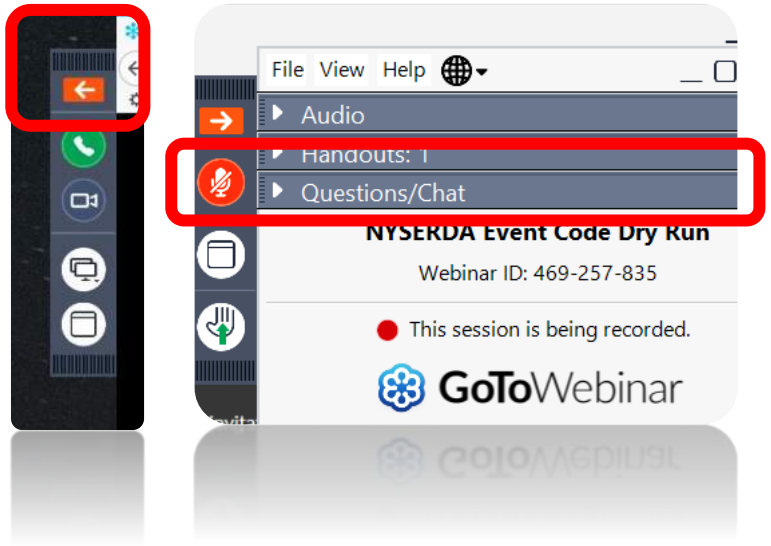
Webinar Overview

All attendees have been placed on mute.

Use the Question Section on the webinar control panel to ask a question at anytime during the presentation.

Q&A will take place at the end of each segment.

Webinar will be recorded and sent.



Submit Responses via PollEverywhere

- Respond at PollEV.com/swa335
- Or text swa335 at 22333 to join, then send your answer

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Take energy efficiency to a new level

Residential New Construction Passive House Multi-family buildings with five units or more

PASSIVE HOUSE INCENTIVE STRUCTURE FOR MULTI-FAMILY (5 UNITS OR MORE)				
Incentive Timing	Activity	Incentive Amount	Max Incentive (Per Unit)	Max Incentive (Per Project)
Pre-Construction	Feasibility Study[1]	Up to 100% of Feasibility Study Costs	N/A	$5,000.00
	Energy Modeling[2]	75% of Energy Modeling Costs (Before 90% Design Drawings)	$500.00	$30,000.00
		50% of Energy Modeling Costs (90% Design/50% Construction)	$250.00	$15,000.00
Post Construction	Certification[3]	Up to 100% of Certification Costs	$1,500.00	$60,000.00

1. Feasibility Study will require documentation in the form of a Feasibility Study report and invoice from the Passive House Consultant
2. Incentives will only be awarded prior to 50% Construction Drawings for Passive House projects. No incentives will be granted after 50% Construction Drawing set.
3. Certification may be either through PHIUS, PHI, or EnerPHit certification offerings.

Next steps you can take...
Contact your Energy Efficiency Representative or

Go to EnergizeCT.com or call 1-877-WISE USE for more details.

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Workshop 3
High Performance Ventilation

Steven Winter Associates, Inc.

Since 1972, Steven Winter Associates, Inc. has been providing research, consulting, and advisory services to improve the built environment for private and public sector clients.

Our services include:

- Energy Conservation and Management
- Decarbonization
- Sustainability Consulting
- Green Building Certification
- Accessibility Consulting

Our teams are based across four office locations:
New York, NY | Washington, DC | Norwalk, CT | Boston, MA

For more information, visit
www.swinter.com

Learning Objectives

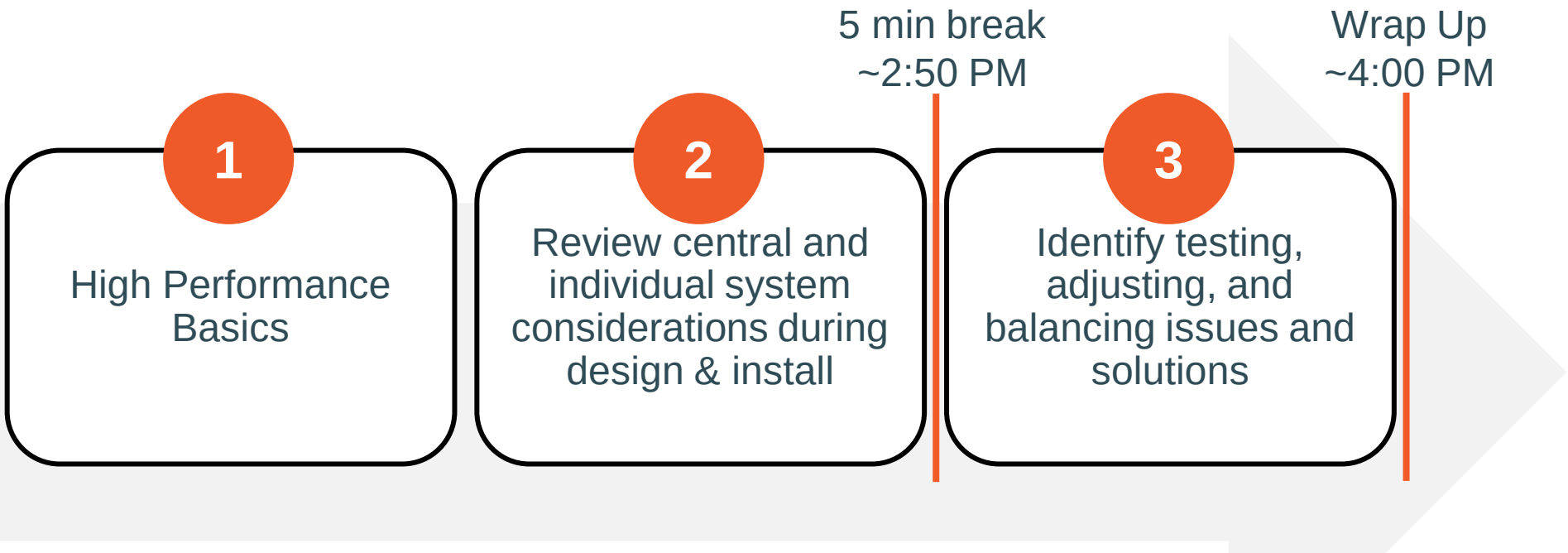
Understand the principles of ventilation and air movement

Identify various types of heat recovery ventilation equipment

Describe occupant and building issues resulting from improper ventilation

Develop a successful ventilation system layout plan

Overview of Presentation



What is your profession?

A. Architect

B. Engineer

C. Contractor/CM

D. Owner/Developer

E. Consultant

F. Other

What is the one thing that you were hoping to learn about today? (hint: link words with an underscore)

Why are We Here

- Push for Building Electrification (Passive House as a pathway)
- Incentives available
- Benefits
  - Drastically lower energy use and operational cost savings
  - Healthy air quality from ventilation systems
  - Consistent and comfortable room temperatures without air drafts
  - Increased natural lighting and quieter acoustic conditions
  - A more resilient and comfortable building

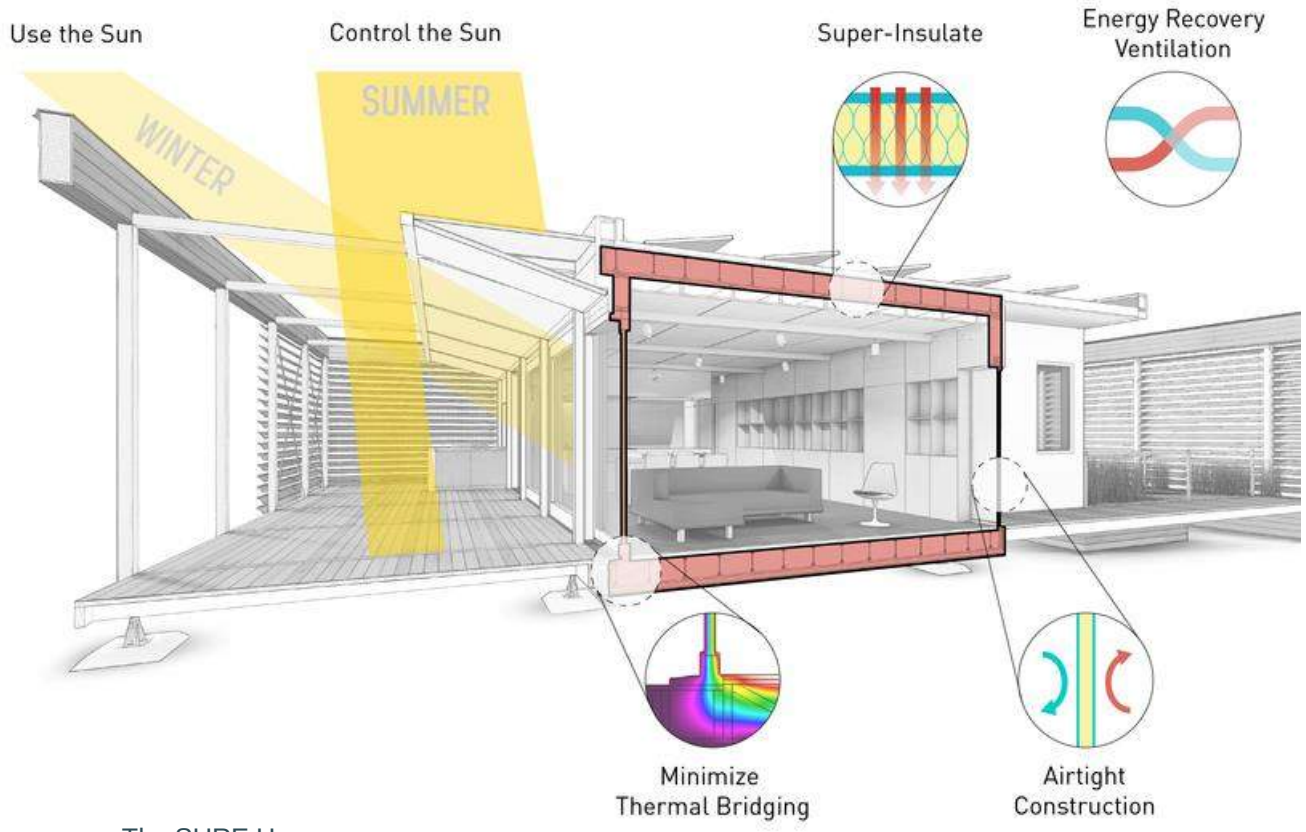
These **Trainings - Each has two parts**

- **Workshop 1:** Continuous Insulation
- **Workshop 2:** Air Sealing and Insulation for Homes
- **Workshop 3:** **High Performance Ventilation Systems for Homes**

High Performance Basics

Goals of High Performance Buildings

- Building durability
- Energy $ reduction
- Optimal thermal comfort
- Superior indoor air quality
- Carbon emissions reductions



The SURE House

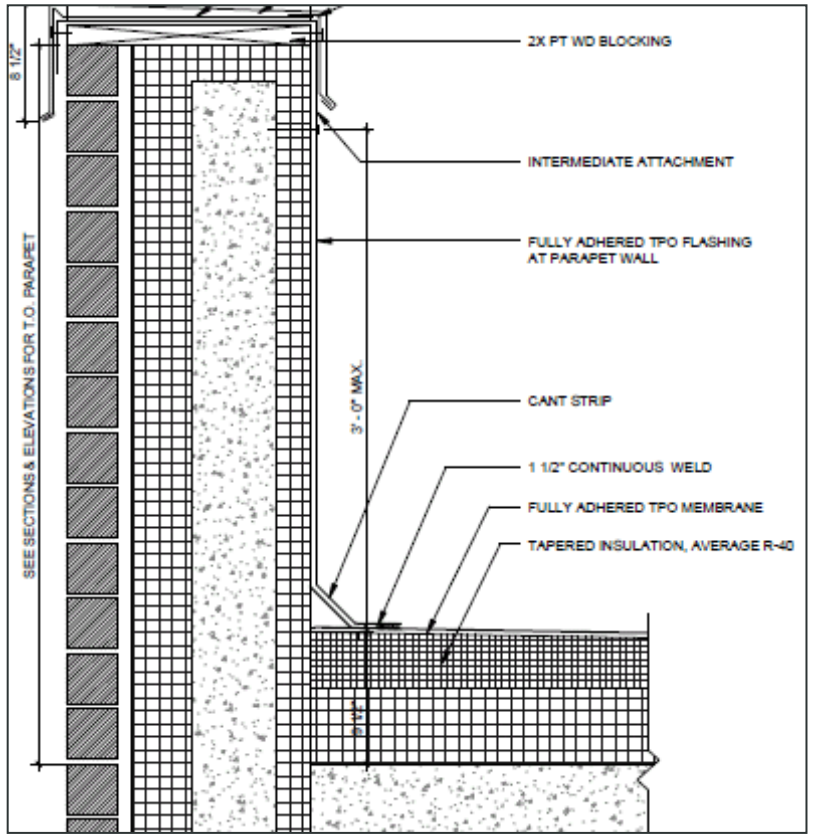
Winner of the 2015 D.O.E. Solar Decathlon

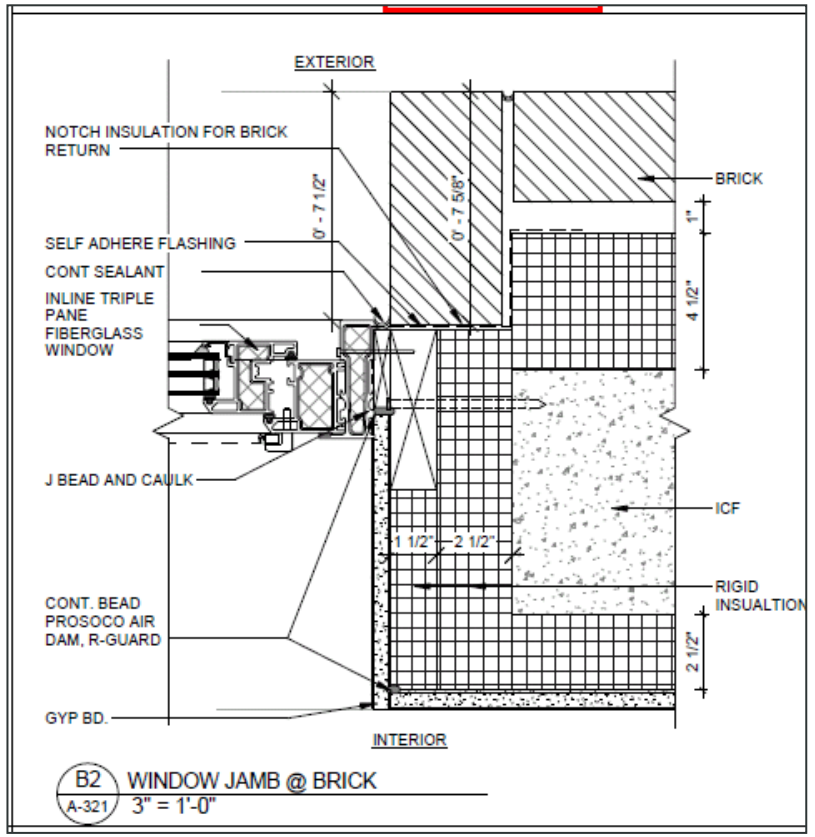
www.surehouse.org

Passive House as a Pathway to High Performance

- Thermal insulation continuity
- Thermal bridge free construction
- Solar control
- Airtightness
- Balanced mechanical ventilation

Continuous Insulation

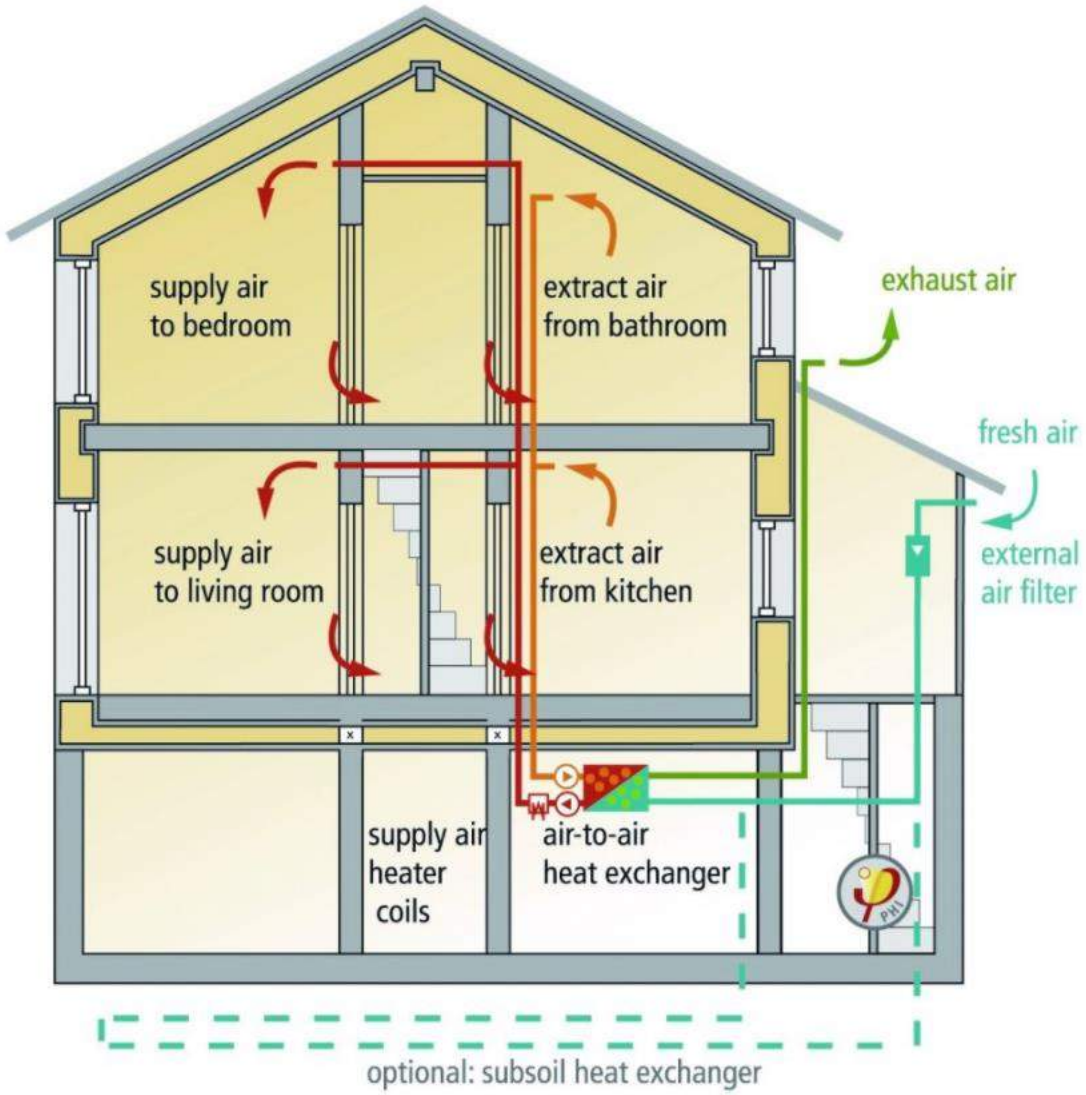




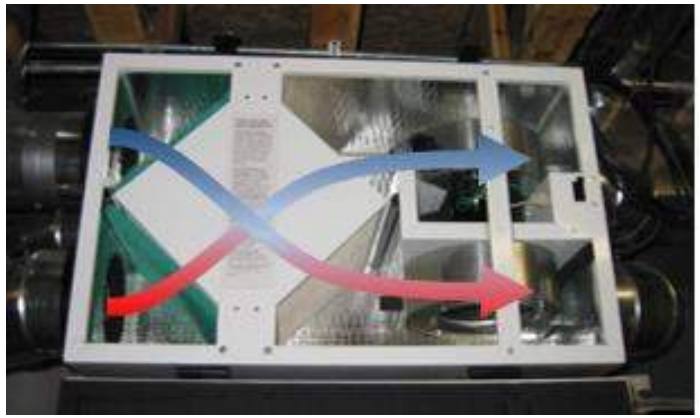
Air-Tightness Blower Door Testing

- Basic Components
  - Gauge (manometer)
  - Shroud
  - Frame
  - Fan

Balanced Ventilation and Heat/Energy Recovery



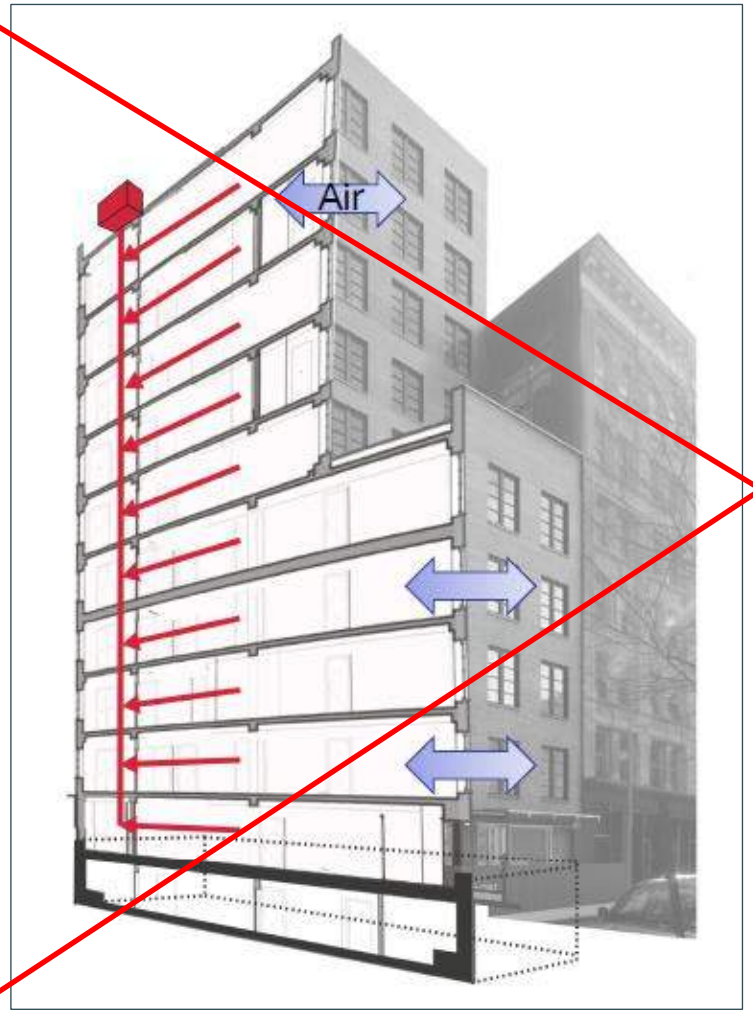
- Provide fresh, filtered air 24 hours a day
- Heat exchanger +75% Efficient
- Highly insulated and air-sealed ductwork



Questions?

System Design Layout and Considerations

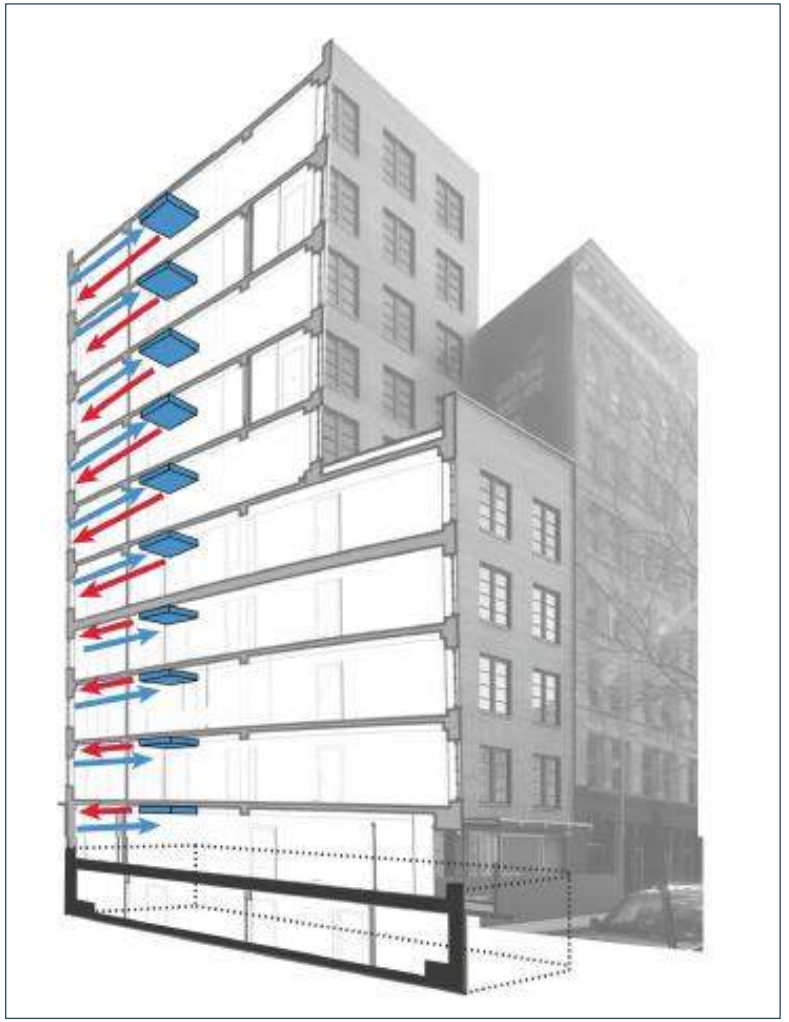
Exhaust Only



Credit: ZH Architects

Balanced Ventilation

Central System



Individual systems

Credit: ZH Architects

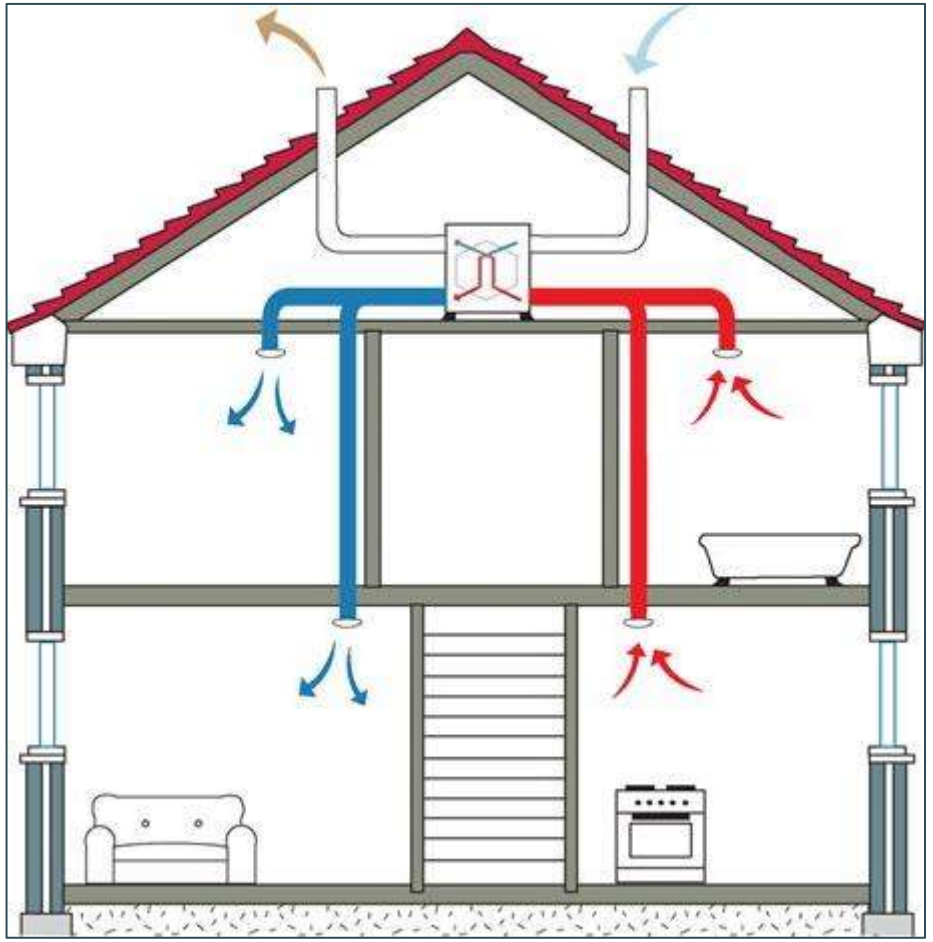
SWA Party Wall Blog Post:
https://www.swinter.com/party-walls/multifamily-passive-house-ventilationdesign-part-1-unitized-or-centralized-hrv-erv/

Balanced Ventilation – Reminders (PH)

1. Balanced supply and exhaust within 10%
2. Supply to all living spaces
3. Exhaust from kitchens and bathrooms
4. Energy recovery > 75%
5. Supply > 62°F on winter design day

Passive House Recommendations

1. PH certified unit NOT REQUIRED, but most likely needed
2. Fan power efficiency: < 1.0 W/CFM total
3. Allow for a buffer in the energy model for additional fan energy due to duct leakage



Recommendations – for Project Success Design

- Size the ERV such that the standard operating flow rate is approximately 50% of the maximum flow of the unit to optimize efficiency.
  - Allows for additional fan capacity to overcome system leakage.
- Account for buffer in the energy model for system leakage (~10%)
  - Not accounting for leakage could cause failure to meet space conditioning and/or source energy thresholds
- Understand the energy penalty of additional system leakage on the energy model
  - As CFM flow increases, fan energy in W/cfm increases
- Combining ventilation ductwork and heating/cooling system ductwork is very difficult/impossible to construct, verify, and TAB. Avoid.

Individual Systems

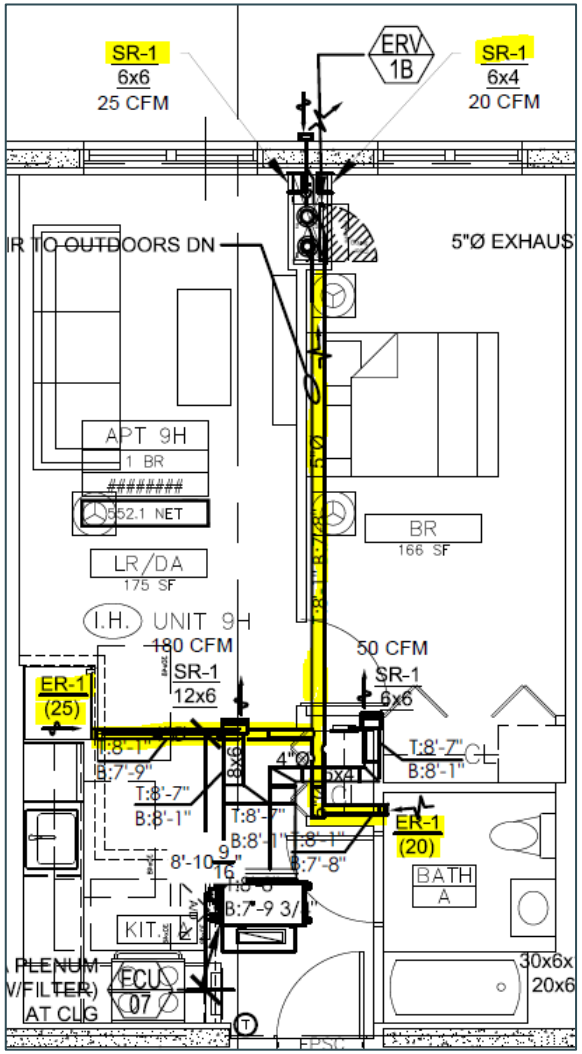
- Single ERV for the home or apartment
- Exhaust from kitchens and baths
- Supplies to living rooms and bedrooms
- Supply and exhaust rates to be balanced
- Larger homes will need more duct runs (e.g. ComfoTube)

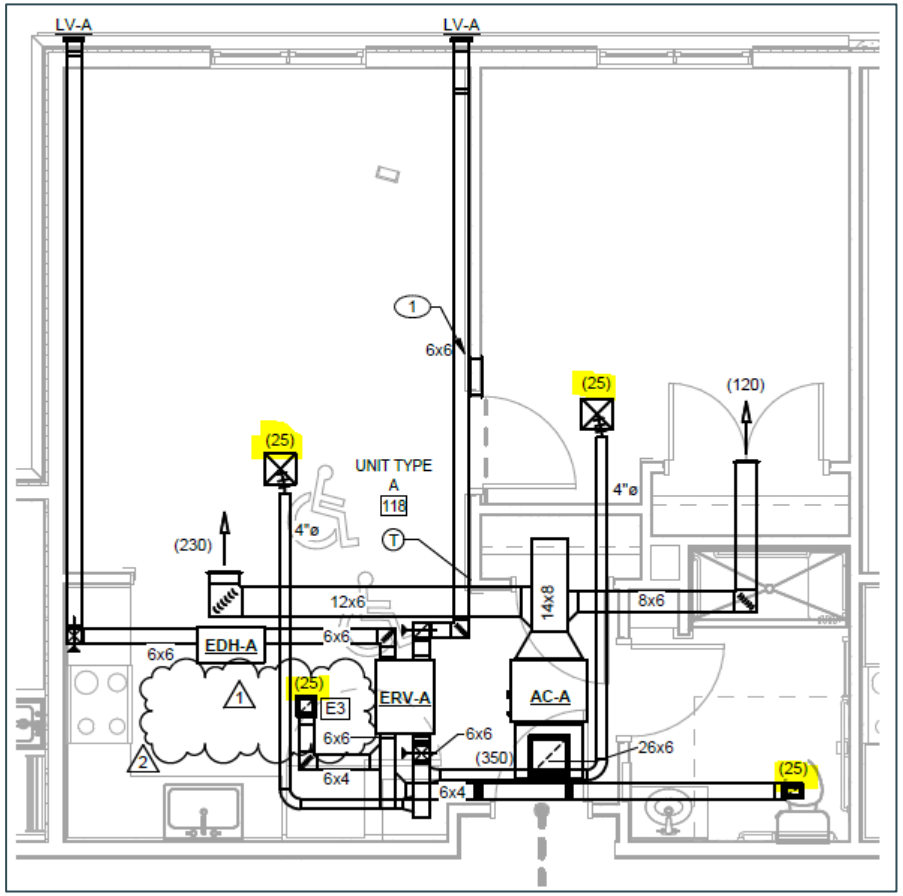
Individual Systems – Considerations

- ERV placement (ceiling or wall mounted)
- Access to unit
- Ducting layouts & ceiling conflicts
- Adequate space to allow for duct sealing
- Sealing of exterior ERV ports
- Room pressure balancing
- Exterior grille cleaning
- Blower door testing, prep

Individual Systems – ERV Placement

- Wall mounted (closet) vs. ceiling mounted
- Floor space consideration for a cabinet vs ceiling space with potential conflicts





Individual Systems – ERV Closets

Individual Systems – Ceiling Mounted

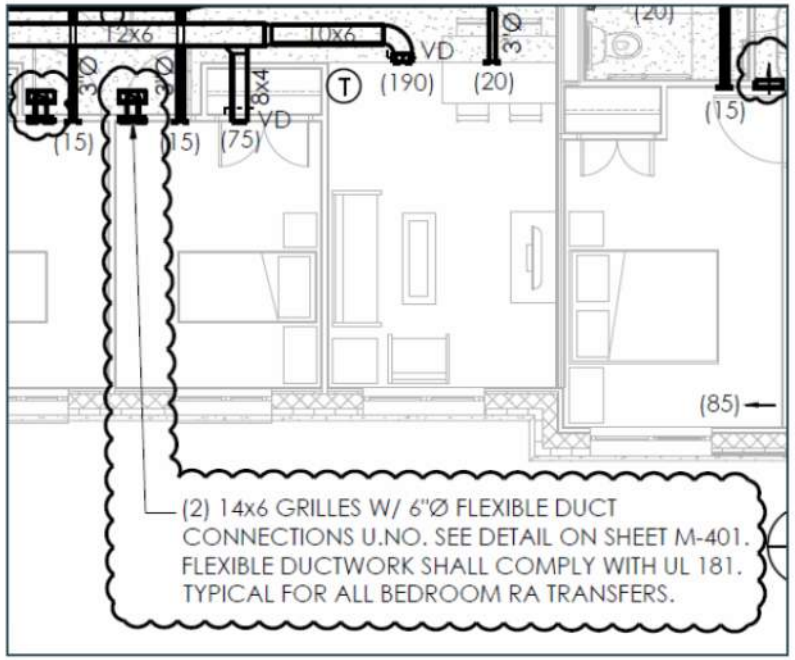
Individual Systems – Ducting Layouts / Conflicts

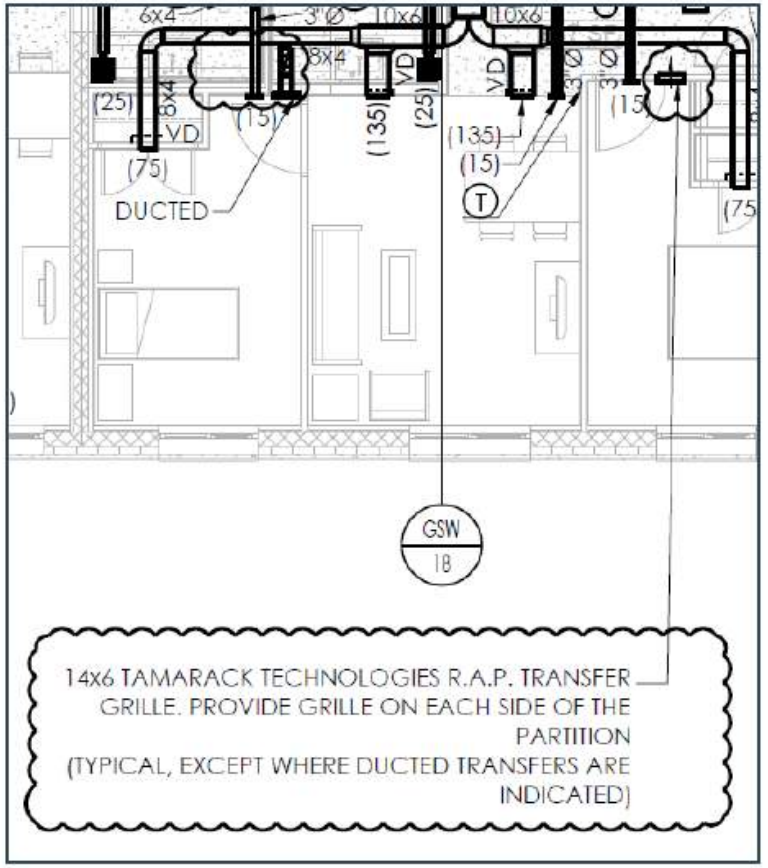
Individual Systems – Space for Duct Sealing

- Mastic visible on the ceiling is never a good sign!
- Round duct, face the seams down so they can be sealed rather than pinning to the ceiling

Individual Systems – Room Pressure Balancing

- Transfer grilles / jump ducts for bedroom pressure balancing
- Required final testing by Verifier for PHIUS requirements
- Would also apply for central systems





Individual Systems – Potential Issues

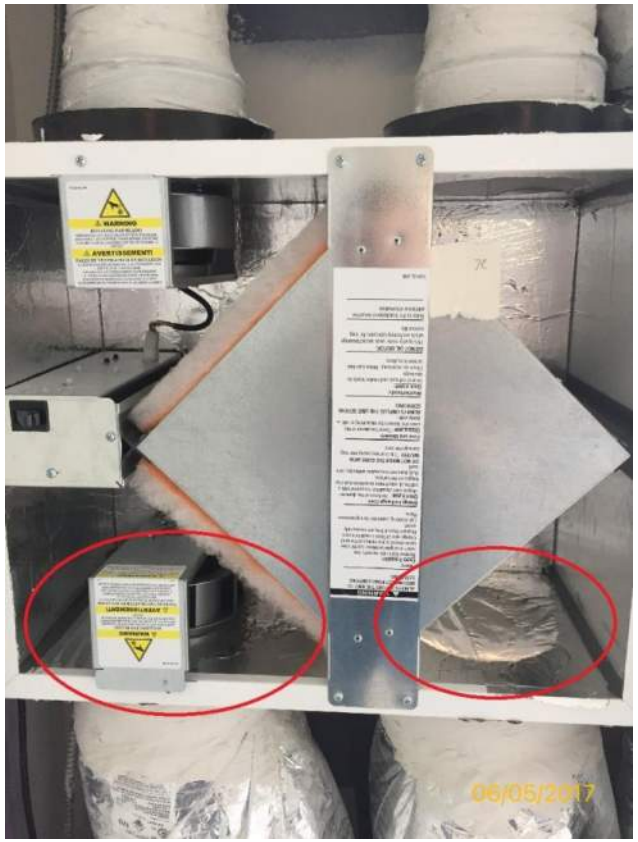
- Cramped ERV closets
- Difficulty in properly air sealing and insulating exterior wall connections
- 2x wall penetrations, per apartment
- Future maintenance and access to apartments for filter changes

Individual Systems – Potential Issues

- Future maintenance (filter changes, exterior intake port cleaning)

Individual Systems – Blower Door Testing Prep

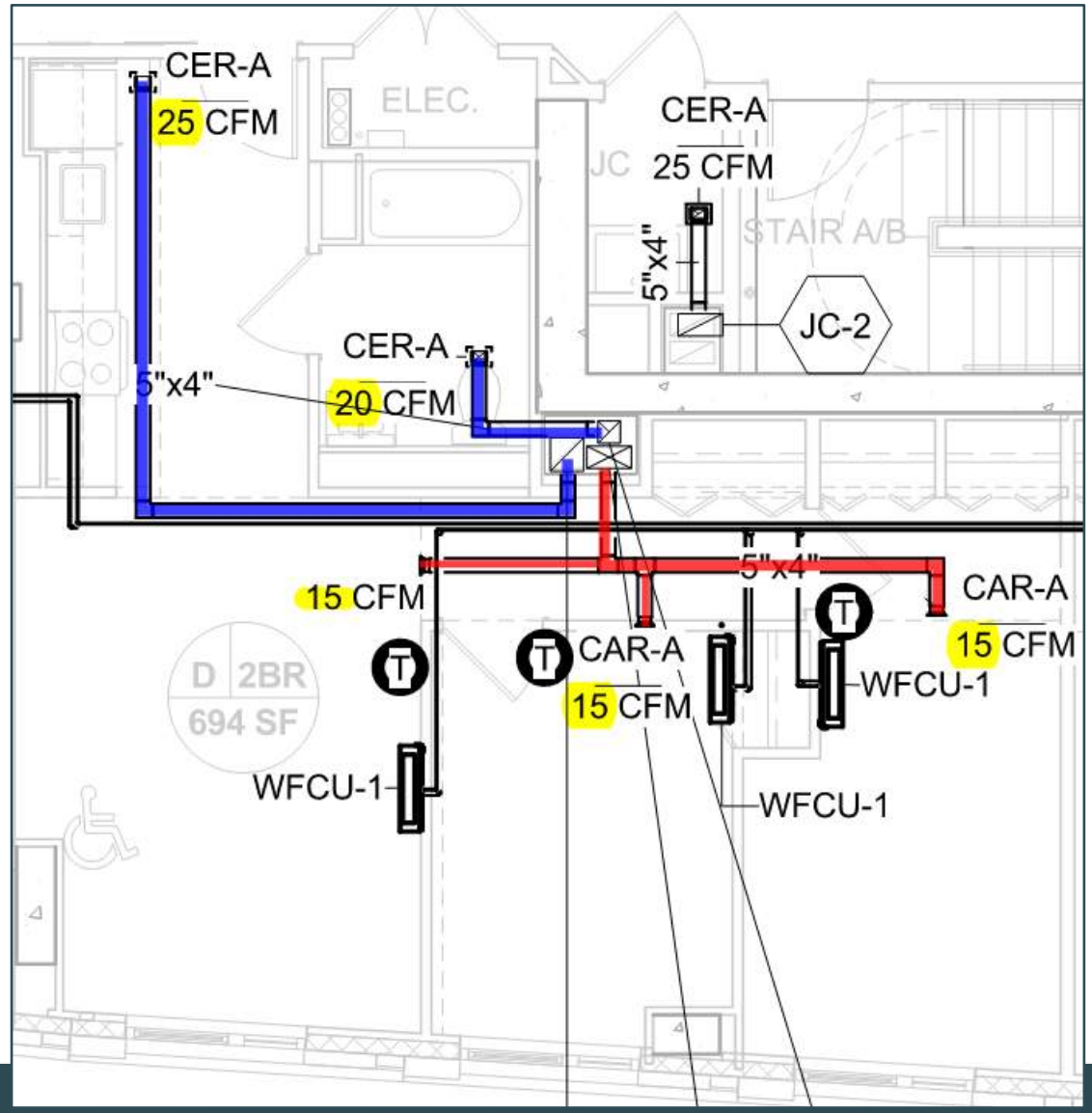
- Need to block of all intake and exhaust ports prior to the whole building blower door test



Central Systems

- Central ventilation rather than individual units allows for easier access and maintenance.
- High efficiency PH certified units typically selected and installed
- Demand control ventilation (DCV) can be implemented to reduce rates when common areas are unoccupied (e.g. gym, community room)
- DX coil can be added to ERV supply to help with pre-conditioning and dehumidification

Central Systems – Sample Layout

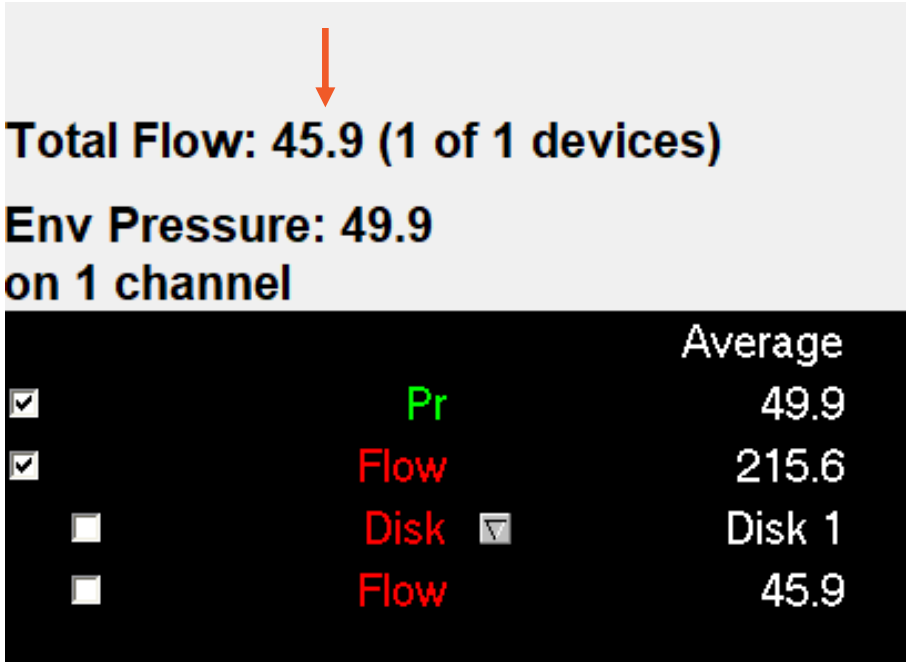


Individual Systems – Duct Sealing

- Duct sealing to be visually inspected before being wrapped with any insulation
- Beyond visual, projects are *required** to utilize Aeroseal duct sealing technology

Duct Sealing – Ventilation Riser (No Sealing)

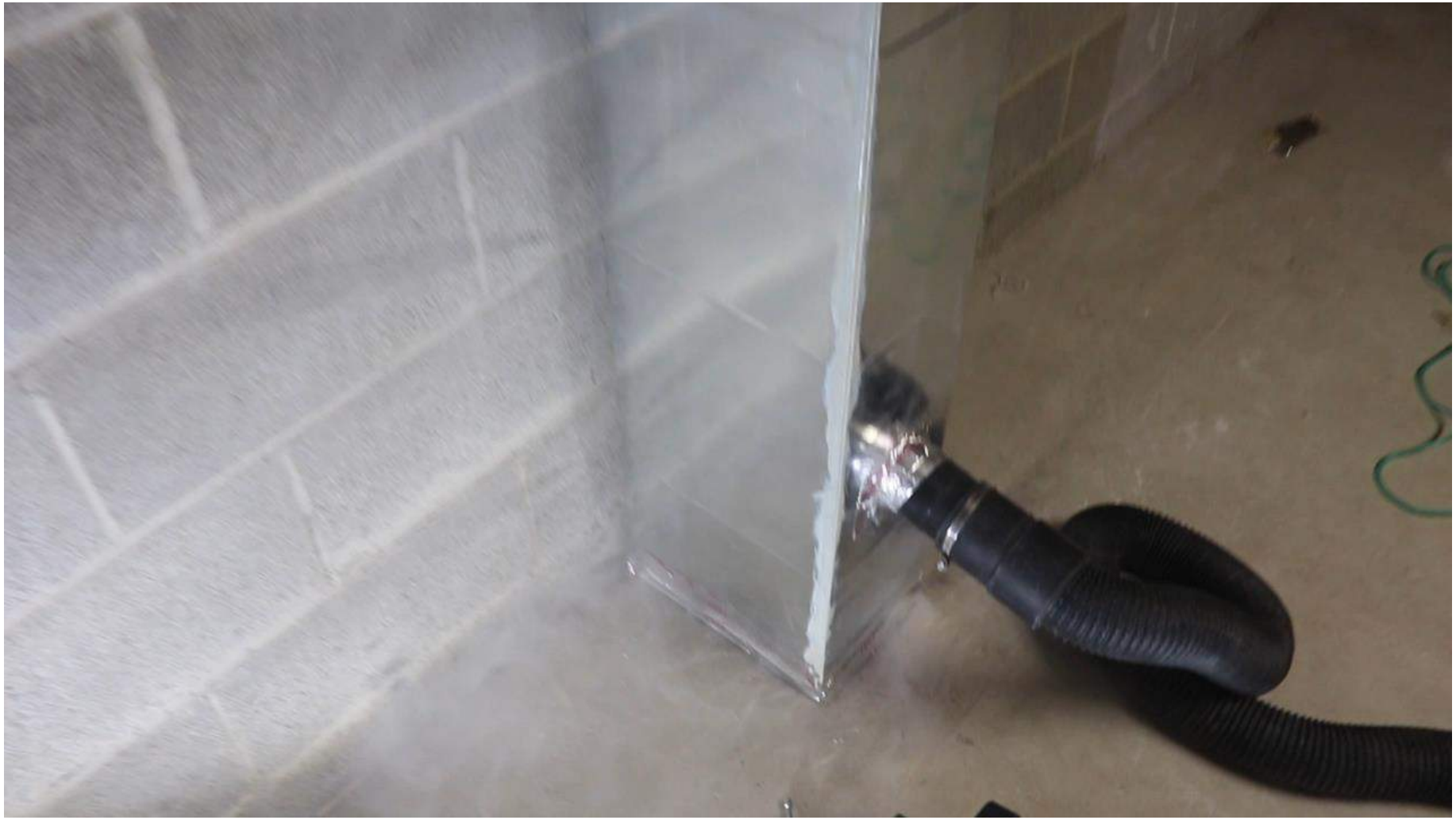
Duct Sealing – Ventilation Riser (No Sealing)



Duct Sealing – Manual Sealing

Duct Sealing – Manual Sealing (Testing After)

Duct Sealing – Testing After Closer View



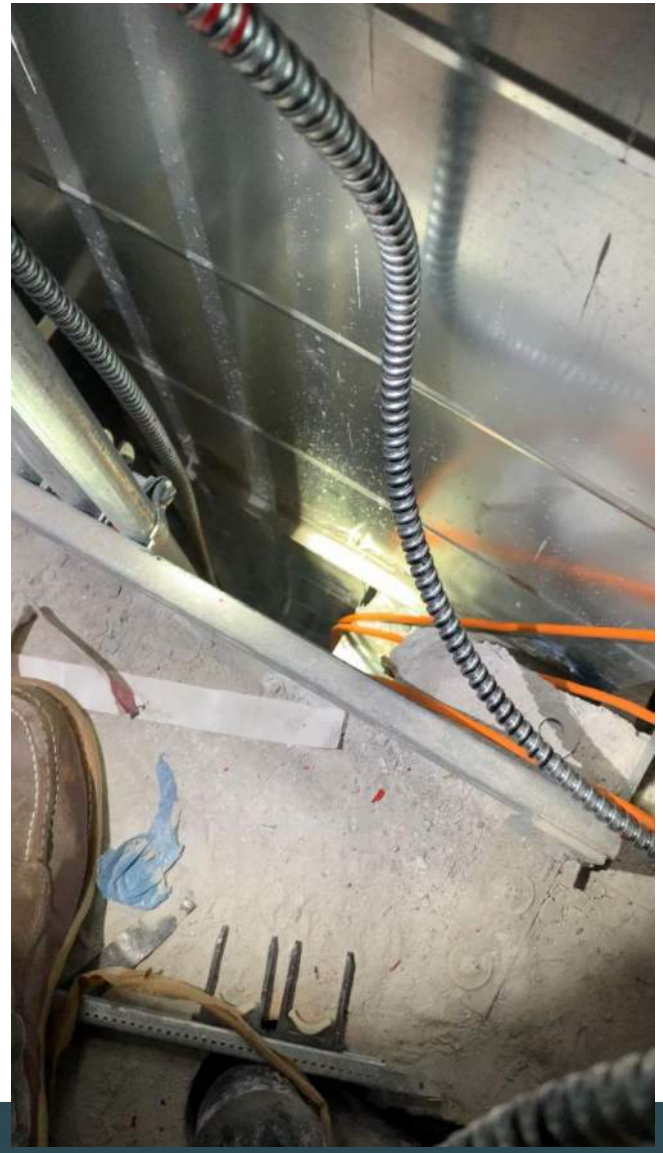
Duct Sealing – Seams Sealed minus Back Seam

Total Flow: 23.5 (1 of 1 devices)

Env Pressure: 50.0
on 1 channel

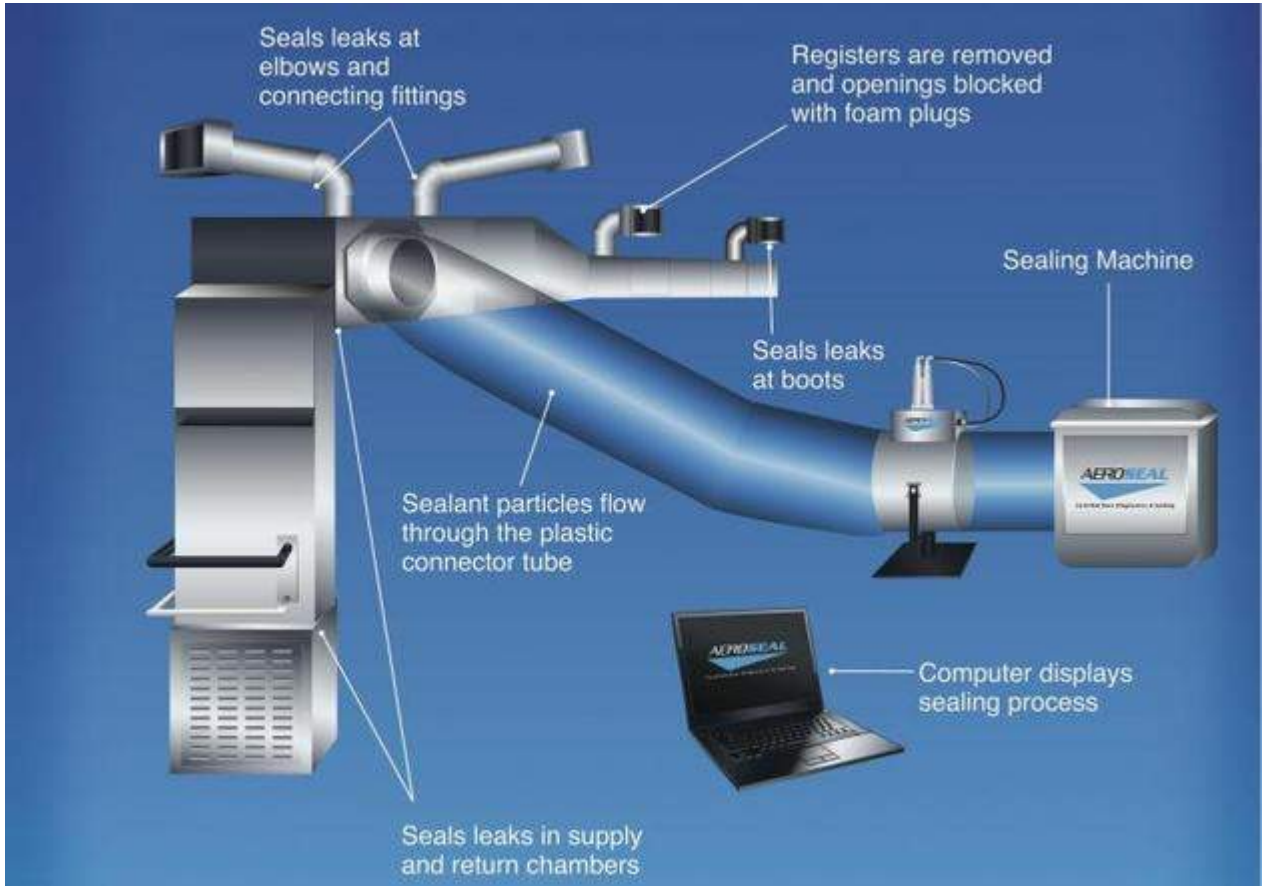
		Average
☑	Pr	50.0
☑	Flow	54.4
☐	Disk ▽	Disk 1
☐	Flow	23.5

Duct Sealing – Fog Testing on Site

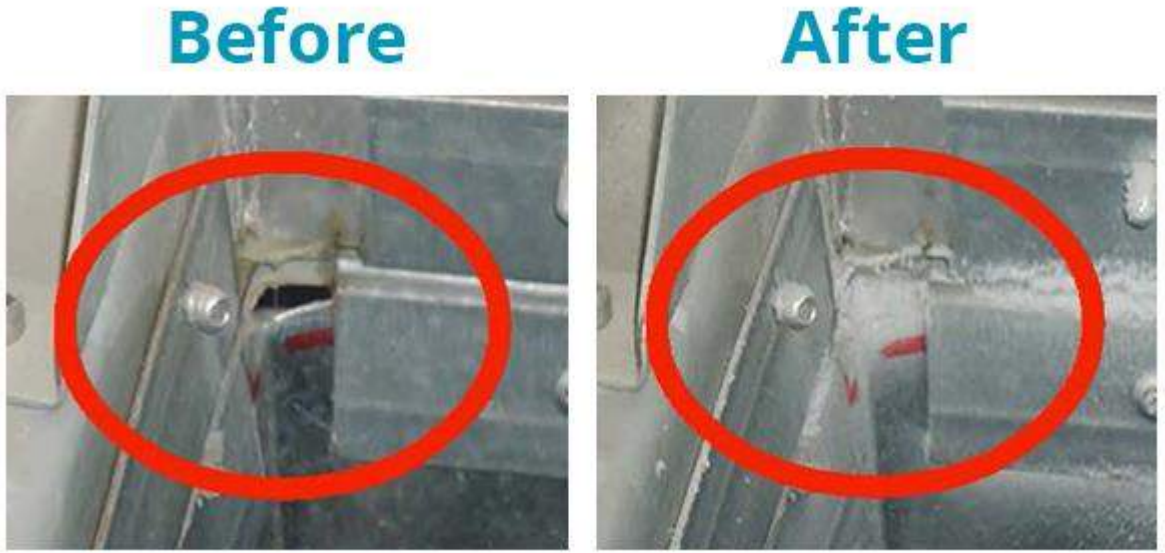


Aeroseal Duct Sealing

- “Duct sealing from the inside”
- Developed by LBNL in 1994
- Pressurized aerosolized particles forced through the duct systems and build up at leak locations
- No need to manually locate leakage
- Verification of leakage rate
- Can seal leaks up to ½”

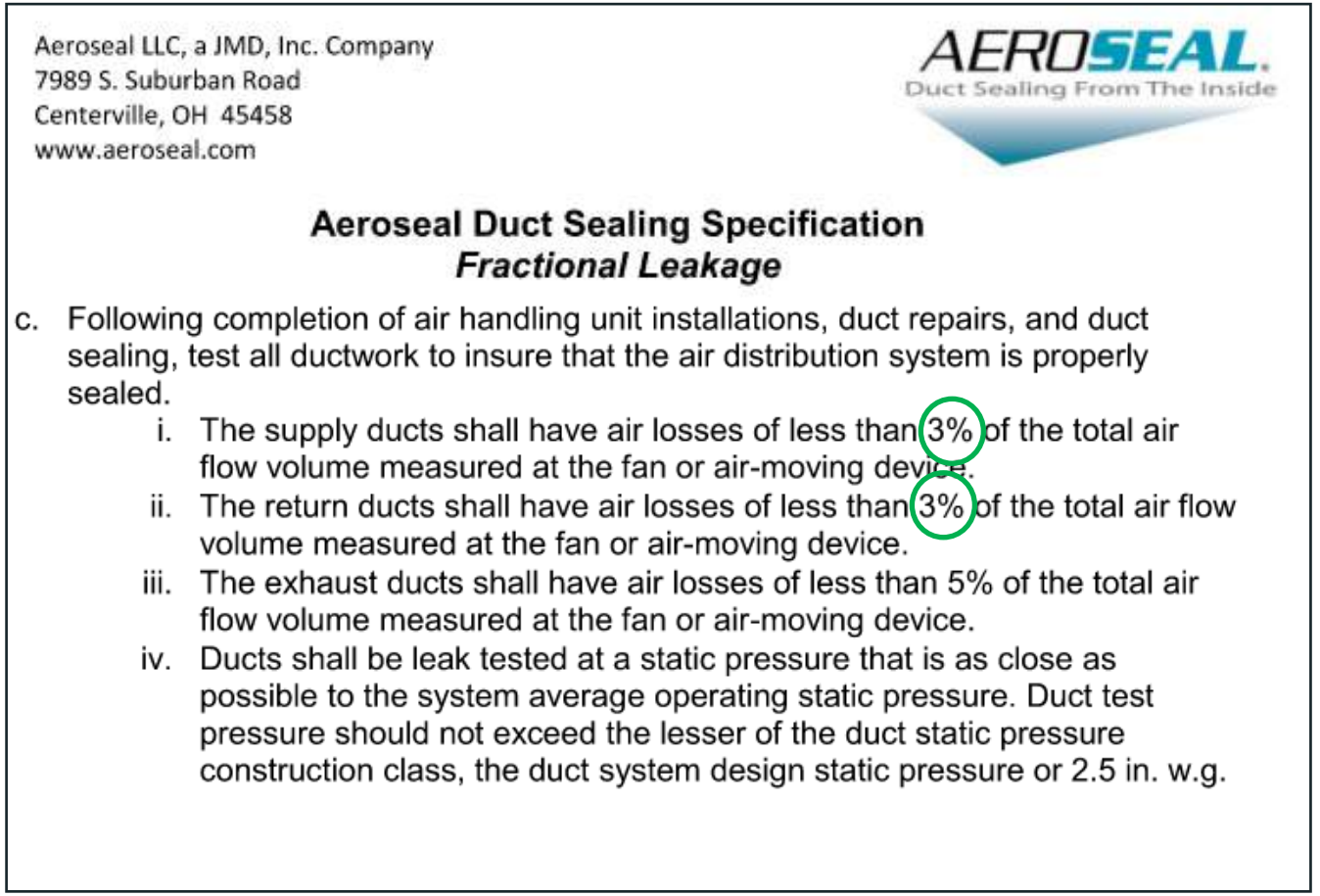


Aeroseal Duct Sealing



Aeroseal Duct Sealing - Specs

- Don’t do it too early!
- Ensure all components of duct system are installed so all areas receive the sealant.
- Ensure allowable leakage targets are known by the installer.



Aeroseal LLC, a JMD, Inc. Company
7989 S. Suburban Road
Centerville, OH 45458
www.aeroseal.com

AEROSEAL
Duct Sealing From The Inside

Aeroseal Duct Sealing Specification
Fractional Leakage

c. Following completion of air handling unit installations, duct repairs, and duct sealing, test all ductwork to insure that the air distribution system is properly sealed.
   i. The supply ducts shall have air losses of less than 3% of the total air flow volume measured at the fan or air-moving device.
   ii. The return ducts shall have air losses of less than 3% of the total air flow volume measured at the fan or air-moving device.
   iii. The exhaust ducts shall have air losses of less than 5% of the total air flow volume measured at the fan or air-moving device.
   iv. Ducts shall be leak tested at a static pressure that is as close as possible to the system average operating static pressure. Duct test pressure should not exceed the lesser of the duct static pressure construction class, the duct system design static pressure or 2.5 in. w.g.

Other System Components

- Sound level – ventilation system must not be noisy.
  - ≤ 25 db(A): supply air to rooms
  - ≤ 30 db(A): rooms in non-residential buildings and exhaust air rooms in residential buildings
- High quality F7 filters (MERV 13-14) to filter incoming air pollutants.
- Duct insulation for intake and exhaust ducts with vapor tight seal. R-8.
- Ductwork behind registers needs to be thoroughly sealed.
- A means of balancing air flows is critical. One strategy is to use Constant Airflow Regulators (CARs).

Intake and exhaust duct insulation

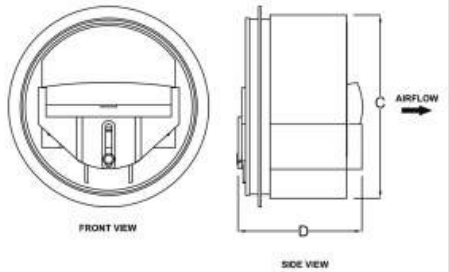
Well sealed ductwork to drywall: If ductwork is not properly sealed to drywall behind registers, air will dump or pull from ceiling or wall cavities, increasing total fan power required to achieve proper balancing.

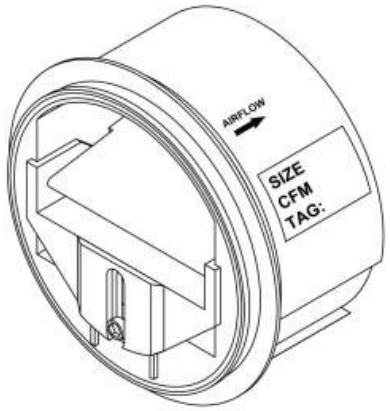
Constant Airflow Regulator (CAR)

SUBMITTAL DATA
eFlow-Constant Airflow Regulator (CAR)

Application and Design

eFlow-CAR is factory set Constant Airflow Regulator designed to save significant amount of energy and money by precisely controlling airflow into or out of space, regardless of static pressure, and all along providing high Indoor Air Quality (IAQ). eFlow CAR is composed of fire resistant ABS plastic. It contains a self regulating aero-wing and spring piston design to maintain a factory preset air flow. These CAR's are designed to operate in pressure range Low Pressure (.08"-.4"w.c.), Standard Pressure (0.2"-1" w.c) and High Pressure (0.6"-2.4" w.c). They automatically adjust for variable duct pressures caused by building pressure, thermal stack effect, dust build up and other variable factors. This Constant Airflow Regulator creates cost effective answer to balancing air systems for HVAC and ventilation in high rise buildings, without the requirement for on-site balancing, electrical/pneumatic controls or sensors. eFlow-CAR may contribute to meeting USGBC LEED Building and Passive House Certification. eFlow CAR requires no maintenance under normal conditions.





Standard Construction

eFlow-CAR: Classified UL R38307 / UL-2043 for heat release rate and smoke optical density.

Damper (nominal)	C	D
3 (76)	3.0 (76)	2.2 (55)
4 (101.6)	3.8 (96.5)	2.8 (70)
5 (127)	4.8 (121.9)	3.4 (86)
6 (152.4)	5.8 (147.2)	3.6 (91)
8 (203.2)	7.7 (195)	3.6 (91)
10 (254)	9.6 (245)	4.7 (120)

**Size in inches(millimeters)

Low Pressure Range of Operation Static Pressure	
Minimum	.08" w.c.
Maximum	0.4" w.c.

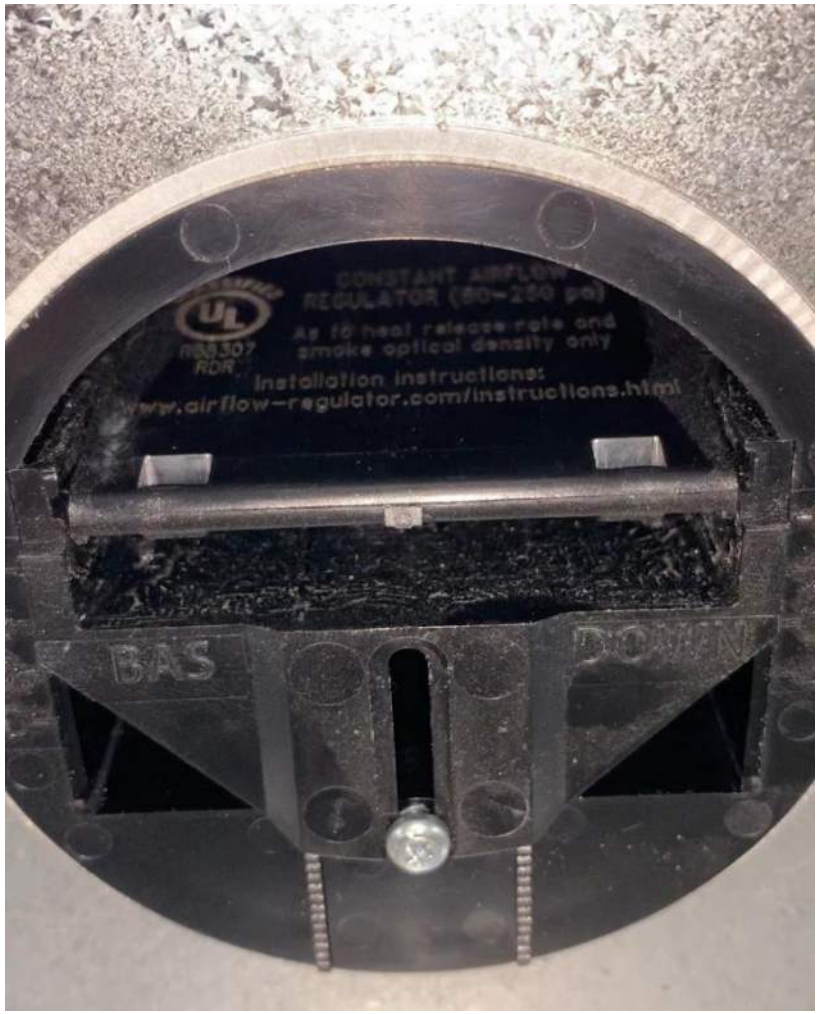
Standard Pressure Range of Operation Static Pressure	
Minimum	0.2" w.c.
Maximum	1.0" w.c.

High Pressure Range of Operation Static Pressure	
Minimum	0.6" w.c.
Maximum	2.4" w.c.

Job Name:	☐ eFlow-Constant Airflow Regulator(CAR) (Supply, Exhaust)
Location:	
Architect:	
Engineer:	
Contractor:	

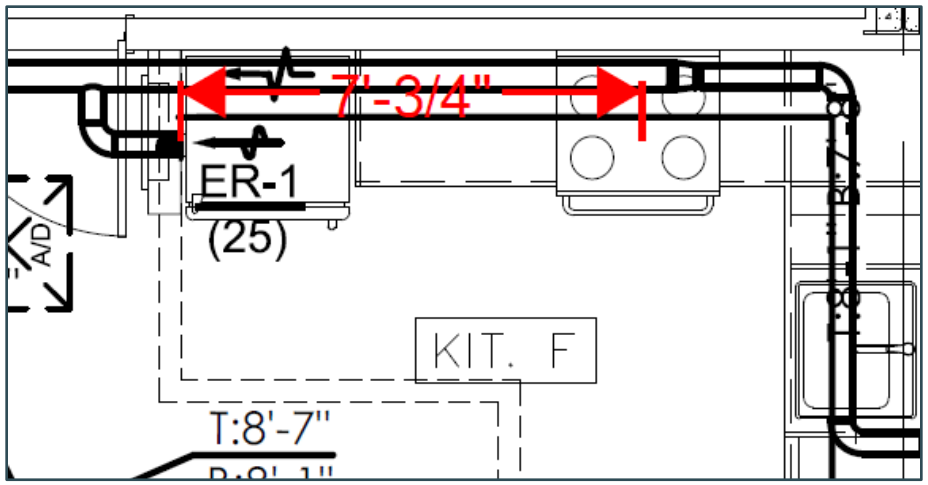
DRAWN BY:	DATE:	REV. DATE:	REV. NO.:	APPROVED BY:	DWG. NO.:
IL	12-08-2018	02-15-2019		EL	

eFlow USA, LLC,184 S. Livingston Avenue, STE 9107, Livingston, NJ 07039, www.eFlowUSA.net, 1-833-FLOW-USA



Ventilation – Kitchen Filtration

- MERV 13 minimum for ERVs
- MERV 3 or washable mesh at kitchen grille locations (PHIUS)
- Kitchen grilles 6’ minimum distance from stoves in plan view (PHIUS)



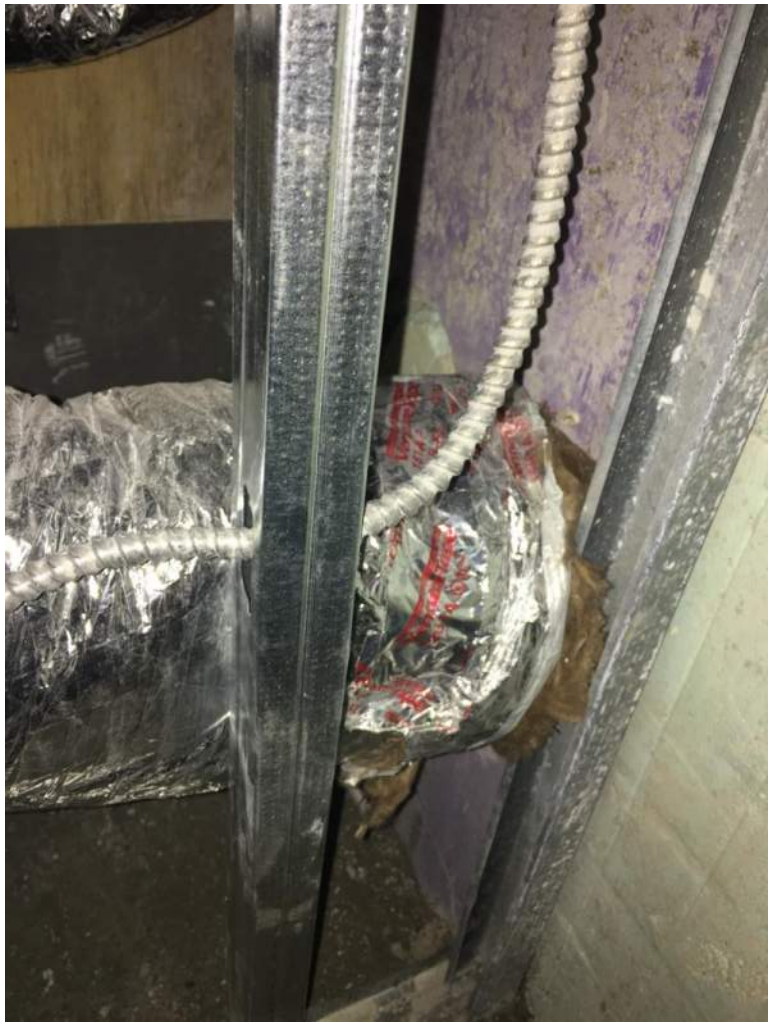
Exterior Exhaust and Intake Placement

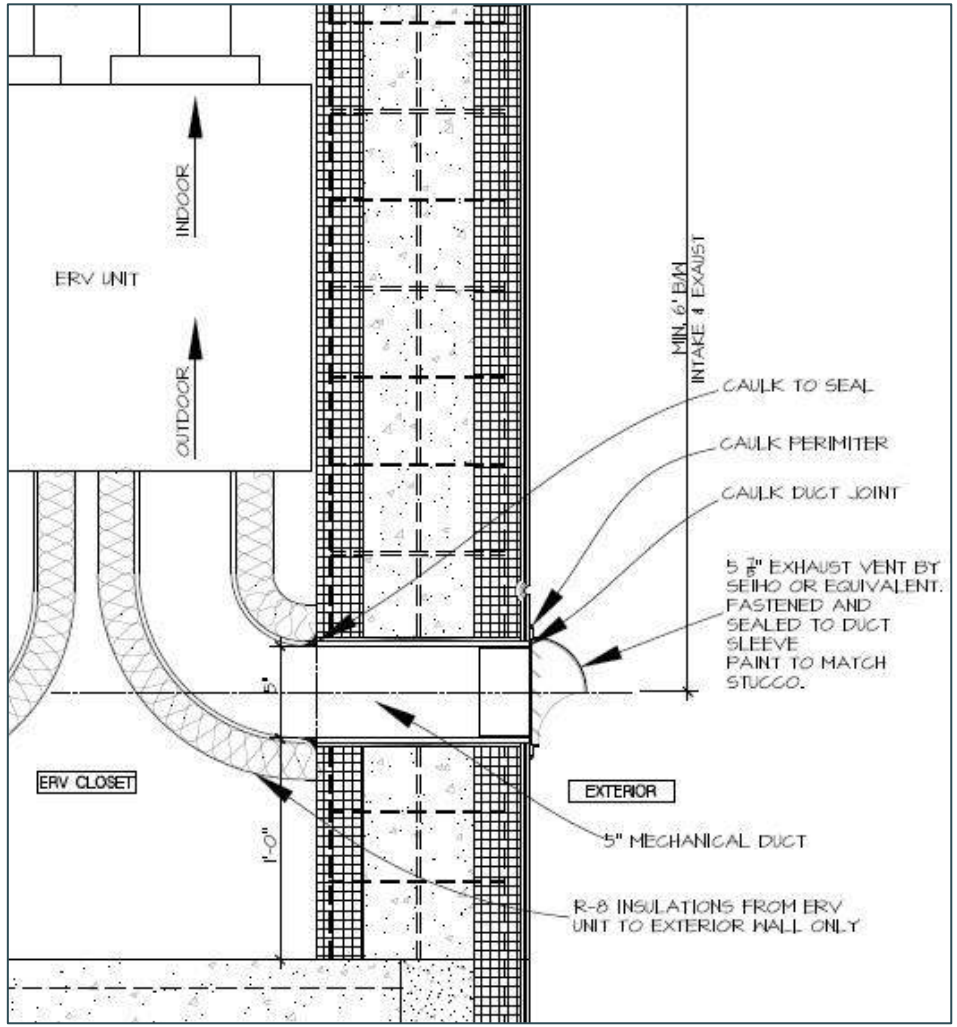
Questions?

5 Minute Break

What's wrong with this photo?

What do you see wrong? Image 1





What item(s) do you see wrong, Image 1? (hint: link words with an underscore)

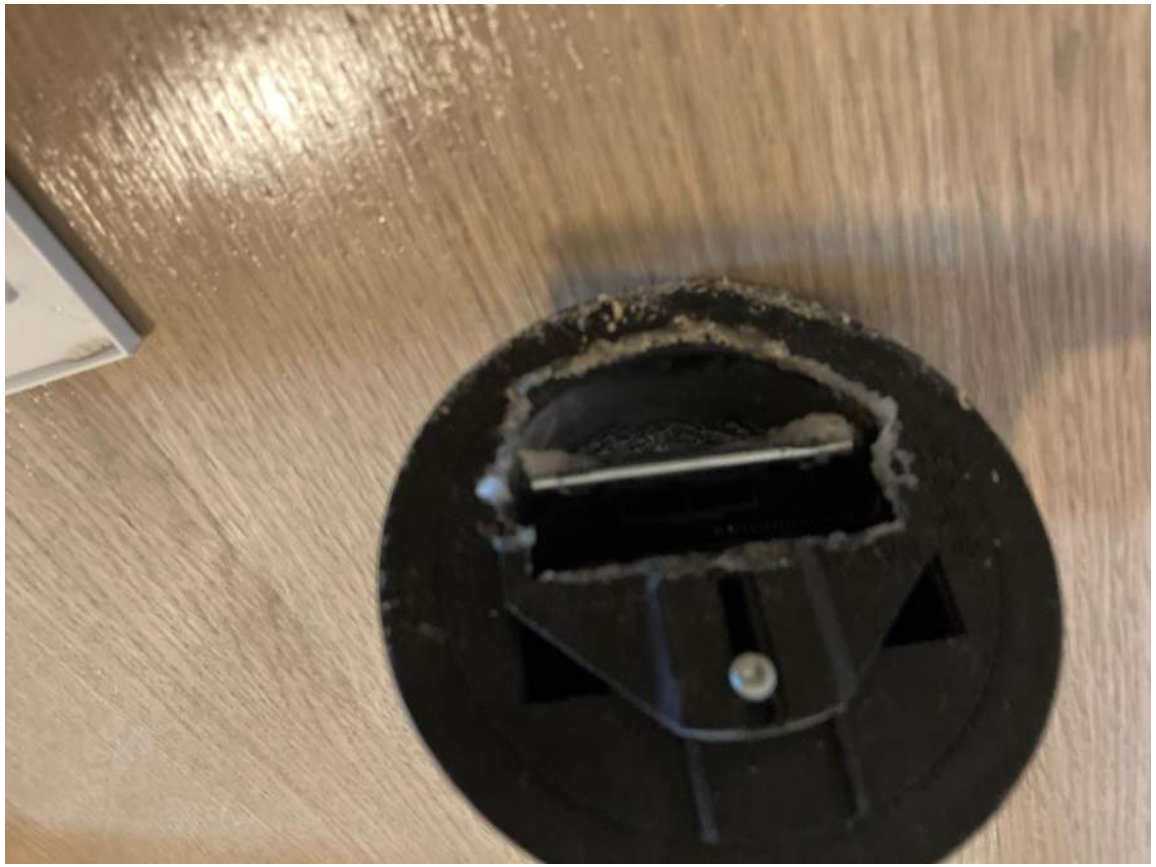
What do you see wrong? Image 2

What item(s) do you see wrong, Image 2? (hint: link words with an underscore)

What do you see wrong? Image 3

What item(s) do you see wrong, Image 3? (hint: link words with an underscore)

What do you see wrong? Image 4

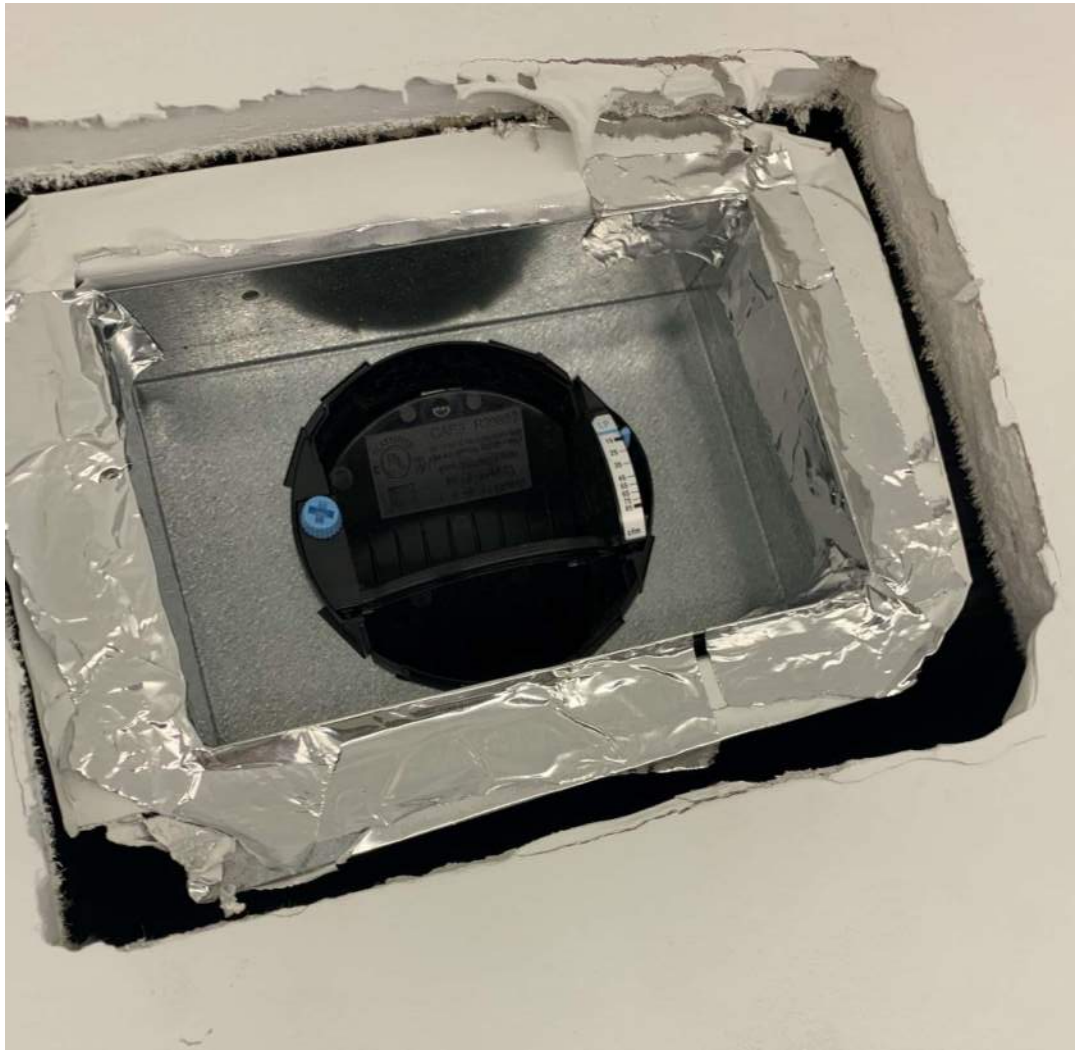


What item(s) do you see wrong, Image 4? (hint: link words with an underscore)

What do you see wrong? Image 5

What item(s) do you see wrong, Image 5? (hint: link words with an underscore)

What do you see wrong? Image 6



What item(s) do you see wrong, Image 6? (hint: link words with an underscore)

What do you see wrong? Image 7

What item(s) do you see wrong, Image 7? (hint: link words with an underscore)

Testing, Adjusting, Balancing (TAB)

Ventilation Tolerances

- Total supply and exhaust are at least 100% of design values and within 10% of each other
  - For PHIUS, minimums especially on exhaust side must be met.
- Air flow measurements at ERV units (traverse) in addition to all grille measurements. Kele FXP measurement for individual ERVs by Verifier.
- Wattage measurement of ERVs
- TAB Requirements
  - Third party (certified air balancing professional)
  - Recommend pre-meeting with TAB contractor to discuss expectations

TAB Scope of Work

- Level of involvement can depend on the size and extensiveness of the project
- Single family home, single ERV – balancing could be done by the equipment manufacturer
- For larger, more complex buildings or systems:
  - Communication between balancer, manufacturer's representative, mechanical contractor, controls contractor
  - Plan far ahead to schedule all parties
  - Be sure that specifications state that balancer must work with manufacturer's rep and/or controls contractor during TAB work
  - Typically, the TAB contractor is a sub of the HVAC contractor

TAB Scope of Work

- The TAB contractor needs to submit the following before starting:
  - Their intended procedures
  - A blank project specific report
  - Marked-up drawings for engineer and consultant review
- BEFORE any on-site work, confirm TAB contractor is aware of ALL required measurements.
- As much as possible, verifier to be on site the same day as the TAB work begins to ensure all parties are on the same page

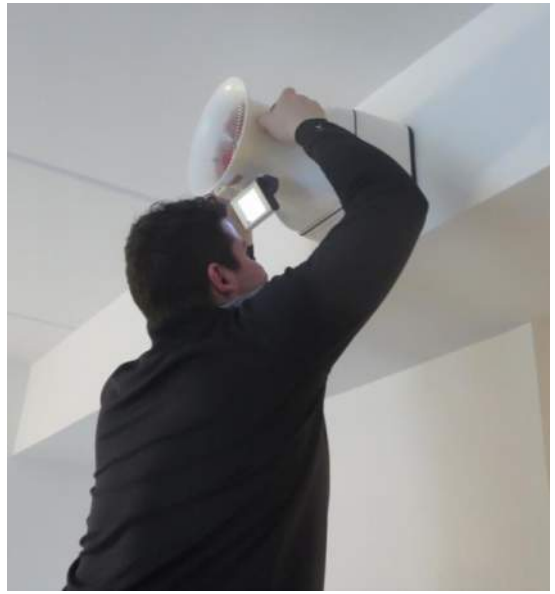
TAB Process

- Engage a certified third party balancing professional (NEBB, AABC, TABB)
  - Have a pre-meeting with the balancer to discuss procedures and expectations
  - Identify flow measuring devices acceptable for the project
- Unitized ERV's – access strategy must be developed in ERV closet to access the ducts to test for air flows at the unit
  - Some units have built in pressure taps, potentially.
- Central ERV's
  - Built in display. Straight runs of duct for traverse.
- CAR damper access strategy must be developed
  - CAR dampers typically need fine tuned adjustments by the TAB contractor and factory pre-sets have been insufficient in meeting PHIUS tolerances

TAB – Instruments

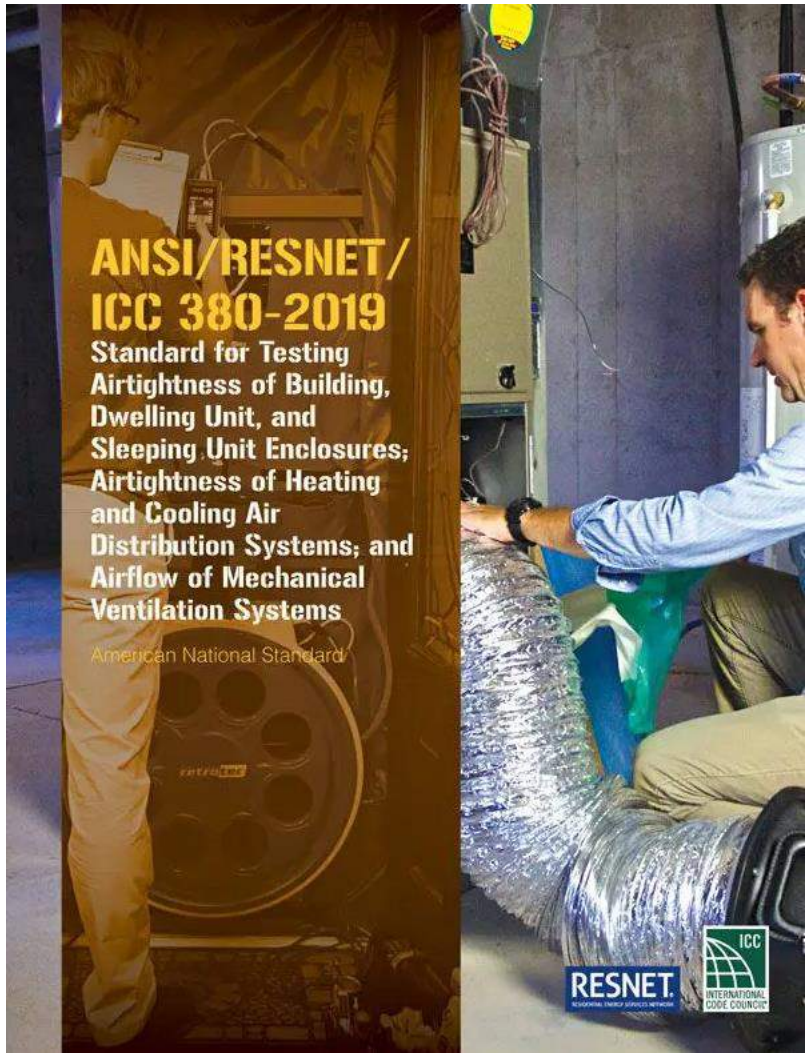
Key Findings of LBNL Report - 47382

"Extensive laboratory tests and several field tests have shown that commercially available standard flow hoods do not meet the accuracy criteria for many of the diagnostics that flow hoods are often used for. Their RMS errors are typically in the 20% to 30% range compared to accuracies of 10% or better required for most distribution system diagnostics. *In particular, they are inadequate for use in estimating duct leakage, air handler flow and individual register flows for room load and comfort."*



"The laboratory results for the reference active flow hood show an RMS error of only 2%."

TAB – Instruments



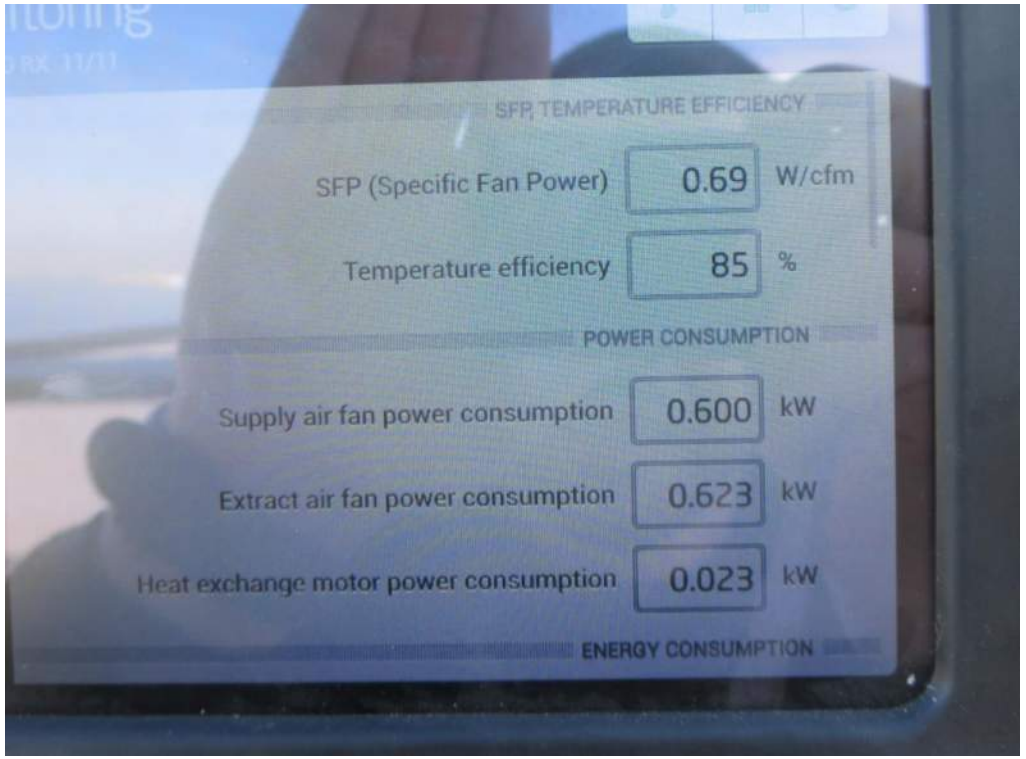
Powered flow hood

CARs & TAB

- Placement in duct and physical accessibility. TAB contractor needs to be able to get to the CAR to make adjustments.
- Installation into duct work (tight fit)
- Orientation of the damper
- Don’t install until after Aeroseal

Airflows and Fan Power – Central System

- Readout from the manufacturer's controller is very helpful to verify the overall air flow rates and the fan power



Airflows and Fan Power – Individual System

- For individual systems, measurements for PHIUS by the Verifier
  - Kele FXP to measure air flow at the unit, in addition to all registers
  - Wattage with either Kill-A-Watt or actual power meter

TAB - Reports

AREA SERVED	OUTLET				DESIGN	ACTUAL
	NO.	TYPE	SIZE	AK*	CFM FLOW	CFM FLOW
ERV-R-1	182	CD	6X6	DRI	20	20
	183	TR	6X6	DRI	35	35
	184	TR	6X6	DRI	15	15
	185	TR	6X6	DRI	15	15
	186	CD	6X6	DRI	20	20
	187	TR	6X6	DRI	35	35
	188	TR	6X6	DRI	15	15
	189	TR	6X6	DRI	15	15
	190	CD	6X6	DRI	20	20
	191	TR	6X6	DRI	15	15
	192	CD	6X6	DRI	40	40
	193	TR	6X6	DRI	15	15
	194	TR	6X6	DRI	15	15
	195	CD	6X6	DRI	20	20
	196	TR	6X6	DRI	15	15

TAB - Reports

- *"Perfect"* balancing report, but it was found on site that speed controller was still on factory settings and that no adjustments had been made at all.
- SWA hired to do all the balancing = time / $$$ / certification risk

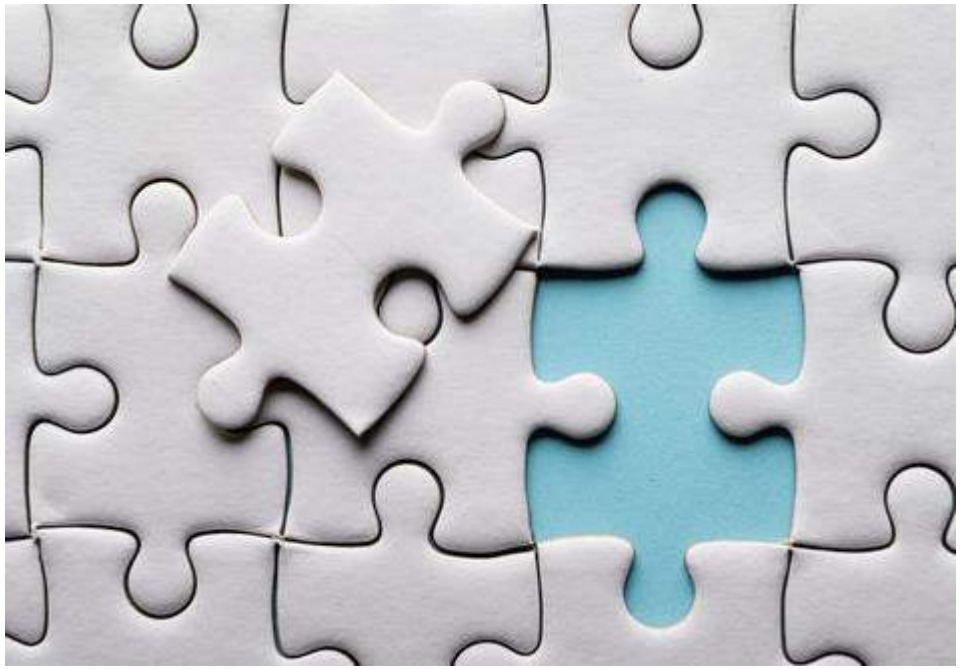
Manufacturer: [redacted]
Model:

Location: Apt 6C Closet

Drawing	Area Served	Supply/ Return	Grille Type	Grille Size	CFM Design	CFM Actual
27	Apt 6C	ERV Supply	SWR	6x4	15	15
28	Apt 6C	ERV Supply	SWR	6x4	15	15
30	Apt 6C	ERV Supply	SWR	6x4	15	15
32	Apt 6C	KX	SWG	6x6	25	25
33	Apt 6C	TX	CG	6x6	20	20

TAB - Timing

- On larger projects, it may take several rounds of back and forth to get it right.
- TAB is usually the last major item needed to complete right before tenant move-ins. Therefore, the process tends to get rushed.
- Just because a project passes the blower door test, remind them they still need to get through TAB which is critical for certification.



TAB - Resources

- ASHRAE Guideline 11-2018, Field Testing of HVAC Controls Components
- ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings
- https://www.smacna.org/store/product/tab-procedural-guide
- https://www.tabbcertified.org/
- https://nebb.org/
- https://www.aabc.com/

Recommendations – for Project Success
Construction

- Specify and require ductwork shop drawings and As-Built drawings for review
- Mechanical engineer should be engaged during construction and conducting inspections
- Early engagement of TAB contractor and Aeroseal installer
- Hold contractor trainings to ensure all parties are aware of the project's goals
- Borescope ductwork prior to Aeroseal installation to find any major disconnects, and/or smoke testing.
- Be on site same day as the TAB contractor to ensure all required readings and set points are being understood and covered.

Questions?

What are your final thoughts and takeaways from the presentation today (hint: link works with an underscore)

Questions & Final Discussion

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- **Workshop 3:** High Performance Ventilation Systems for Homes

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