-Unit Make Up Air		
	Central Exhaust Only	Central Exhaust Only ERV	Central with ERV	Floor-by-Floor	Unit Level
100% Lost Air	☒				
Duct Risers Penetrate Floors	☒	☒	☒		
Make-up Air Equipment Outside Envelope	☒	☒	☒		
Stack Effect	☒	☒	☒		
Fire/ Smoke Dampers	☒	☒	☒	☒	
Uses Corridor Ceiling Space	☐	☐	☐	☒	
Multiple Inside Mechanical Spaces				☒	☒
In Unit Mechanical Service					☒
Unit-Level Thru-Wall Penetrations					☒

Commissioning: The Ducts

Was it Built to Design?

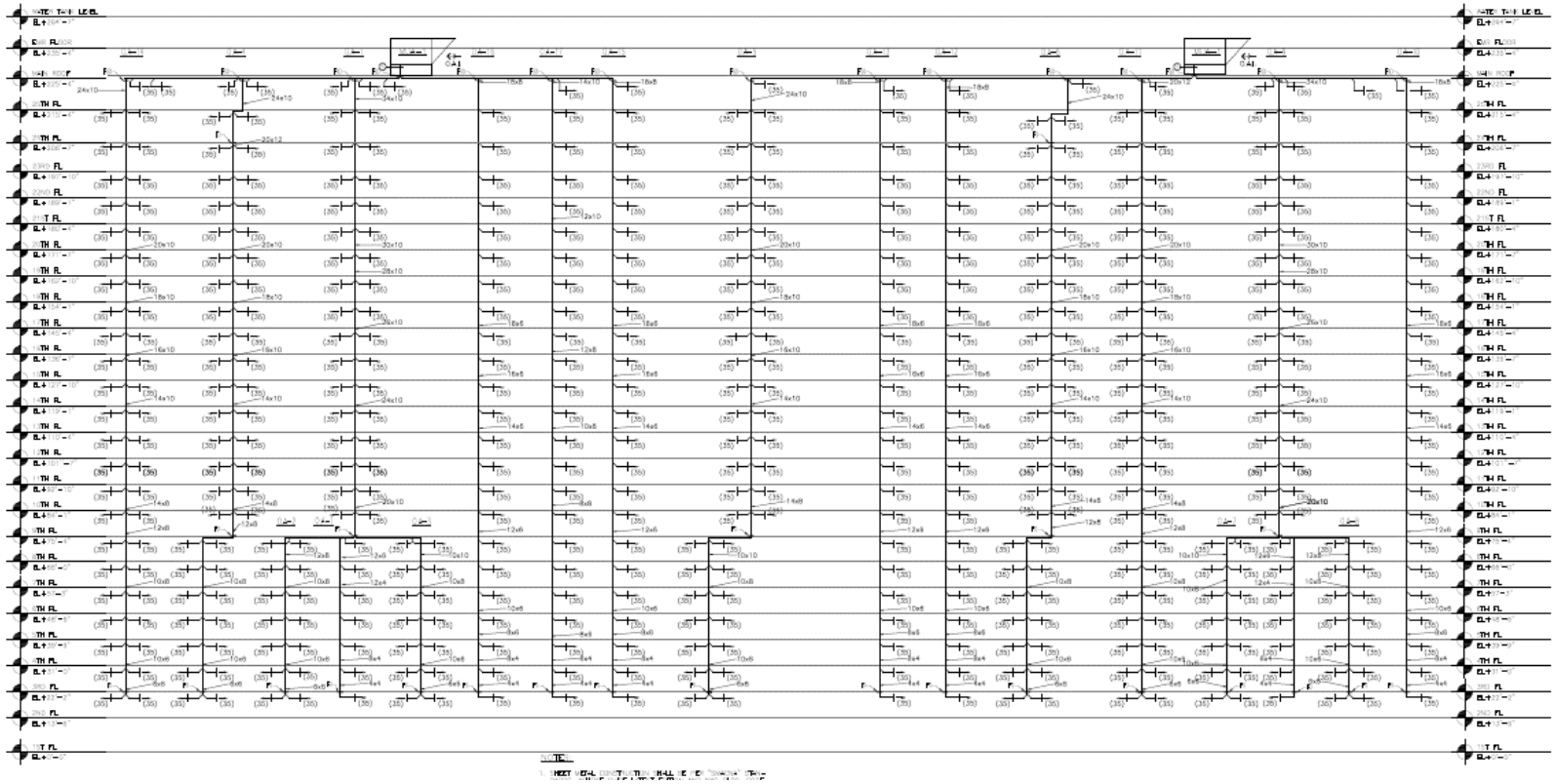
- Multi-unit systems are COMMERCIAL
  - ✓ Fans designed for operating flow/ SP
  - ✓ Ducts designed for a known leakage
  - ✓ Tolerances should reflect project parameters
  - ✓ Put it in the specs
- In-unit systems are RESIDENTIAL
  - ✓ RESNET, PHIUS – put it in the specs



How Tight is Tight?

Manual
Vent Damper

Self-Regulating
Vent Damper (CAR)

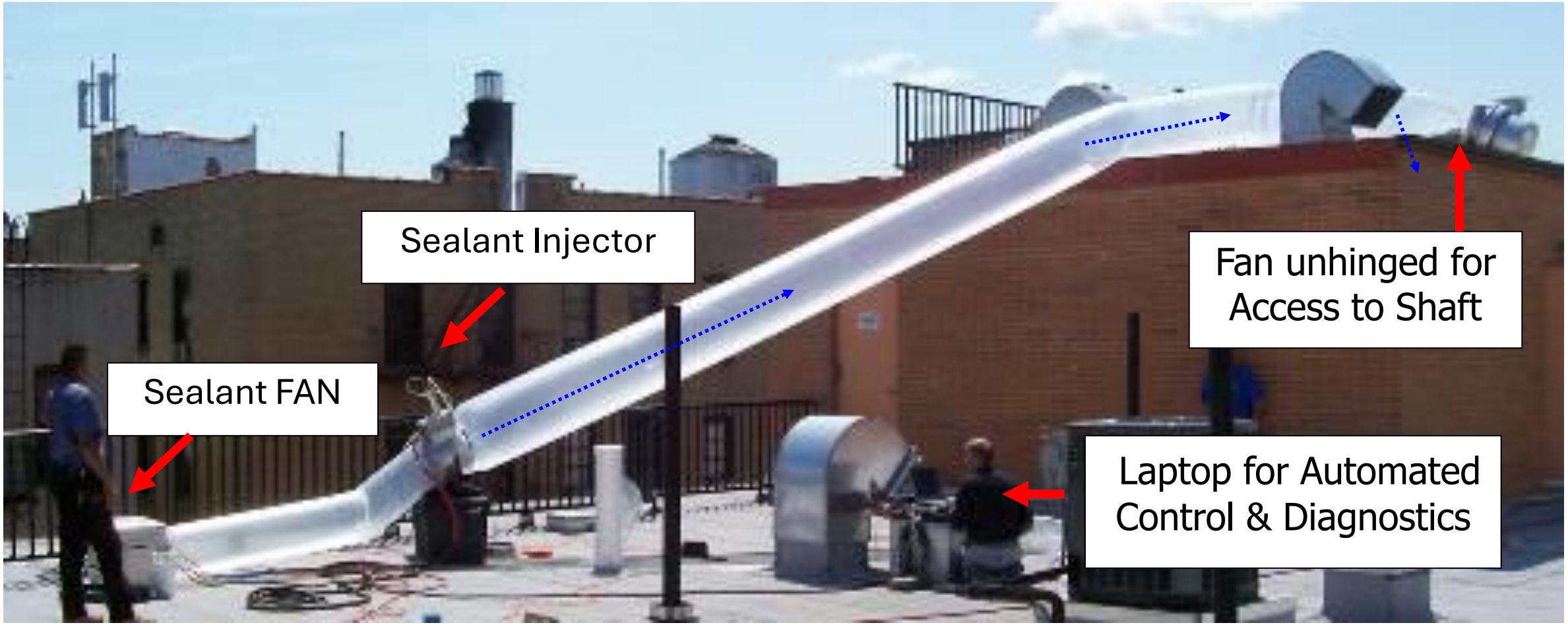


When it comes to ductwork, there's no such thing as "too tight"!

Non-invasive Aeroseal Sealant

- Seals holes up to ¼”
- Sealant remains rubbery
- Vinyl polymer is safe (UL Listed)
- No lingering odors or off-gassing
- Lasts 10+ years (3yr warranty)
- Over 25,000 homes and 1,000 commercial buildings

Aeroseal Rooftop Application



100% Testing & Verification

- ✓ Test system *at operating pressure*
- ✓ Test to SMACNA Standards using identical protocol.
- ✓ Test to percent of flow
- ✓ Test from fan to final vent
- ✓ Test In/ Seal/ Test Out –

  Can be witnessed by engineer or owner's rep.

aeroseal DUCT

COMMERCIAL LEAKAGE REPORT

Duct sealing performed at:
Clemson
5637 peachtree cir east
Ridgefield, Ct 06877

Building Type: Library
Seal Date: MM/DD/YYYY
Barometric Pressure (Inches in HG): XXX

Aeroseal Gen 2.1 Case ID: XXXX
Manometer Model: 900351
Manometer Serial Number: 2121-SS-0025

Seal Specifics
System Description: ERV-1
Operating Pressure (WG): 0.40 inches
Fan Capacity: 900 CFM
Seal Description: 2nd Floor Exhaust
Seal Type: Exhaust
Seal CFM: 5,400 CFM

Duct Class (WG): 0.5 inches
Test Pressure (WG): 2 inches
Seal Class: C

	Rectangle	Round
Test Duct Surface Area (ft²)	483	365
SMACNA Leakage Class	16	8
Leakage Allowed at 2" WG	25	12.5

Allowable Leakage
165 CFM

Leakage Before Test
253 CFM

Leakage After Test
11 CFM

Leakage Test
PASS

Leakage at .40" WG

Leakage at .40" WG

Duct sealing performed by:
Technician
Dealer Name
54 Danbury Road Suite 171
Ridgefield, Ct 06877
Phone: 203-921-8994

Dealer Logo

Note: Duct leakage results reported by Aeroseal conform to the calculations laid out in method D of ASTM # 1154: Standard Test Methods for determining air leakage of air distribution systems by fan pressurization.

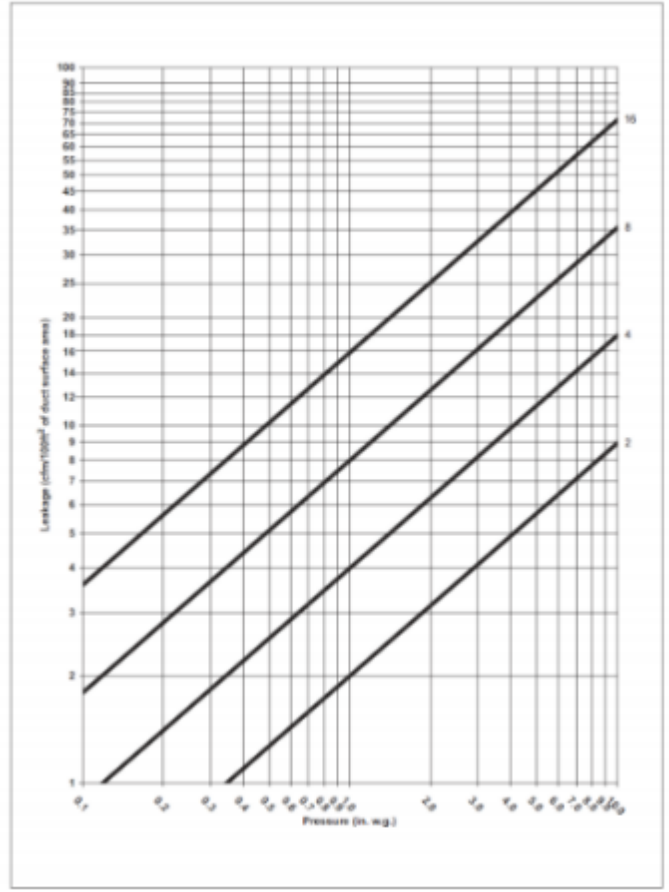
Aeroseal | aeroseal.com | 877-FIX-DUCT | info@aeroseal.com

Commissioning: Percent of Flow Method

- Specified % of Design Flow
- Measures entire system
  - ✓ Curb to Vent
  - ✓ Test at OP – 1.5 OP
- Can test sections, but subsequent tests should include prior tests until the whole system is measured.
- Can be riskier if they wait till the system is complete

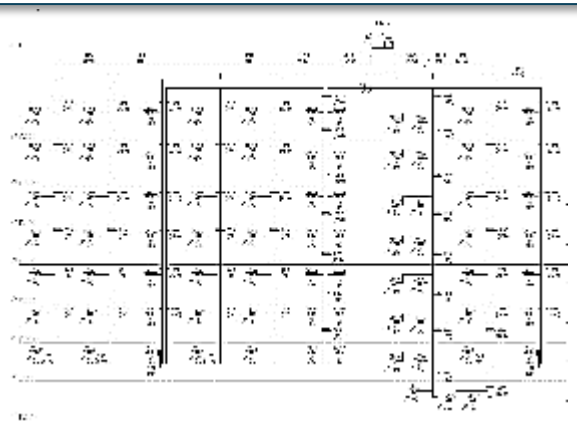
Commissioning: SMACNA Method

- Seal & Leakage Class Well Defined
- X CFM per 100SF of *DUCT* @ YSP
  - ✓ Duct Only - Excludes curbs, vent boxes, etc.
  - ✓ Done as sampling only throughout construction (when engineers stay on it)
- Lower volume systems with lots of ducts pass at higher leakage percentages



Compare Allowable Leakage

- Size: 8”
- Len: 2,500 ft
- Area: (5,236 SF)
- OP: 1” WG
- Vents: 25 @ 35CFM
- Sys Flow: 835 CFM



SMACNA

- 1” WG
  - *Class 2: 105 CFM*
  - *Class 4: 209 CFM*
  - *Class 8: 419 CFM*
- 1.5” WG
  - *Class 2: 136 CFM*
  - *Class 4: 272 CFM*
  - *Class 8: 545 CFM*

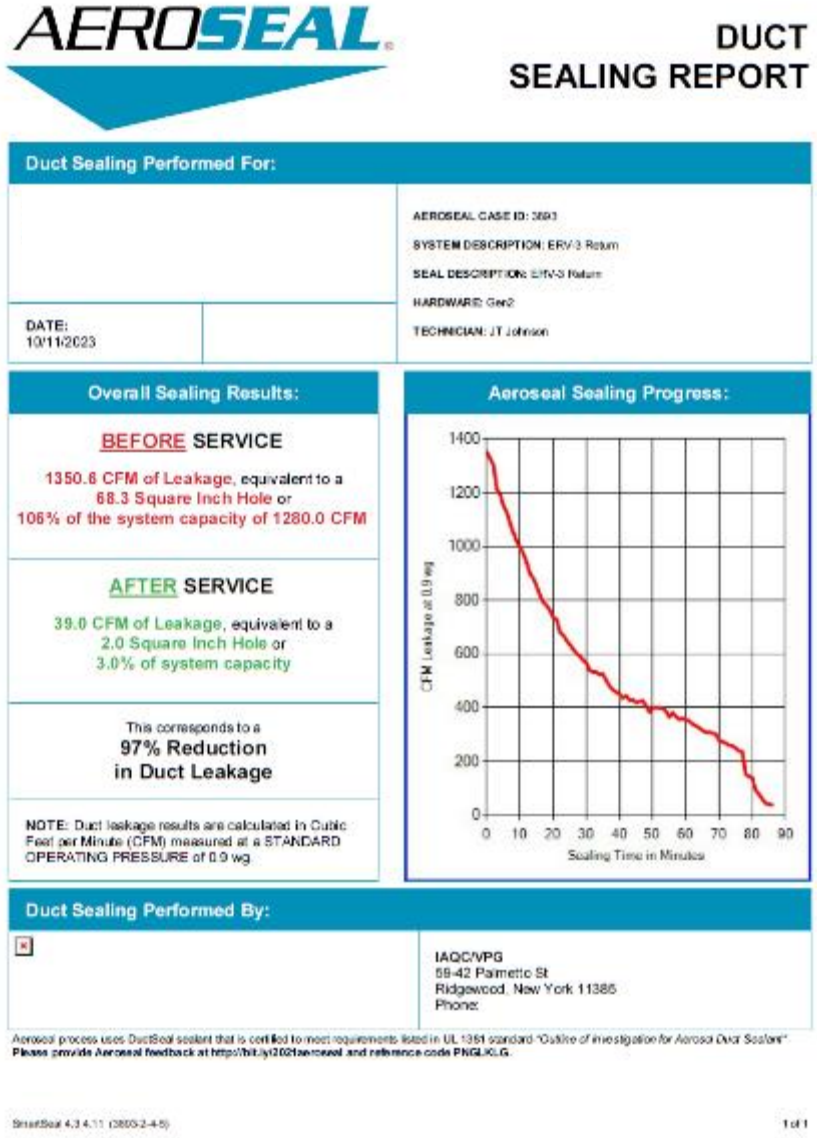
Percent of Flow

- 1” WG
  - *10%: 84 CFM*
  - *5%: 42 CFM*
  - *3%: 26 CFM*
- 1.5” WG
  - *10%: 84 CFM*
  - *5%: 42 CFM*
  - *3%: 26 CFM*

High Performance Building Results

- System Design: 1,280 CFM @ 1”wg
- 51 vents @ 25 CFM per vent
- Test-in Leakage: 1,350 CFM - *108%* of design
- Test-out Leakage: 39 CFM – 3% of design

97% Reduction in leakage – in under 2 hours!



AEROSEAL

DUCT SEALING REPORT

Duct Sealing Performed For:

AEROSEAL CASE ID: 3693
SYSTEM DESCRIPTION: ERV-3 Return
SEAL DESCRIPTION: ERV-3 Return
HARDWARE: Gen2
TECHNICIAN: JT Johnson

DATE: 10/11/2023

Overall Sealing Results:

BEFORE SERVICE

1350.6 CFM of Leakage, equivalent to a 68.3 Square Inch Hole or 106% of the system capacity of 1280.0 CFM

AFTER SERVICE

39.0 CFM of Leakage, equivalent to a 2.0 Square Inch Hole or 3.0% of system capacity

This corresponds to a **97% Reduction in Duct Leakage**

NOTE: Duct leakage results are calculated in Cubic Feet per Minute (CFM) measured at a STANDARD OPERATING PRESSURE of 0.9 wg

Aeroseal Sealing Progress:

Duct Sealing Performed By:

IAQC/VPG
59-42 Palmetto St
Ridgewood, New York 11385
Phone:

Aeroseal process uses DuctSeal sealant that is certified to meet requirements listed in UL 1851 standard "Outline of Investigation for Aerosol Duct Sealant"
Please provide Aeroseal feedback at https://bit.ly/2021aeroseal and reference code PNGLXLG.

SmartSeal 4.3.4.11 (3693-2-4-5)

1 of 1

Cambridge Housing Authority

PROJECT OVERVIEW

Cambridge Housing Authority
LEED Construction

LOCATION
Cambridge, Massachusetts

SERVICE TECHNICIAN
P.J. Dionne

AEROSEAL CONTRACTORS
Aspen Air Duct Cleaning

GOAL
Meet required duct leakage rate of 250 CFM or less in order to achieve LEED certification

BEFORE AEROSEAL
Average 900+ CFM* of total leakage

AFTER AEROSEAL
Average 40 CFM of total leakage

RESULTS
Met LEED certification requirements;
Reduced leakage by approximately 95%

*Cubic feet per minute

> *I'm a 100% believer in Aeroseal. I wish we had it specified for the job in the beginning.*
>
> ***Don Stock** - Project Manager*
> P.J. Dionne

Museum House Condominiums

PROJECT OVERVIEW

MuseumHouse Luxury Condominiums

BUILDING
19-story, 27-unit luxury condominium

LOCATION
Toronto, Ontario, Canada

AEROSEAL CONTRACTORS
J.W. Danforth

CONTRACT ENGINEER
Yorkville Construction

GOAL
Meet air handling unit (AHU) specifications for allowable duct leakage

BEFORE AEROSEAL
Up to 300+ CFM* of leakage

AFTER AEROSEAL
6.5 CFM of leakage (average)

RESULTS
Sealed ductwork to 90% average leakage reduction; Achieved compliance with duct sealing codes and improved HVAC performance of property

*Cubic feet per minute

> *Aeroseal was the only viable option there was. Our only other alternative was to tear down the walls inside each apartment and seal the individual duct systems manually (by hand with mastic/tape). From a purely monetary standpoint, this approach saved us hundreds of thousands of dollars in renovation costs. Aeroseal works – and works very well, reducing average leakage from about 300 CFM down to around 6 CFM.*
>
> ***David Hart** - Project Manager*
> Yorkville Construction

Multifamily Housing Retrofit Examples

Units	**138 Income-eligible**
Cost	**$370,000**
Annual Savings	**83,000 kWh elec 24,500 therms NG**
Annual Cost Savings	**$58,600**

Units	**1,440 (3 market rate bldgs. & 1 income-eligible)**
Cost	**$2.7 million**
Annual Savings	**5 million kWh elec**
Annual Cost Savings	**$1 million**

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THANK YOU!