BUILDINGENERGY NYC

Tales from the Trenches: Passive House Ventilation Commissioning Best Practices

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Northeast Sustainable Energy Association (NESEA)
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Learning Objectives

1. Analyze common passive house ventilation system designs, layouts, and components pertaining to the performance and field installations
2. Demonstrate through examples common problem areas related to the implementation and operation of high-performance ventilation systems
3. Recommend ways to design for best ventilation performance based upon lessons learned
4. Describe the Passive House certification criteria and the actual performance necessary for ventilation systems to be within compliance

SWA

Overview of Presentation

1. Passive House Basics and Context
2. Cx Process & Relevance in PH Buildings
3. TAB, Shop Dwg, System leakage
4. ERV/HRV Controls & Interlocks
5. Operations & Maintenance

Passive House Basics & Relevance

Passive House In the News

Local Law 97

Future

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REAL ESTATE COMMERCIAL REAL ESTATE

NYC buildings prepare to drastically reduce emissions to avoid penalties

By Emily Nonko

Published Jan. 16, 2020, 3:31 p.m. ET

A $13.4 million retrofit has helped the iconic Empire State Building cut its energy use by 40 percent.

Getty Images

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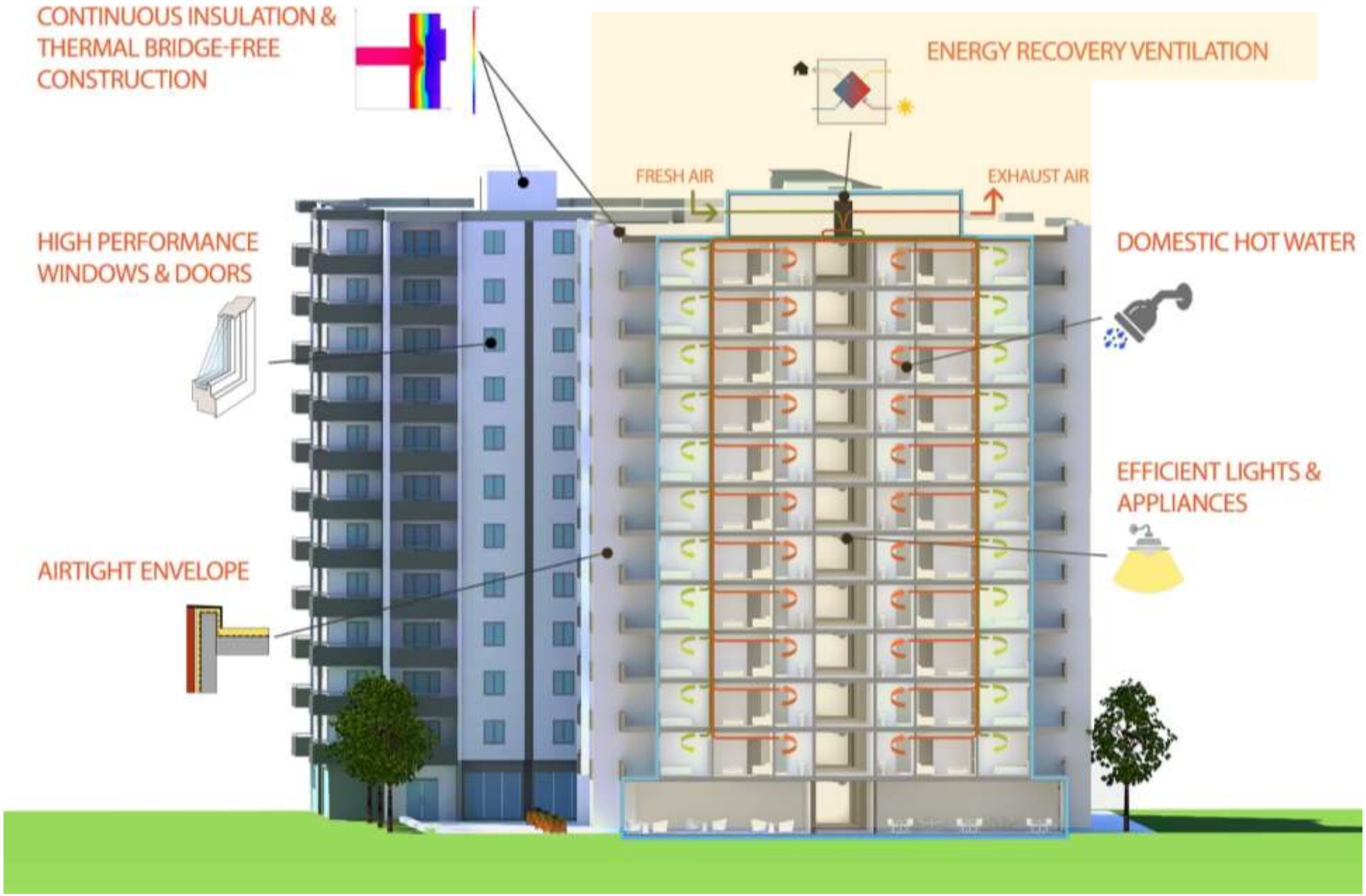
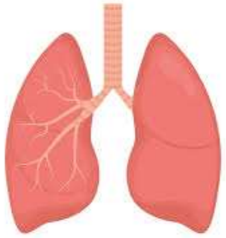
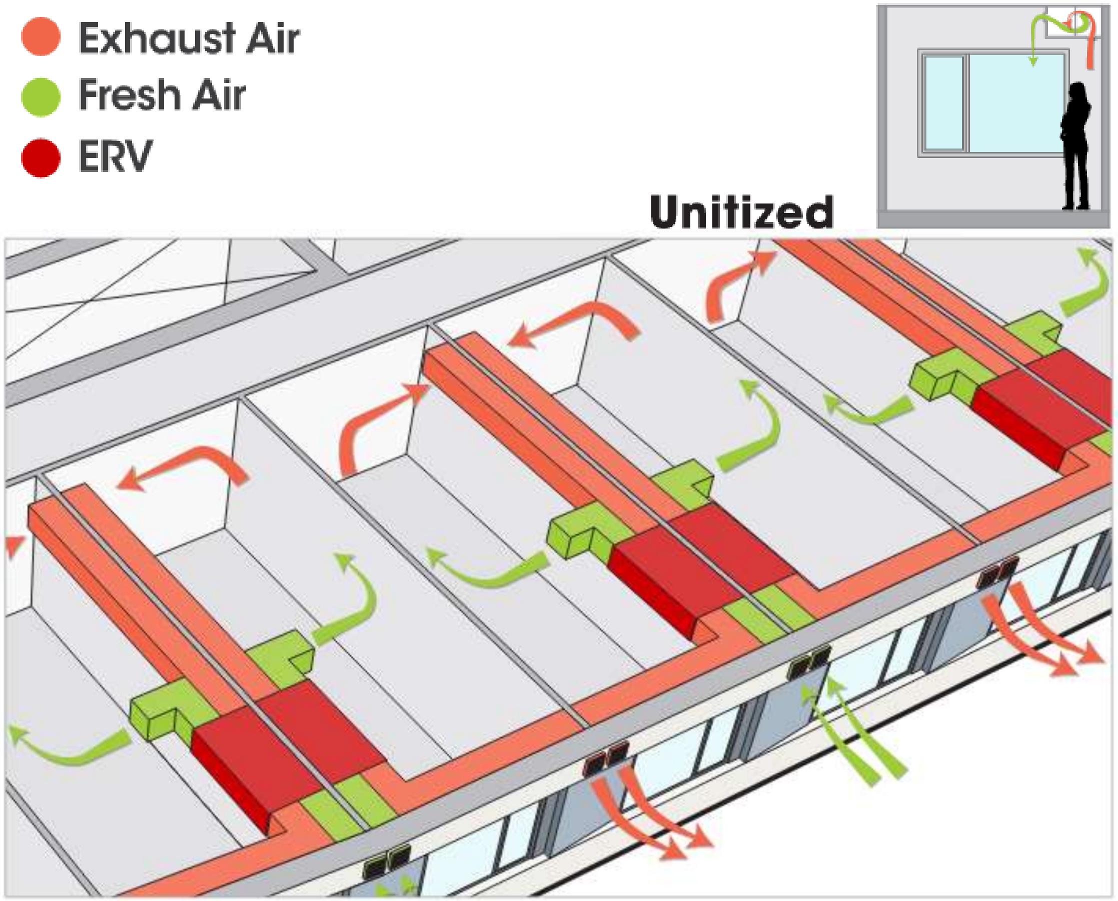
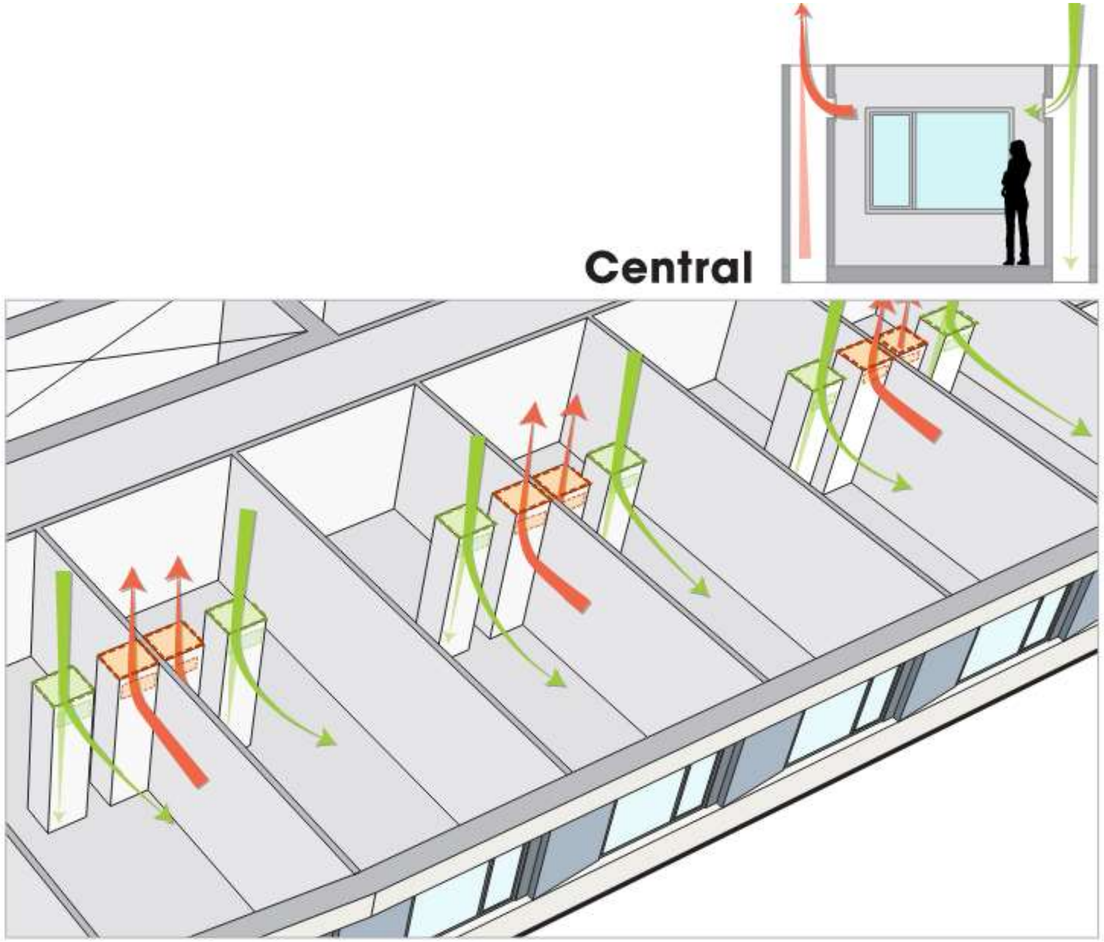
ELEMENTS OF A LARGE MULTIFAMILY PASSIVE HOUSE BUILDING





Ventilation: Unitized vs. Central vs. Semi- Central





Credit: Handel Architects

Introduction – Ventilation Recommendations and Requirements

Energy Efficiency:

- Recommend ERV/HRV **fan motors consume 0.76 W/cfm** or less at the highest power setting
  - **Verify ERV/HRV wattage at final**

Balancing Requirements:

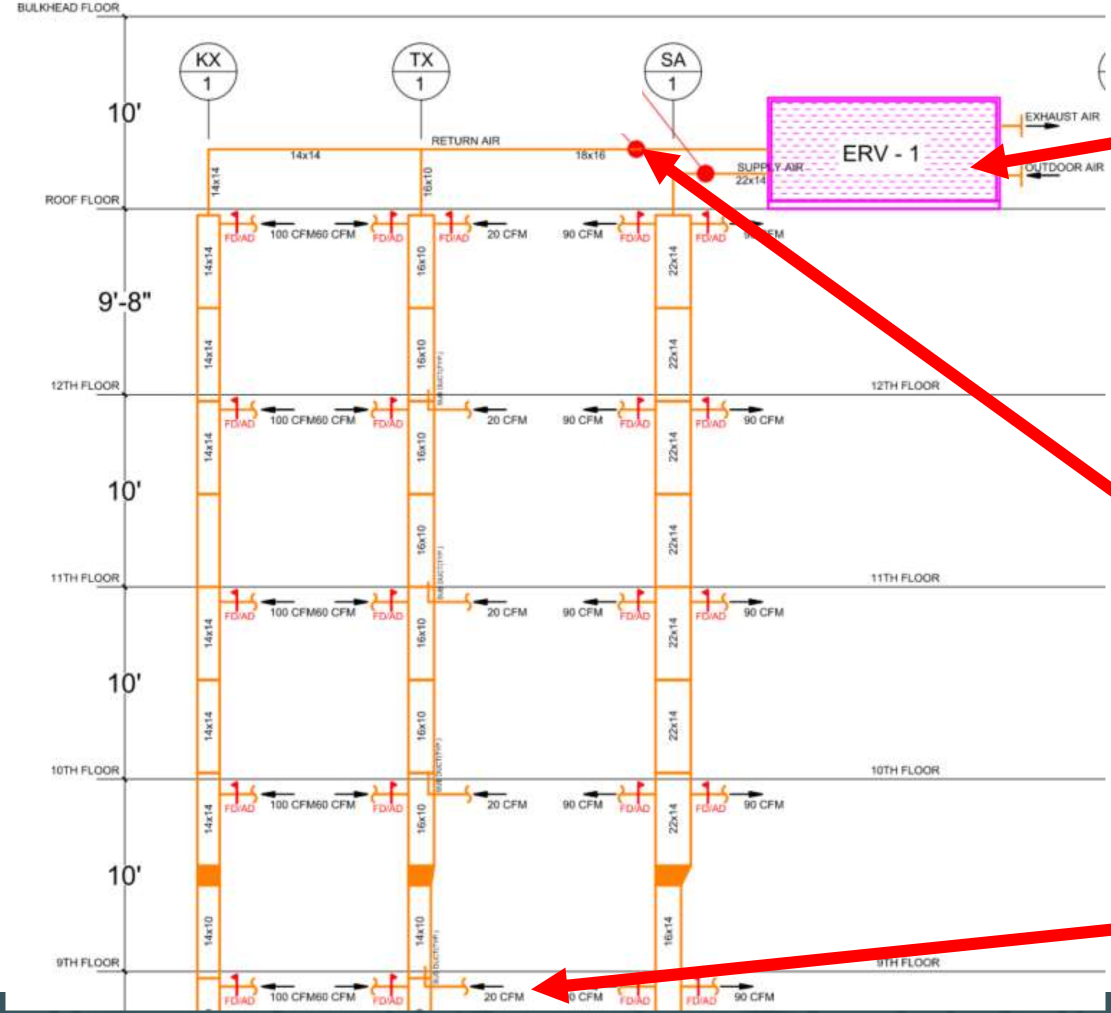
- Supply and exhaust flows are **within 10% of each other (at the unit)**
- A targeted air change rate between 0.30 and 0.50 air changes per hour (ACH)
- Minimum **flow rates must be met** in apartments
- Supply and exhaust flows are **+/- 15% or 15 CFM of design values** (in apartments)
- **Third-party** (certified air balancing professional e.g. NEBB, AABC)
- Required pre-meeting with TAB contractor to discuss expectations

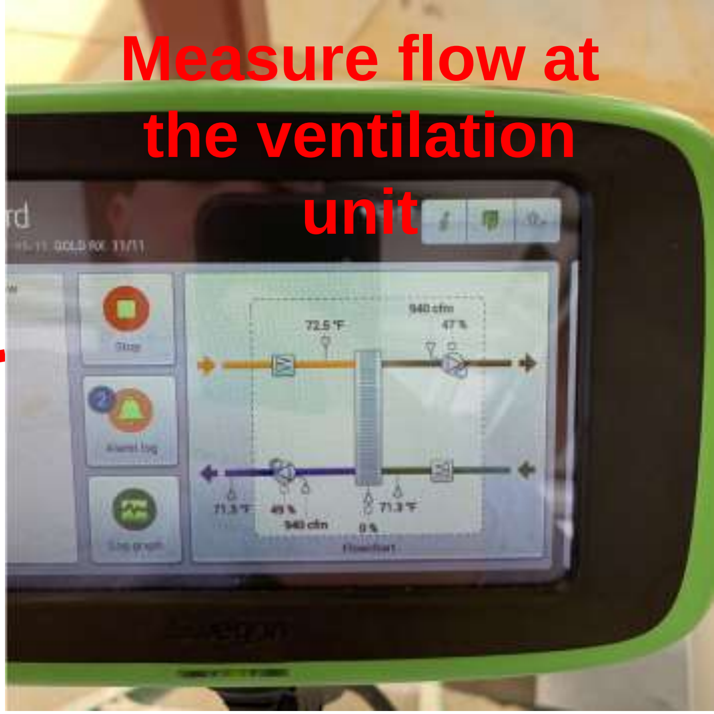
Project Flow

Modeling and Design	Project Kickoff	Review Feasibility, 100 DD, 50 CD, and 100 CD	Model performance and provide reports	Develop Cx specs, Create Cx plan
Pre-Construction	Develop construction checklists	Construction kickoff meeting with client	Define training requirements	Clarify roles & responsibilities for Cx scope
Construction Phase	Contractor Training	Ongoing site inspections	Submittal review	Interim testing
Construction Completion	Verify proper installation of MEP systems	MEP Startups & Functional Testing	Testing and Balancing (TAB)	Ventilation system readings (Post-TAB verification)
Closeout Phase	O&M & As-Built Documentation	Submission to a certifying body	Warranty review	Seasonal testing

TAB, Shop Drawings and System Leakage

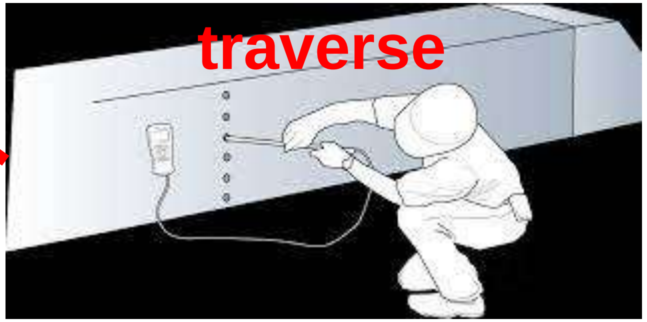
Testing and Balancing - Process





Measure flow at the ventilation unit

Pitot tube traverse



Measure and adjust flow rates in apartments

Testing and Balancing – Comparing Flow Hoods

Key Findings of LBNL Report - 47382

"Extensive laboratory tests and several field tests show…errors are typically in the 20% to 30% range. *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%."

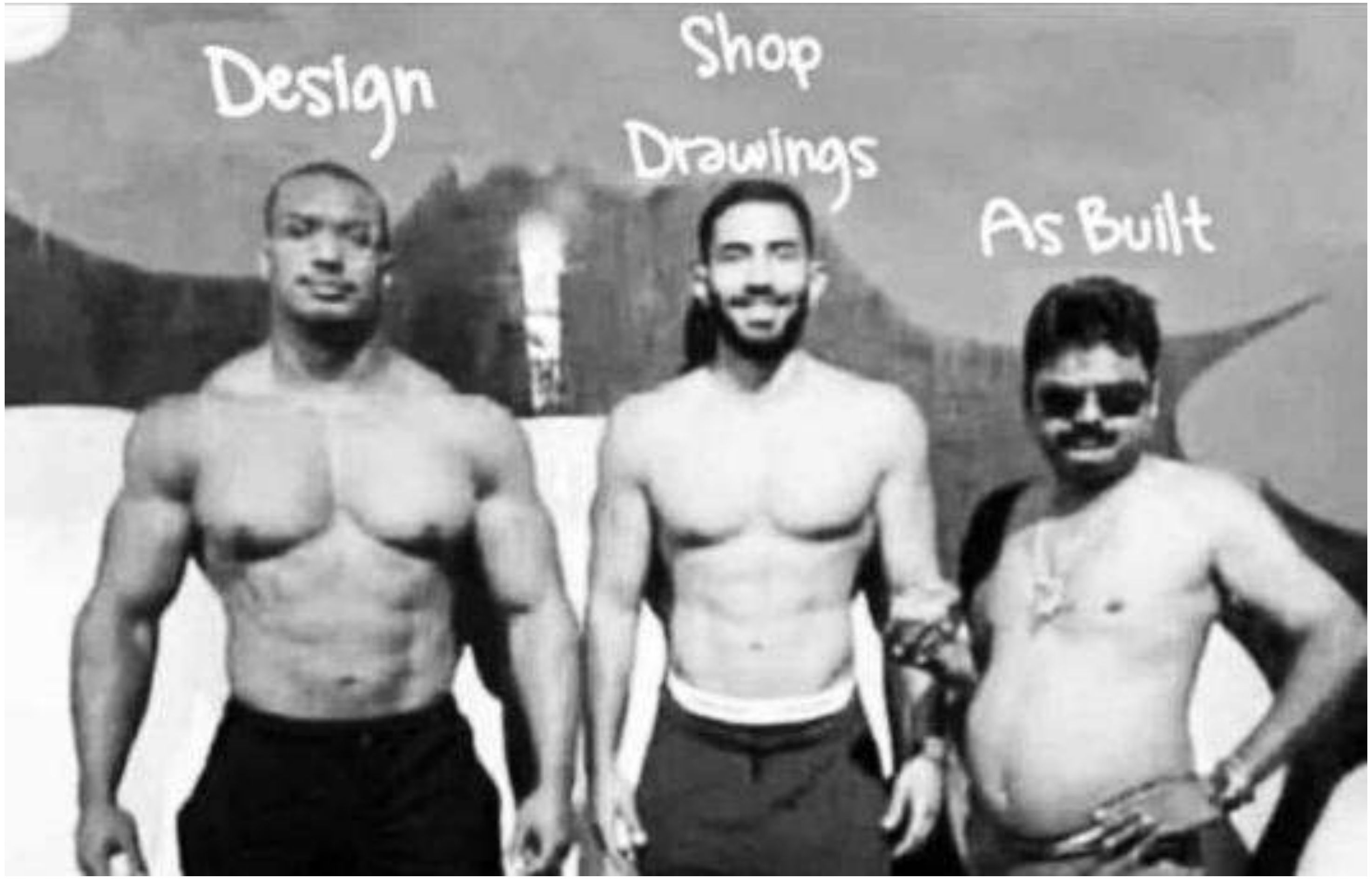
Testing and Balancing - Reporting

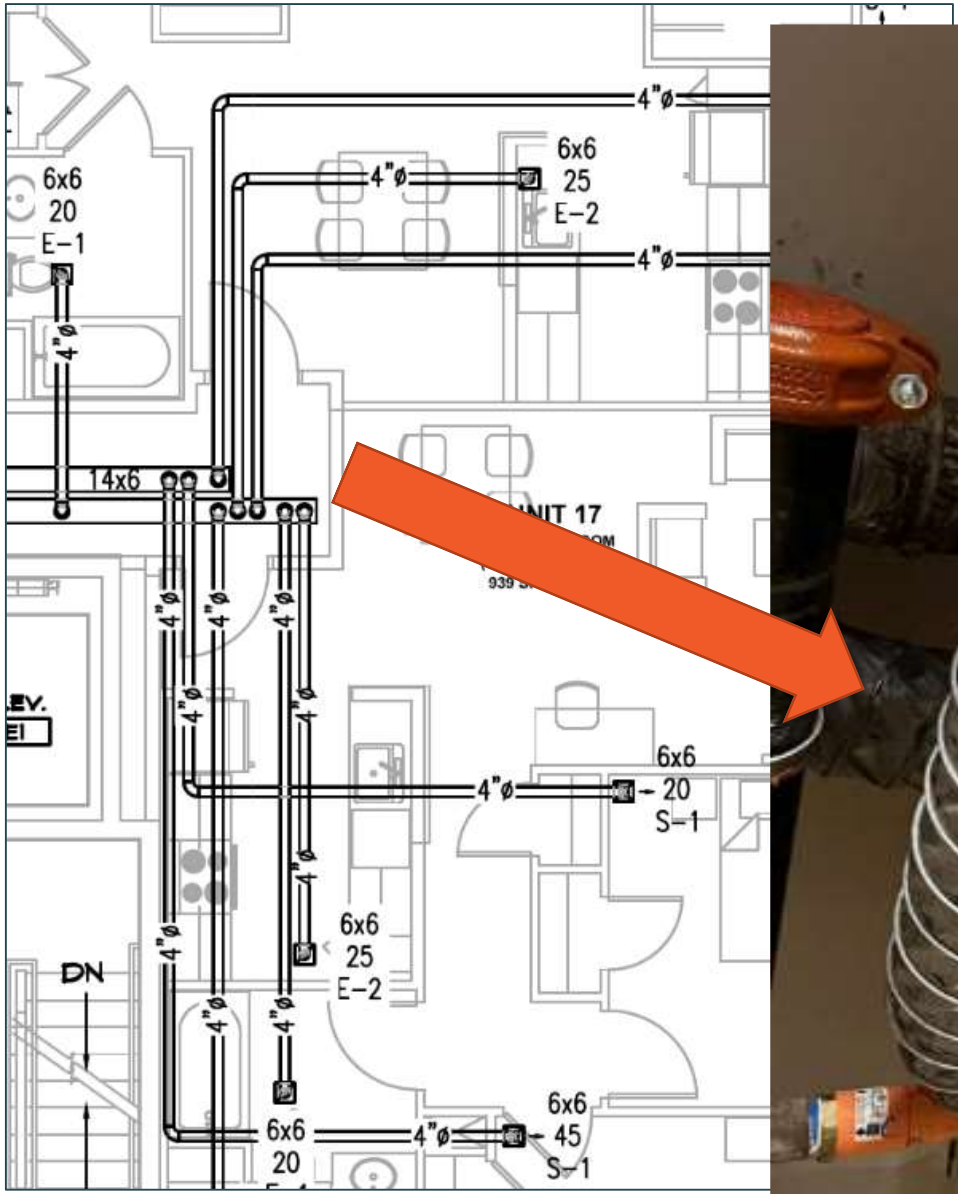
Manufacturer: [redacted]
Model:

Location: Apt 6C Closet

			Grille		CFM	
Drawing	Area Served	Supply/ Return	Type	Size	Design	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

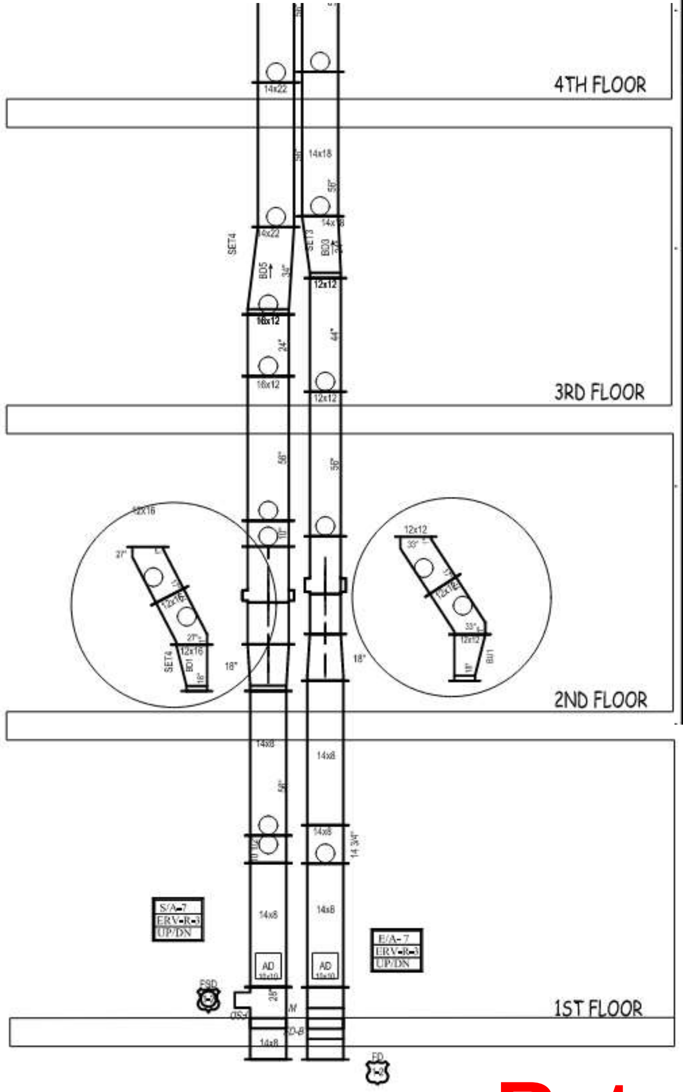
Let's talk about shops…

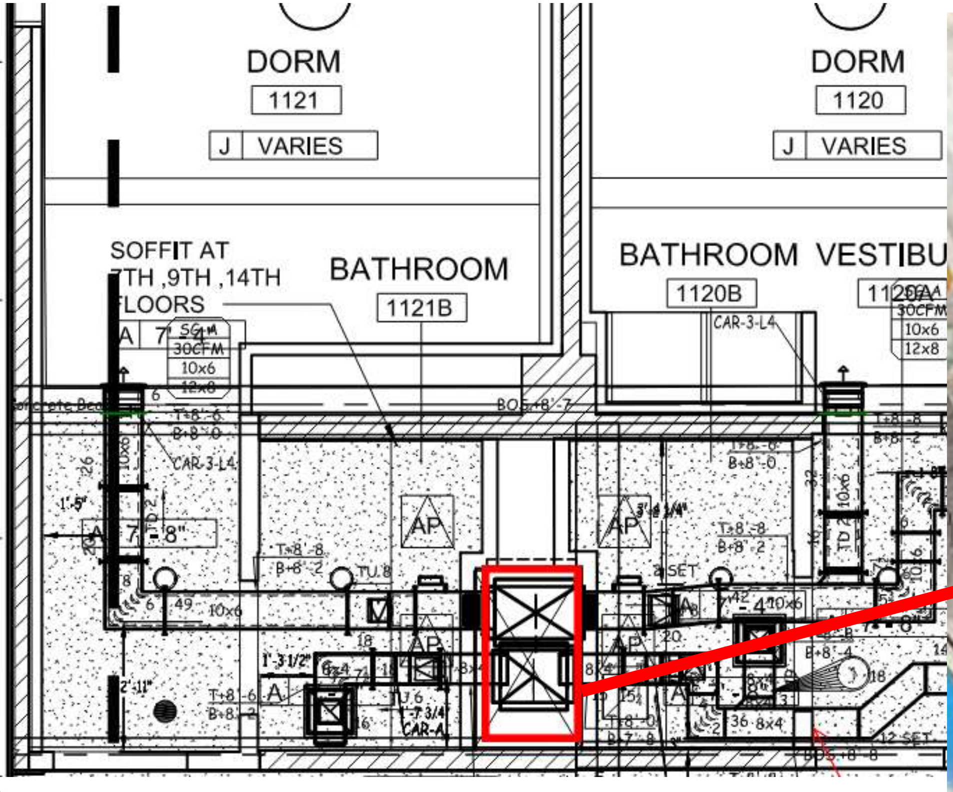




Design

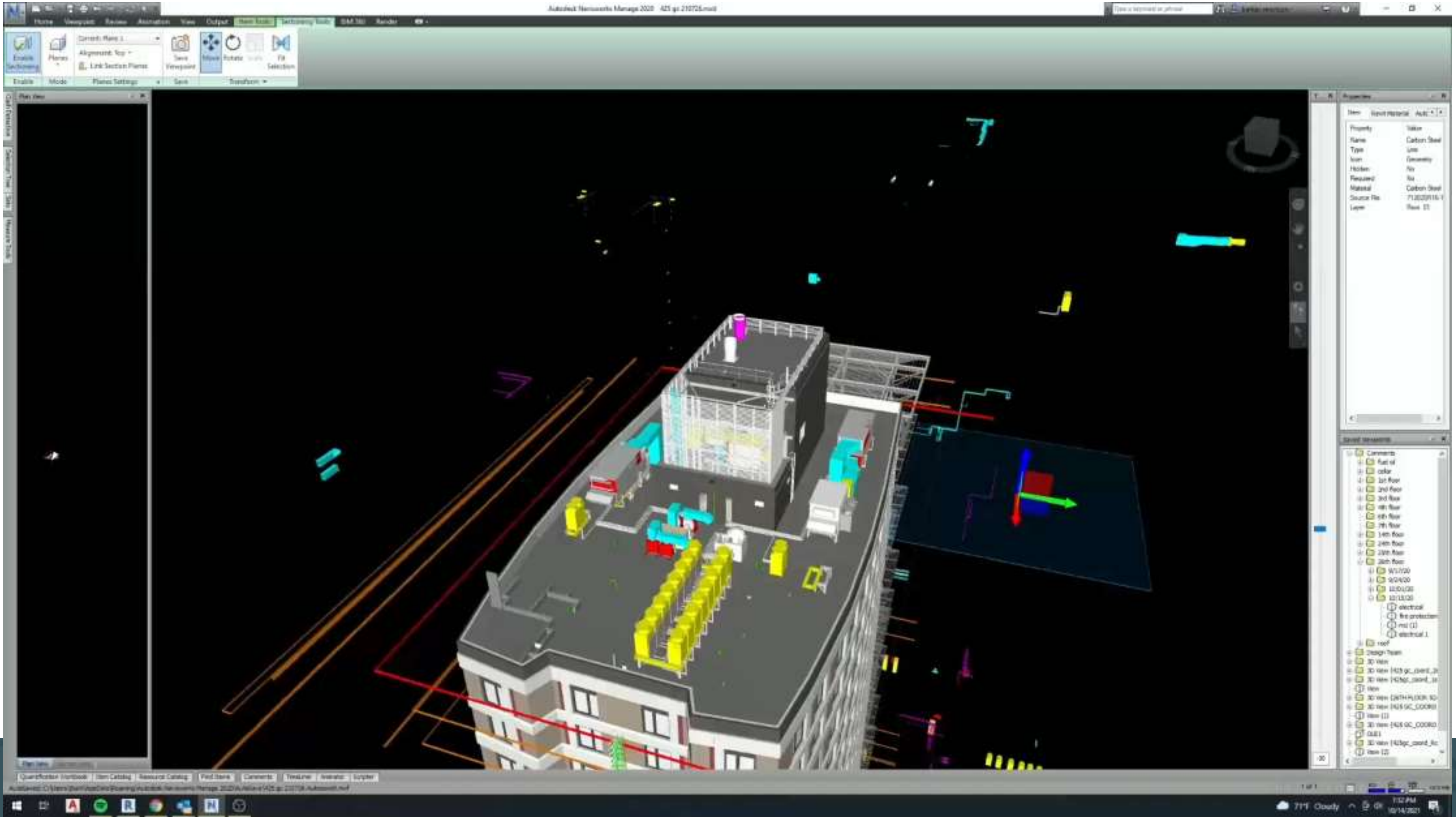
As-Built





Retrofit Detailed Shop Drawings

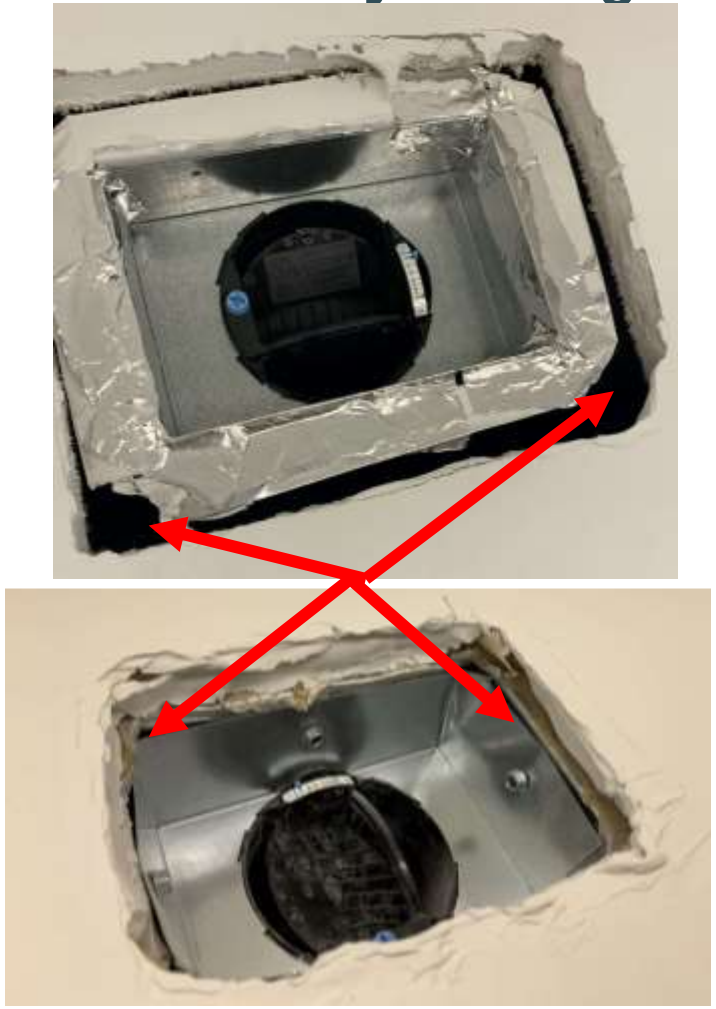
Coordination Between Trades



System Leakage Examples

Duct Leakage

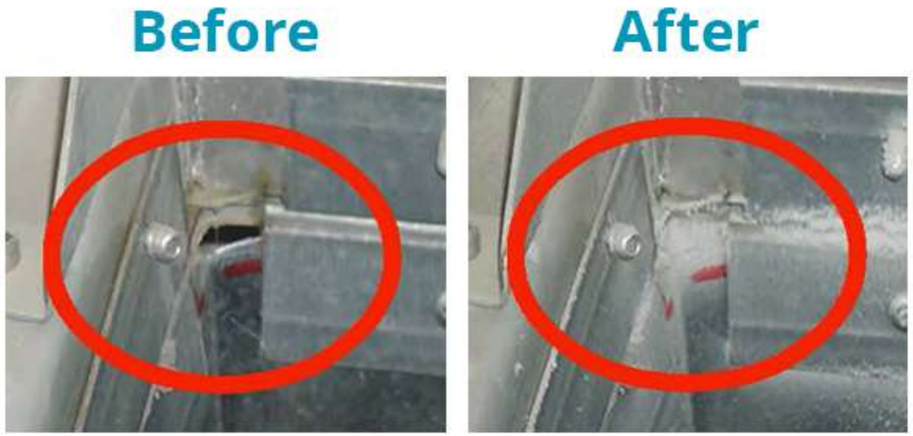
Accessory Leakage



Equipment Leakage

Duct Sealing using Aerosolized Sealant

- Seals ducts from the inside
- Pressurized aerosolized particles are forced through the duct systems and build up at leak locations.
- Can seal leaks up to ½” size



Aerosolized Sealant – Volumetric VS SMACNA Duct leakage Standard

Recommended 3% Fractional Leakage Method

	ERV-Unit 1	
	Supply	Exhaust
Design Flow Rate (CFM):	450	450
3% Volumetric Leakage %	3%	3%
(SMACNA CL 8) % Leakage of design flow	32%	19%
(SMACNA CL 2) % Leakage of design flow	8%	5%

9% Leakage reduction from early Cx engagement

Is SMACNA Duct Leakage Class Outdated?

HVAC AIR DUCT LEAKAGE TEST MANUAL

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.

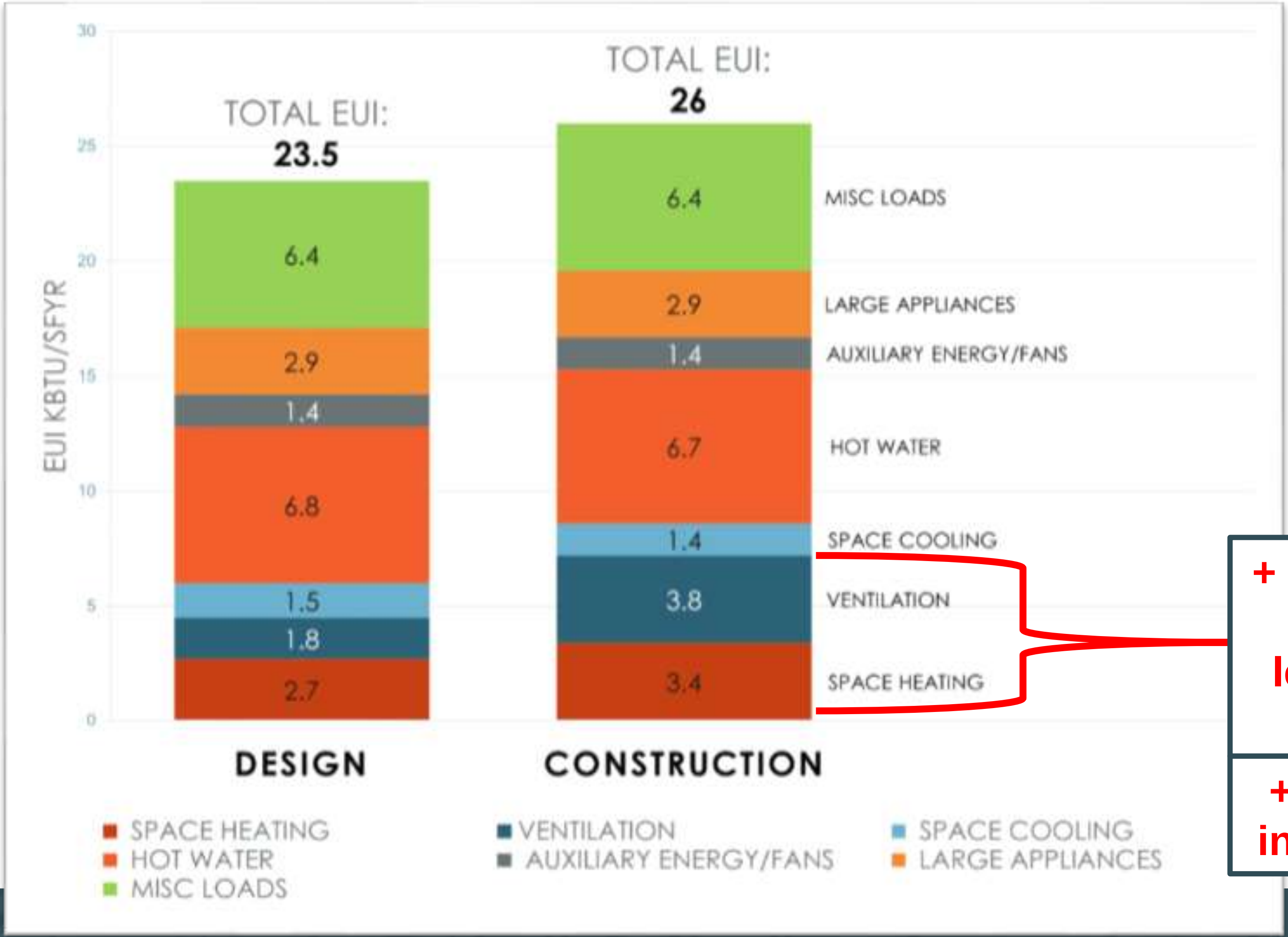
4201 Lafayette Center Drive
Chantilly, VA 20151-1219

Printed in the U.S.A.

FIRST EDITION – 1985
SECOND EDITION – 2012

38-year-old Standard Specification

Leakage Impacts on PHIUS WUFI Energy Model

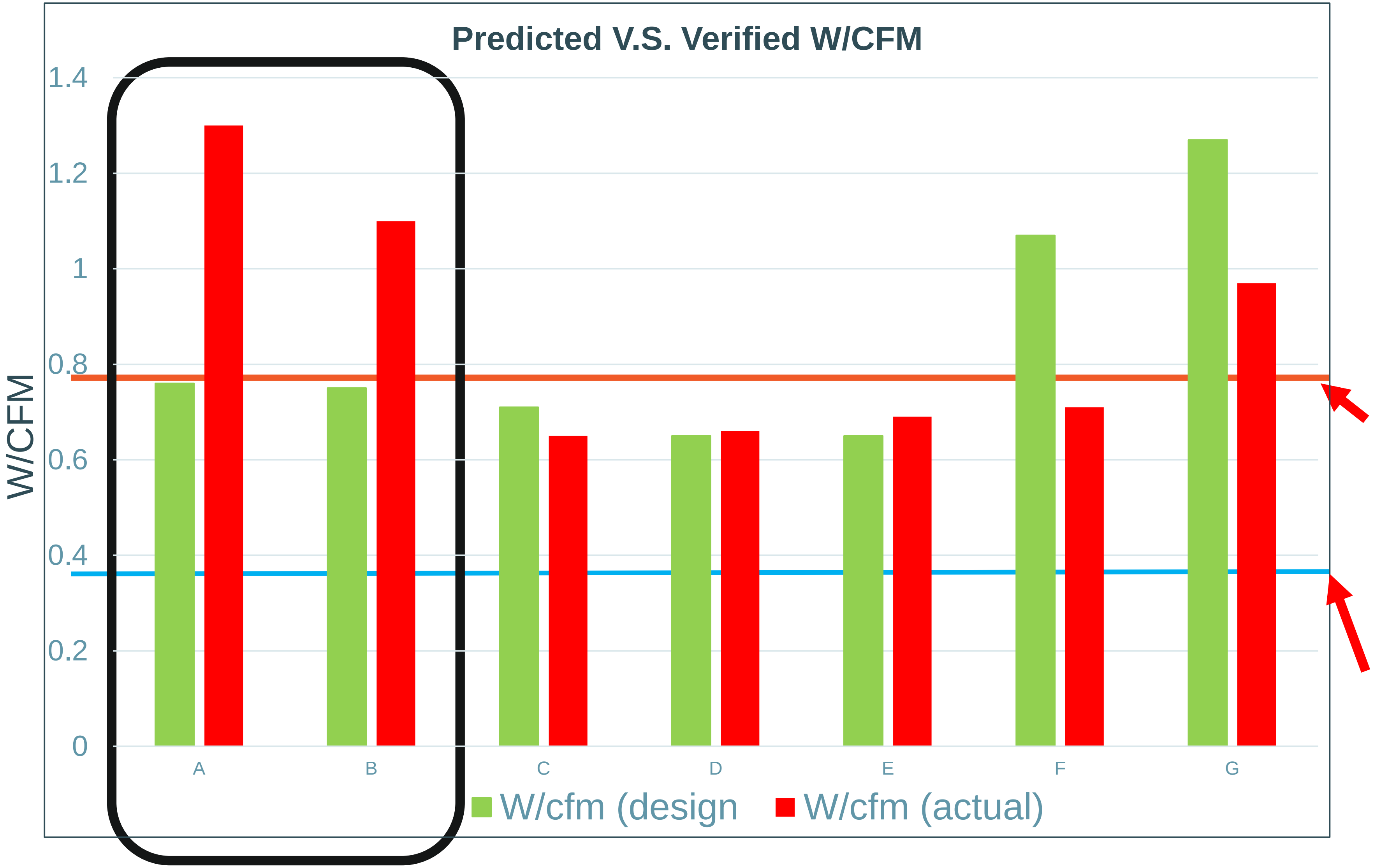


+ 2.5 Site EUI Due to high duct leakage and fan power

+ ~$ 3,500 / year increased energy

Comparing Predicted V.S. Verified Fan Energy

Can you spot projects with high duct leakage?



0.76 W/CFM

0.36 W/CFM (Exhaust Only)

Conclusion

- Traditional and **typical specifications for duct leakage are not adequate** for high-performance buildings
- Communicate **design AND construction expectations** through specifications **reinforced with on-site training**
- Emphasize the need for coordination between trades, **require shop drawings**, and ensure they match as-built conditions
- **Communicate project nuances** and PH requirements early and often
- **Engage CxA early** in the design phase and ASAP after start-ups

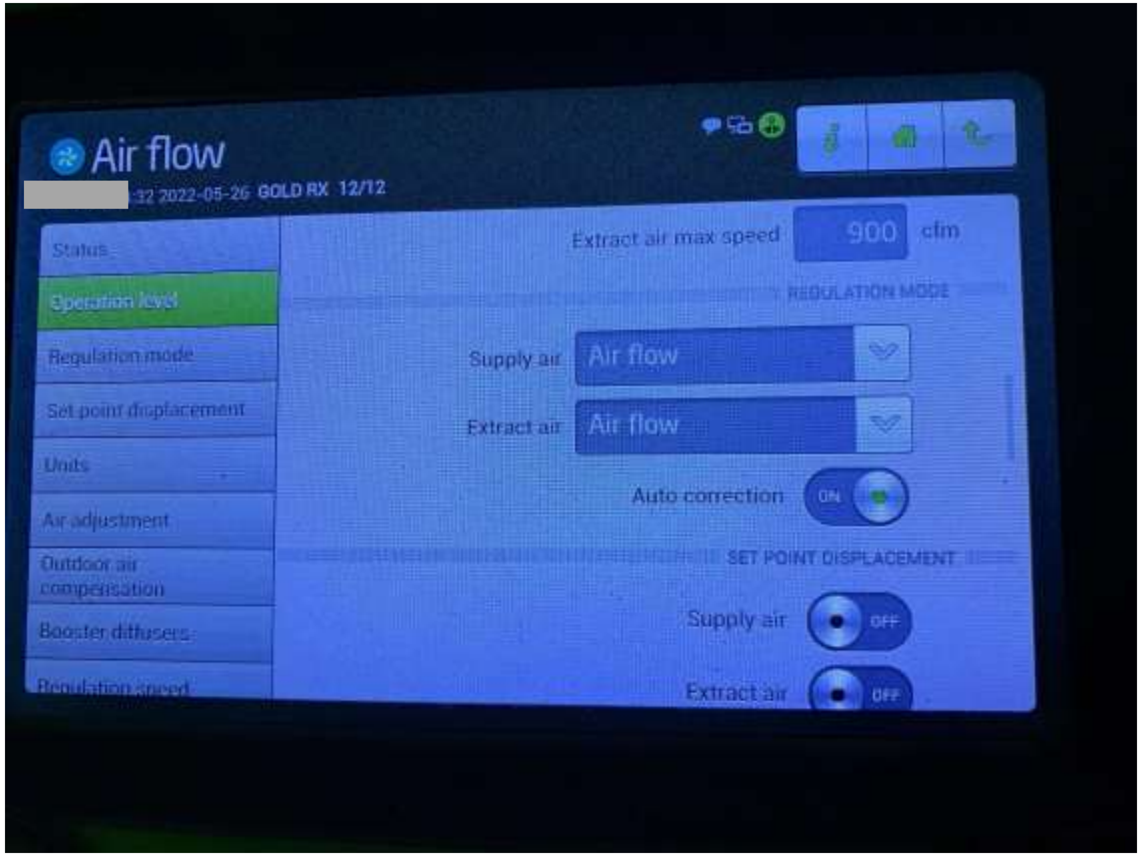
Trust but Verify

Controls and Sequences of Operations

K.I.S.S.

ERV Sequences & Controls

- Constant Flow vs Variable Flow
- Key Setpoints:
  - Airflow
  - Static pressure
  - Supply Air Temperature
  - RH% (Dew Point Temp)
- Other Setpoints:
  - CO2 concentration
  - Schedules



Variable Air Volume – Keep It Super Simple

Minimum

Damper closes

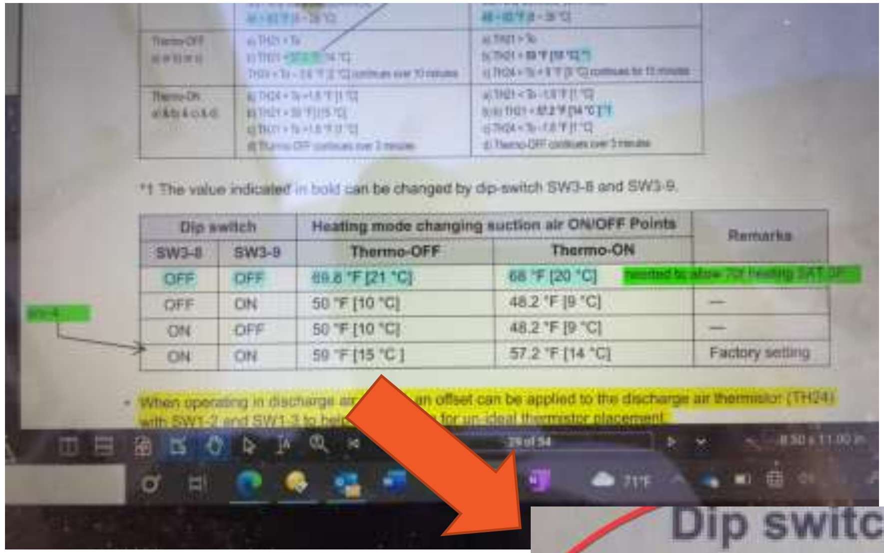
Maximum

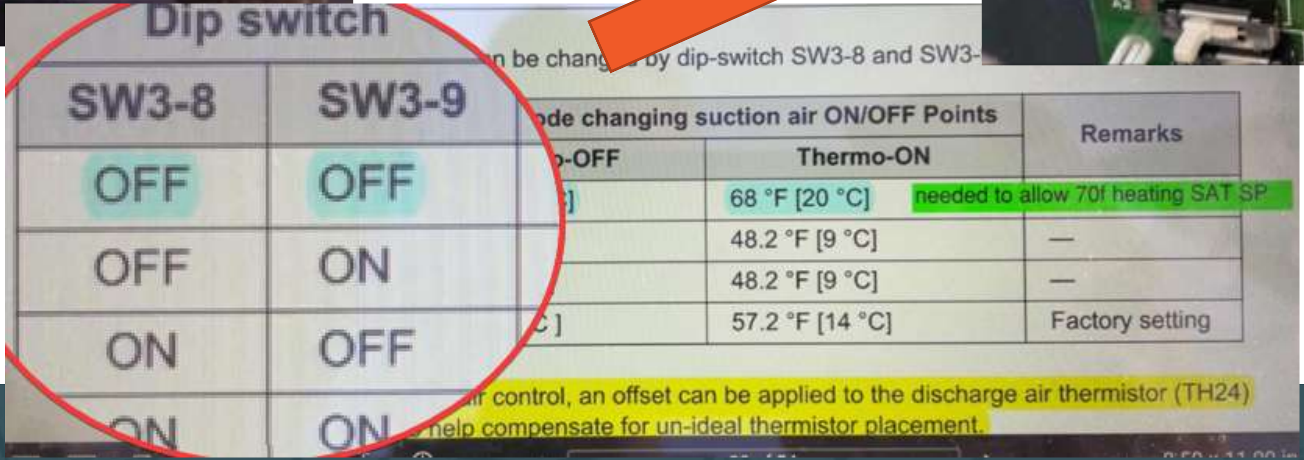
Damper opens

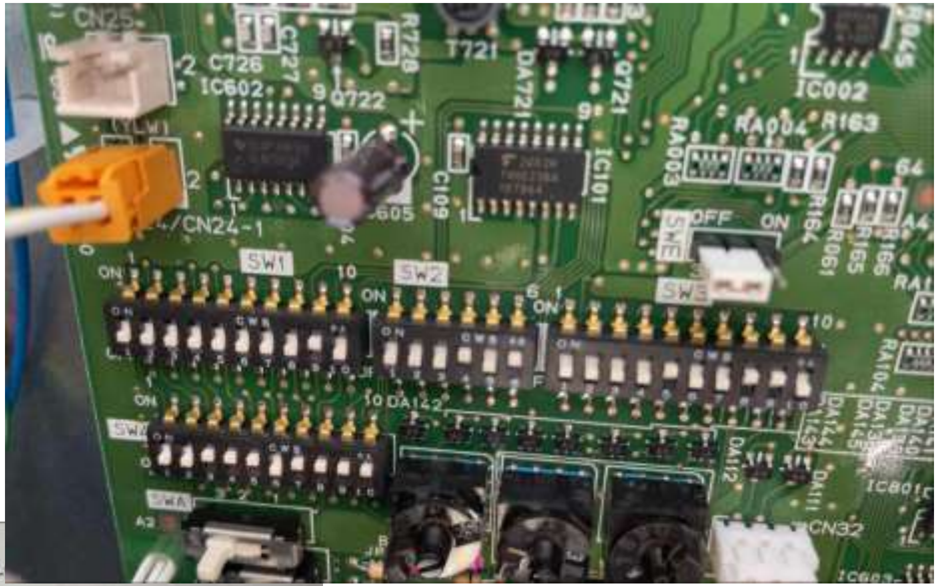
Example – Complicated controls?

Example – ERV & Heat Pump Interlocks (Bldg X & Mfr X)

- Who is responsible for setting these up?





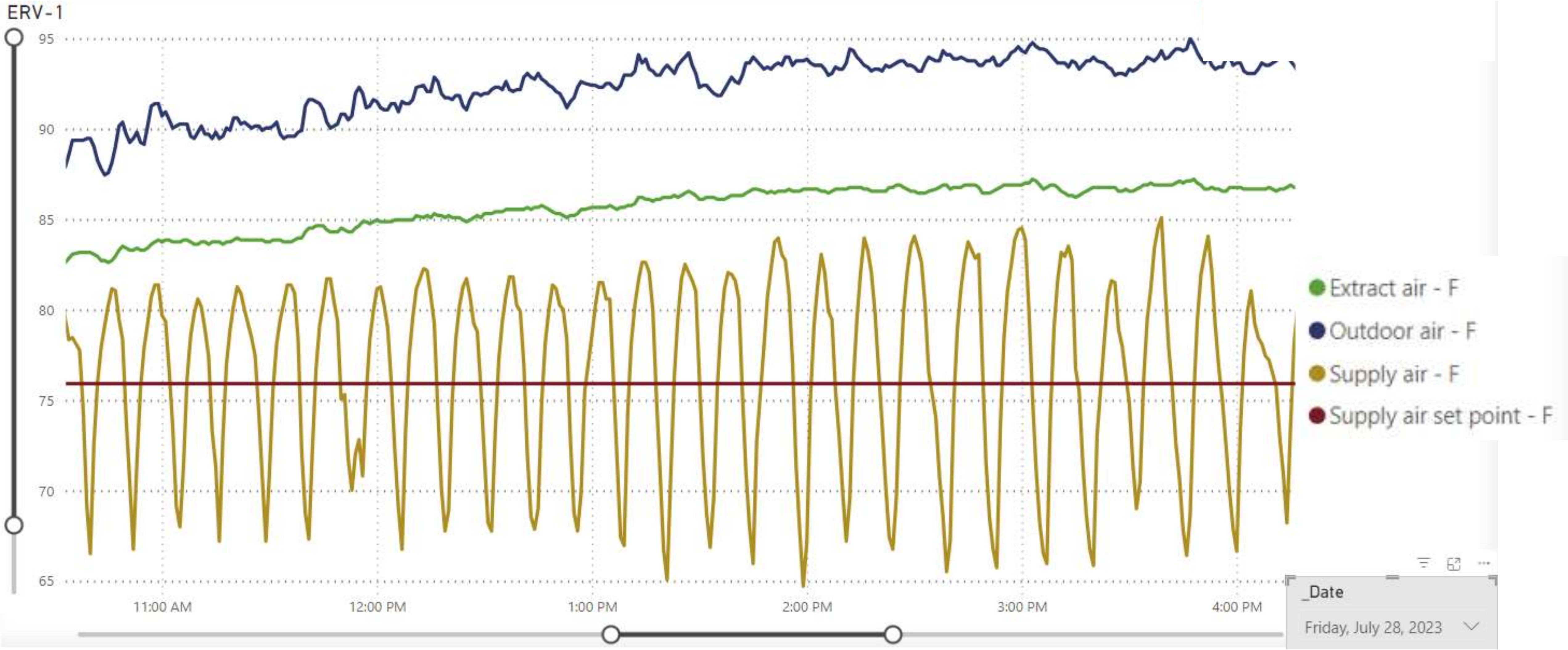


ERV Controls – Heat Pump Interlocks (Bldg Y & Mfr Y)

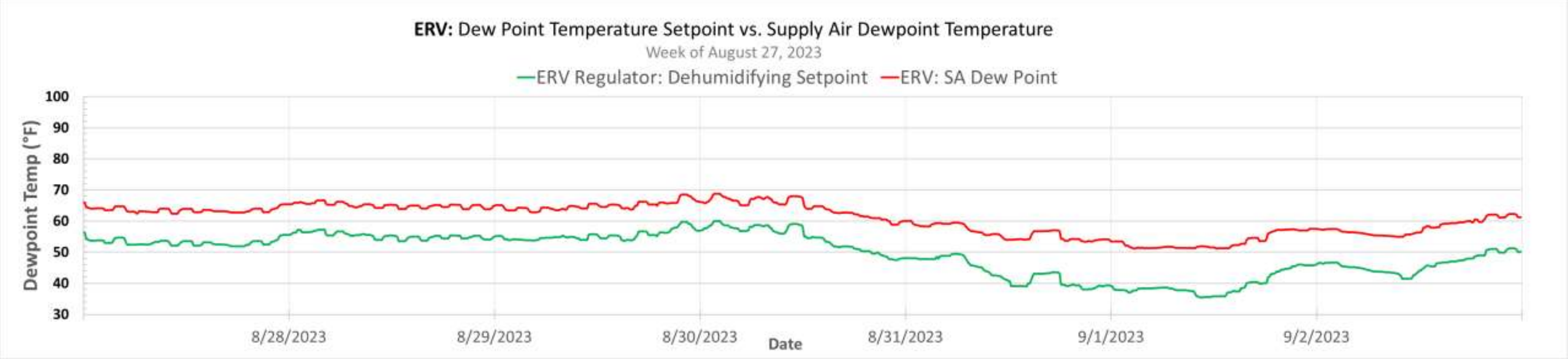
- DIP Switches in OFF position (from Factory) – 6+ months after startup

SW name	No	Item	Setting		Note
SW1	1	ODU Type	ON	Single Comm.	Using Single Split outdoor unit
			OFF	Comm.	Using outdoor unit
	2	Control Type	ON	Communication	Controlled by DDC Modbus or remote controllers & central controllers
			OFF	Contact signal	Controlled by DDC through Contact signal Central controller can only monitor status)
	3	DO Type	ON	Fan Speed	DO1 : High, DO2 : Middle, DO3 : Low (DO changes according to fan speed setting value)
			OFF	Status	DO1 : ON/OFF, DO2 : Defrost, DO3 : Alarm
	4	Fan Speed (available when SW1-3 'ON')	ON	Fixed	The fan will always be running as set fan speed except defrost. (During defrost, the fan speed will change as low fan speed.)
			OFF	Change	The fan speed will be changed according to TH on/off For more detail please check 'Digital Output – Fan Speed'

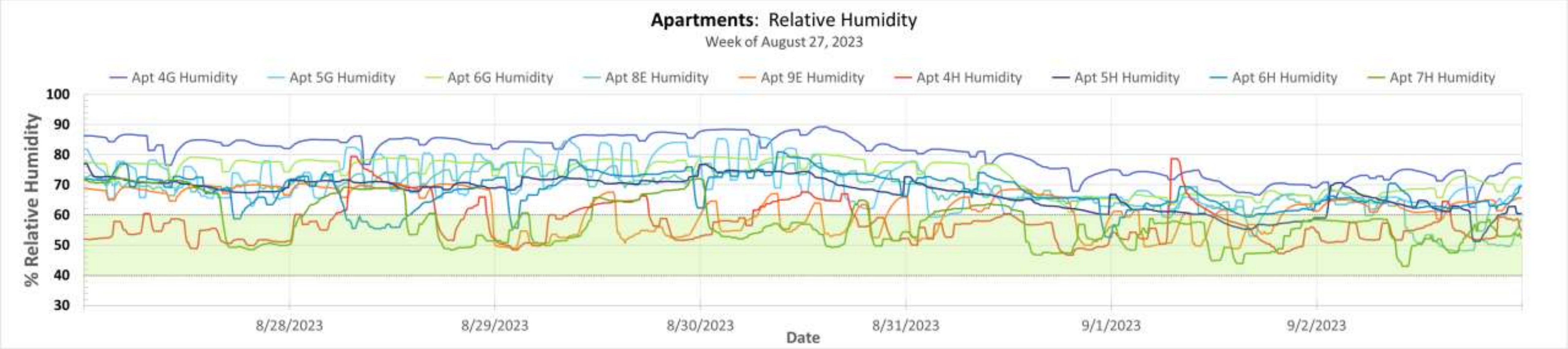
ERV Controls – Heat Pump Interlocks (Bldg Y & Mfr Y)



What's the effect of all this?



What about in the apartments?



How could we avoid these issues?

- Clear & **realistic** sequences of operation
  - Early Design Reviews.
- Don’t reinvent the wheel
  - ERV & VRF **separate**
- **Clearly defined roles**
  - Installer + Supplier + Manufacturer + CxA
- Clear expectations
  - The job is done when…
    - 3 or more days for **tuning (over multiple seasons)** with building staff
  - Warranty periods

Operations & Maintenance

O&M and Ongoing Cx

- Proper training
  - Training requirements come from the spec
- Ongoing Cx
  - Test plans templates

Live-in Building Superintendent

Conclusion

Key takeaways

- Developers/Property Managers – Commissioning is an **ongoing process** and it takes **more than 1 day** of functional testing
- Designers – Include **clear sequences** and performance requirements for installers to complete the job.
- Construction Managers / Contractors – interlocked ERVs with Heat Pumps need a lot of tuning. **Diligence and Patience** are key
- Manufacturers and Reps – Continue developing and **improving documentation** for your systems.
- Push for **clear and realistic sequences** of operation
- If interlocking multiple manufacturers, it’s **Not ONE and DONE**
- Consider **operations and operators** during the design phase

Bridging the Gap

Design - Construction - Operation

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Questions?

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