Presented to:

HPSC Contractor Forum

IMPROVING CUSTOMER SATISFACTION:

LEASONS LEARNED FROM A RESIDENTIAL AIR TO AIR HEAT PUMP CASE STUDY

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Rob Pope

April 29th, 2026

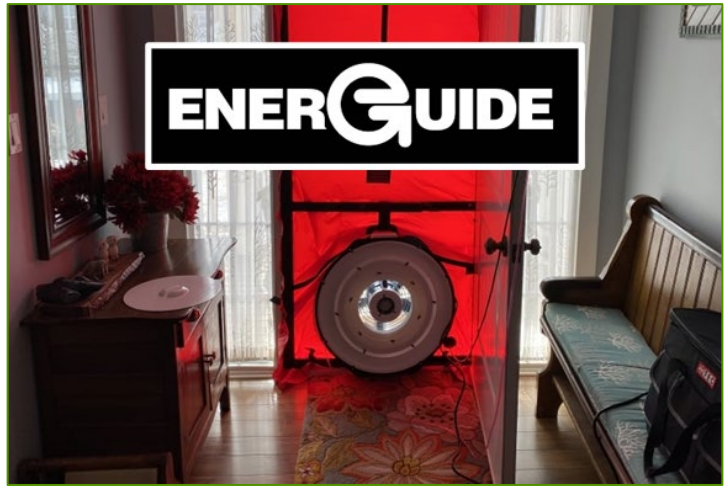
AGENDA

1. Discovery
2. Case Study
3. CSA F280 Calculation
4. Homeowner Complaint
5. Measured Airflows
6. Deficiencies
7. Fixing the Problem
8. Q & A

DISCOVERY

Checklist for Retrofit Pre-Changeout Procedure:

- **Suitability of existing distribution system** *(e.g. ductwork capacity and static pressure check)*
- **Electrical panel/service capacity**
- **Envelope performance / airtightness** (Energuide evaluation)
- **CSA F280-12 Load Calculations**



DISCOVERY

A ‘Discovery Session’ is the foundation to successful project planning, to ensure project goals and client needs are established upfront.

ASK QUESTIONS

What is your experience with the existing HVAC equipment and distribution system?

What are your motivations for upgrading to a heat pump system?

Are you planning any further energy upgrades to your home?

DISCOVERY

Discuss Occupants' Needs and Expectations:

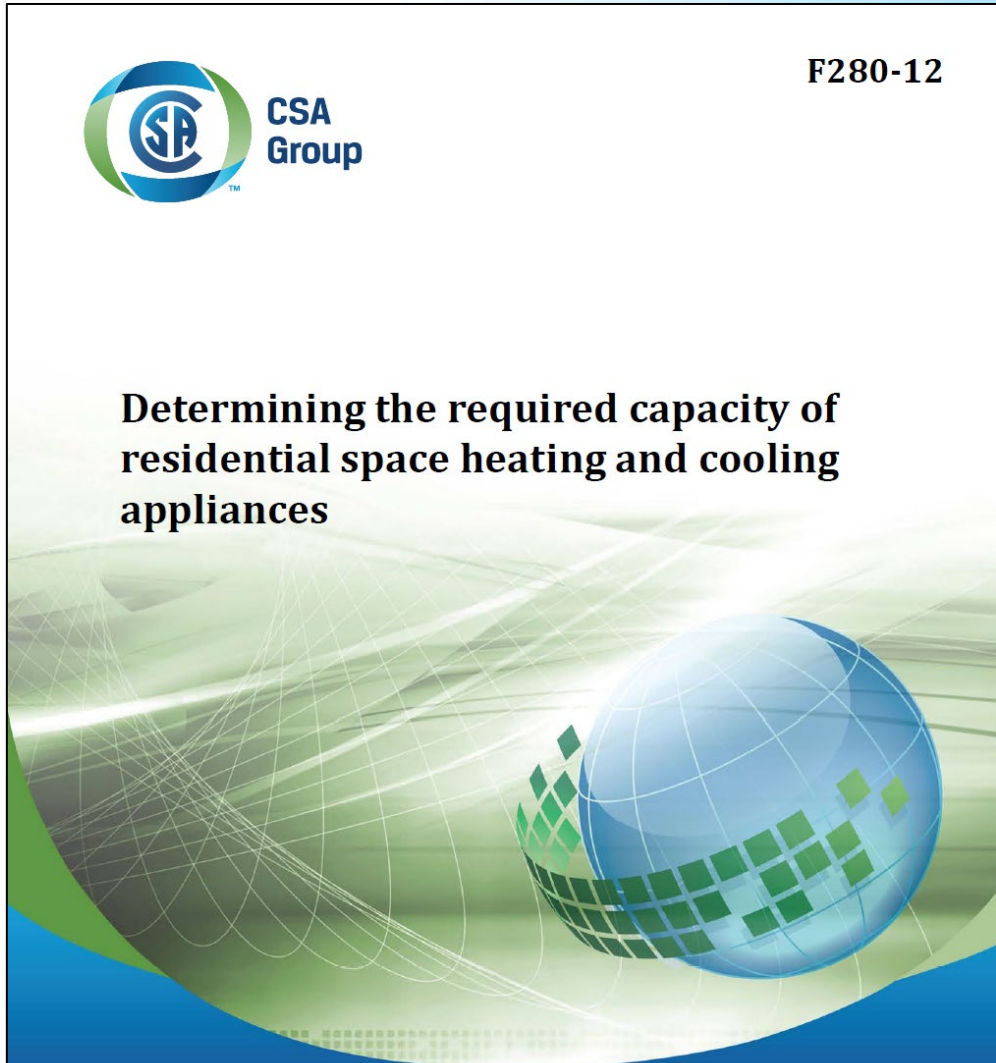
- **Current conditions** - how the HVAC system has been working?
- **Aesthetics** – any issues/concerns with wall mounted units, external piping or outdoor unit placement?
- **Primary motivation factor** – cost savings, rebates, GHG reduction, emergency replacement?
- **Budget** – upfront and operational cost considerations?
- **Comfort & Health** – what is comfortable, what temperatures, are there health issues, allergies, other sensitivities including noise?

DISCOVERY

CAN/CSA F280-12: Canadian Standards Association (CSA) standard on how to properly size residential space heating and cooling equipment that is nationally recognized and referenced in the BC Building Code (Section 9.33.5)

Making sure this standard is used can:

- ✔ Ensure comfort
- ✔ Reduce installed HVAC system costs
- ✔ Ensure you comply with code
- ✔ **Reduce your liability risks**



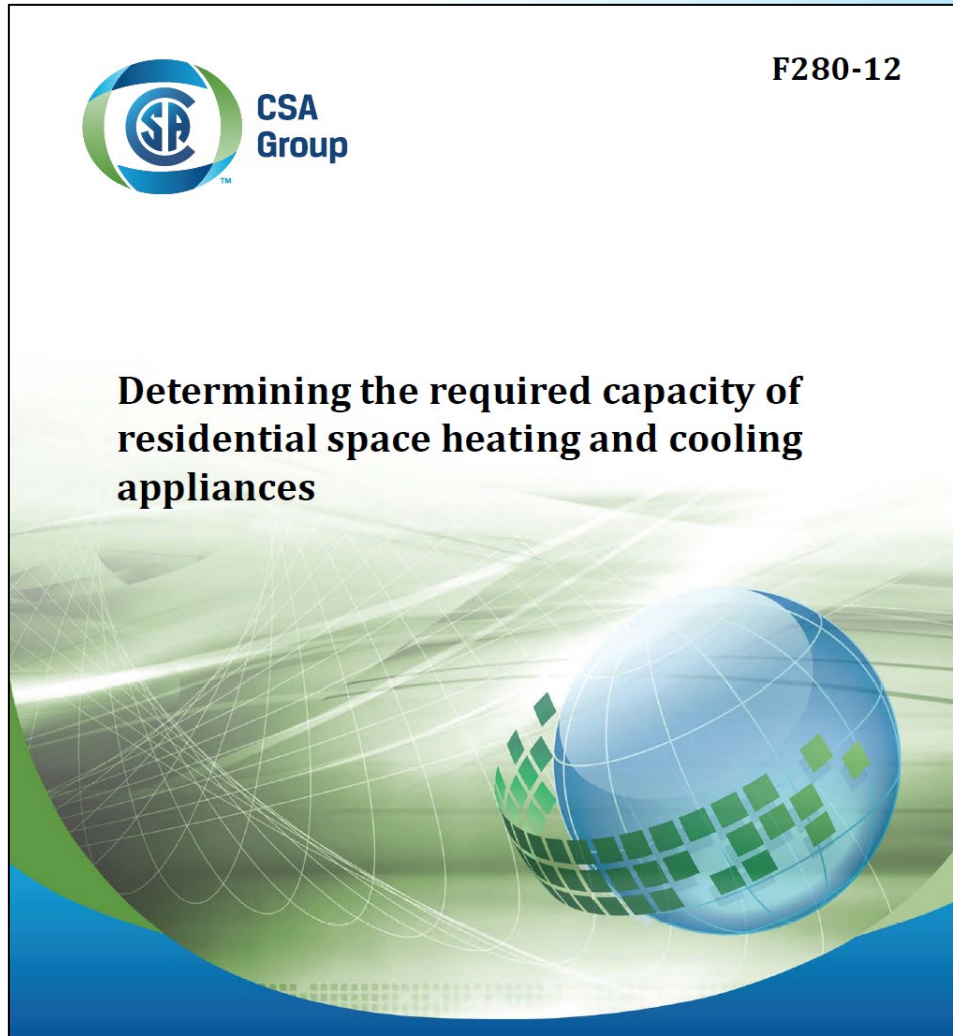
SITE INFO

- **Location: Victoria, BC**
  - Built in 2023
- **2,500 ft² Floor Area**
  - Separate basement suite
- Centrally ducted system
  - Furnace
  - Air to Air Heat Pump
- HRV for ventilation
  - Outdoor air supplied to return air duct
  - Independent exhaust

CSA F280 QUESTION

What are the heat loss & heat gain BTUH results?

- Outdoor design temperatures:
  - Heating: 22°C, 71.6°F
  - Cooling: 24°C, 75.2°F
- Area: 2,048 ft^2
- Occupancy: 3-bedroom, 4 people
- Assemblies:
  - Walls: R-20
  - Ceilings: R-40
  - Windows: USI: 1.96 & SHGC: 0.47



CALCULATION RESULTS

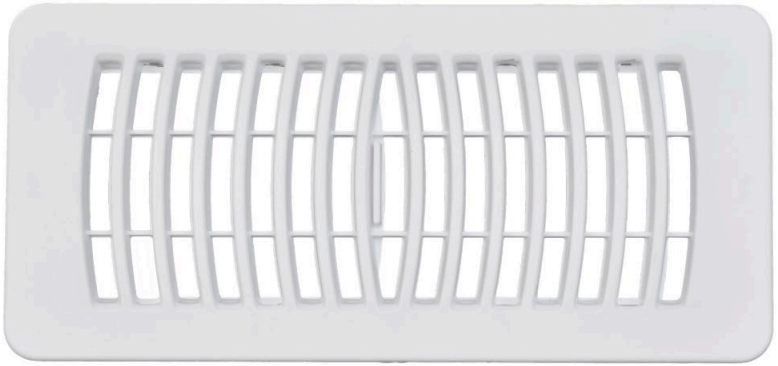
HEAT LOSS & HEAT GAIN SUMMARY, (BTUH) imperial

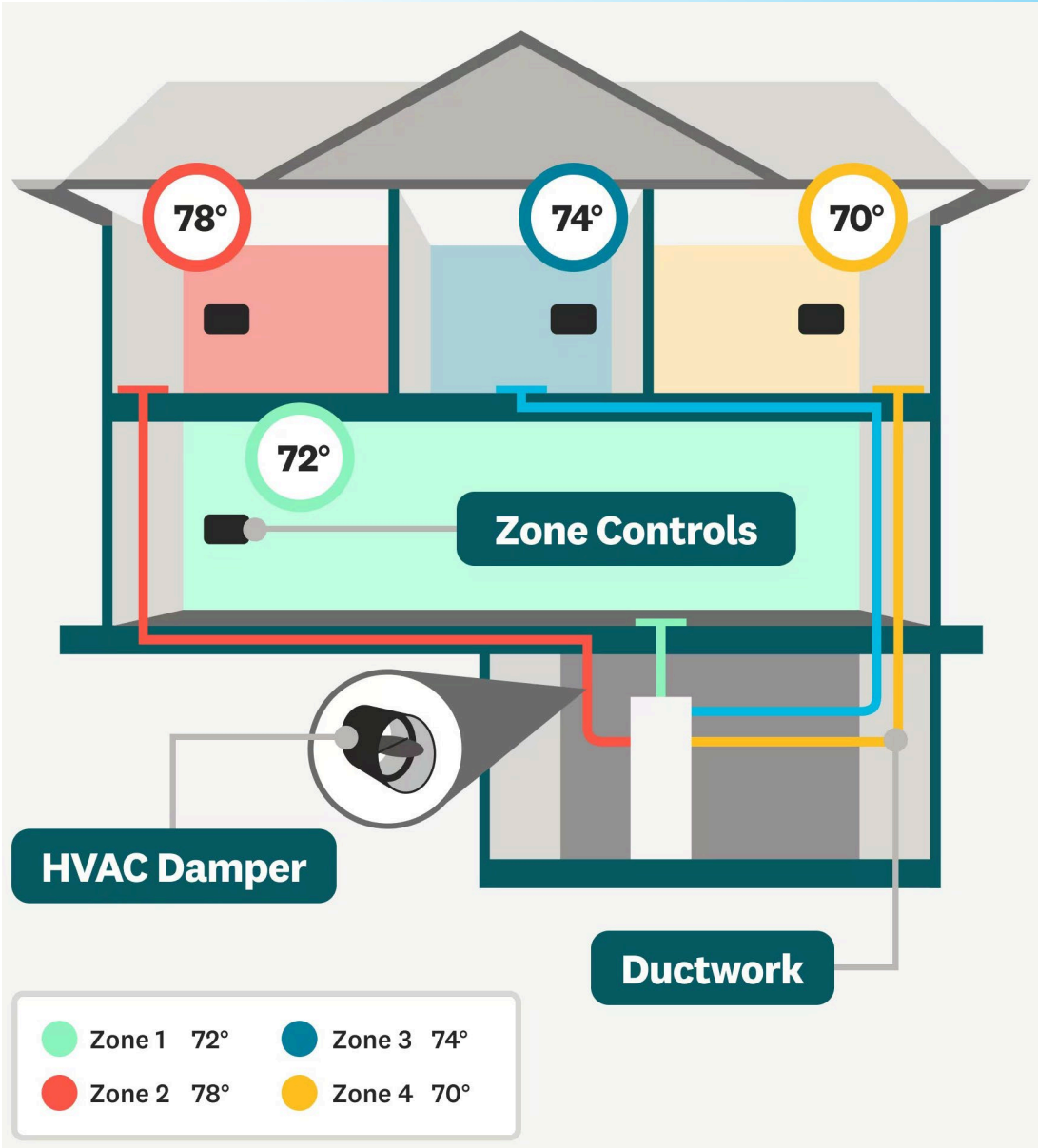
ROOM NAME	FLOOR LEVEL	FL AREA (ft²)	HEAT LOSS TOTAL	HEAT GAIN SENS.	HEAT GAIN **TOTAL (sensible + latent)**
(#1)Basement	1	206	2346	3	**4**
(#2)Kitchen	2	230	1651	2380	**3094**
(#3)Dining & Great Room	2	300	2367	4299	**5588**
(#4)Pantry	2	69	210	11	**15**
(#5)Mudroom & Hall	2	90	584	9	**12**
(#6)Foyer	2	97	864	437	**568**
(#7)Half Bath	2	32	281	6	**8**
(#8)Ensuite	3	117	1011	997	**1296**
(#9)WIC	3	78	272	63	**81**
(#10)Main Bath	3	52	182	42	**54**
(#11)Laundry	3	32	212	29	**38**
(#12)Bedroom 2	3	136	1750	1657	**2154**
(#13)Bedroom 3	3	140	1030	667	**867**
(#14)Bonus, Hall & Stairs	3	261	836	901	**1172**
(#15)Primary Bedroom	3	208	1674	1353	**1759**

	AREA	HEAT LOSS	GAIN (sens.)	GAIN (total)
OVERALL BUILDING	2048	15268	12853	**16708**

ZONE CONTROL

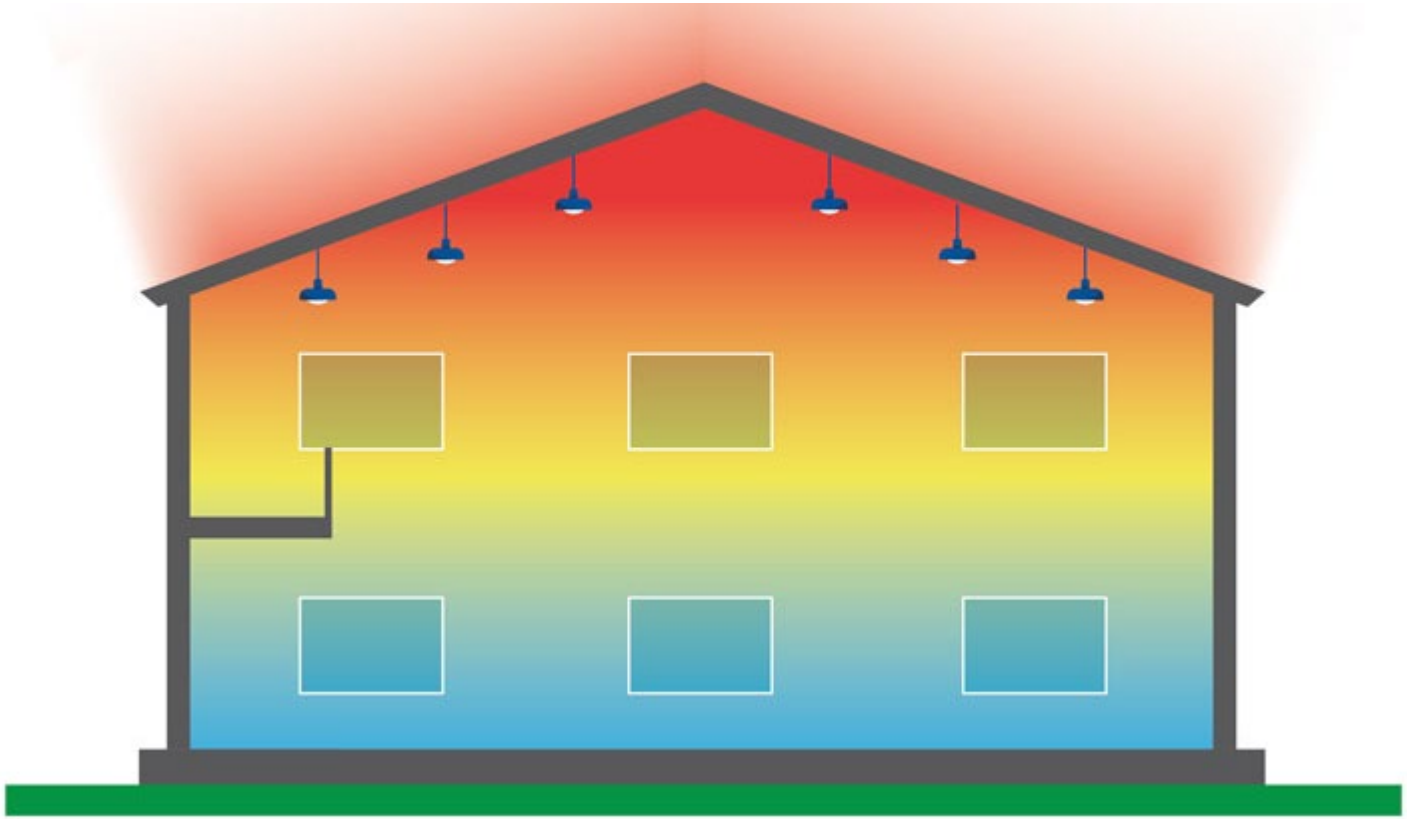
- Heating and cooling loads change throughout the year
- Zone control of this system can only be achieved by opening and closing grilles
  - Duct system too small to close grilles?
- Single thermostat on main floor





CUSTOMER COMPLAINT

- Poor thermal comfort, especially on the top floor
  - System is worse in cooling mode
- Inconsistent temperature throughout the home



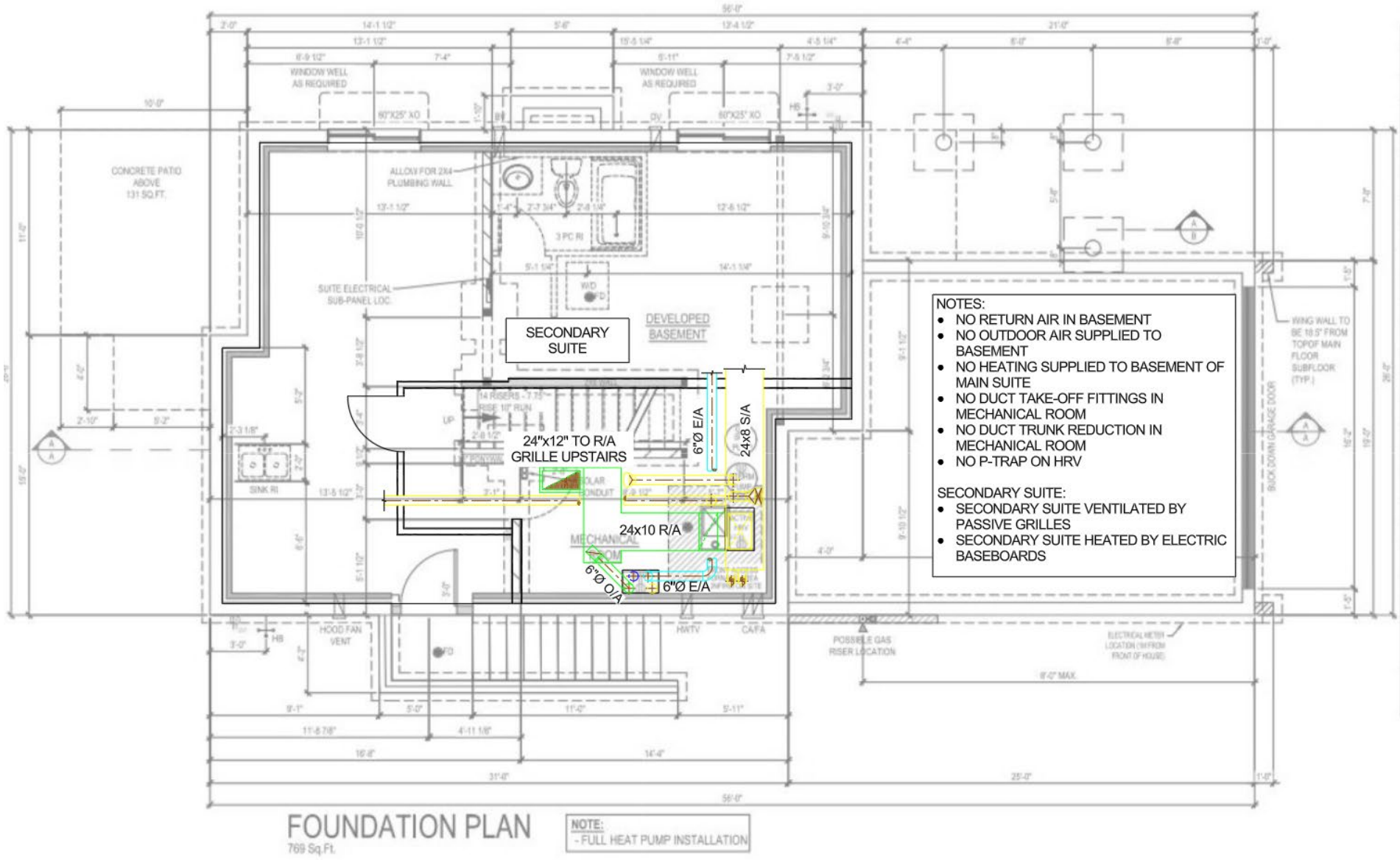
COMPLAINT TIMELINE

- Customer complained to builder
- HVAC contractor has been to site multiple times
  - Cannot resolve the issues to the customer's satisfaction
- Customer has escalated the complaint to the insurance company
- Customer hired an independent contractor to analyze the system

What do you think the results of the report are?

FOUNDATION PLAN

No return or supply air to basement



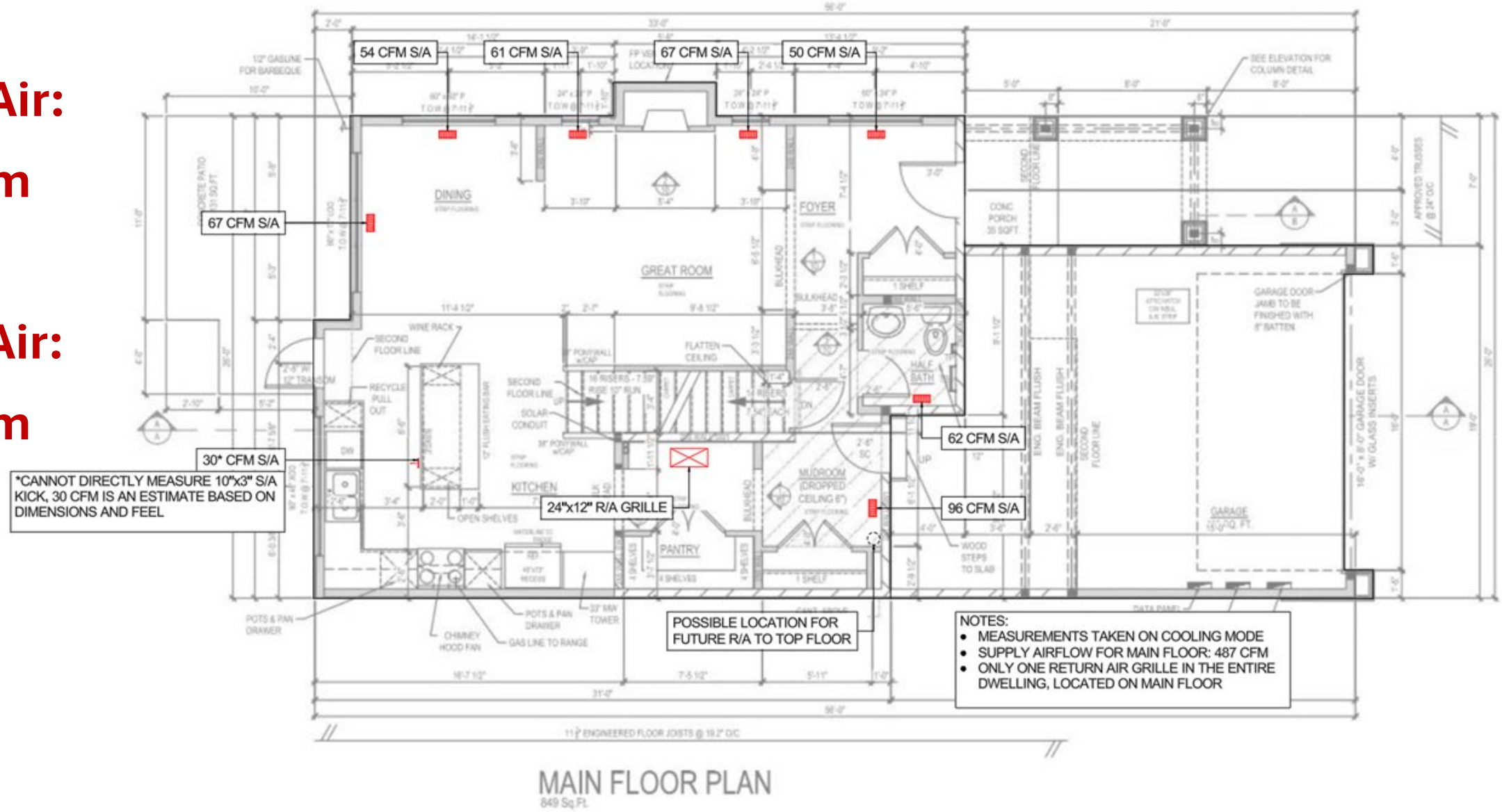
MAINFLOOR PLAN

Supply Air:

487 cfm

Return Air:

738 cfm



MAIN FLOOR PLAN
849 Sq.Ft.

TOP FLOOR PLAN

Supply Air:

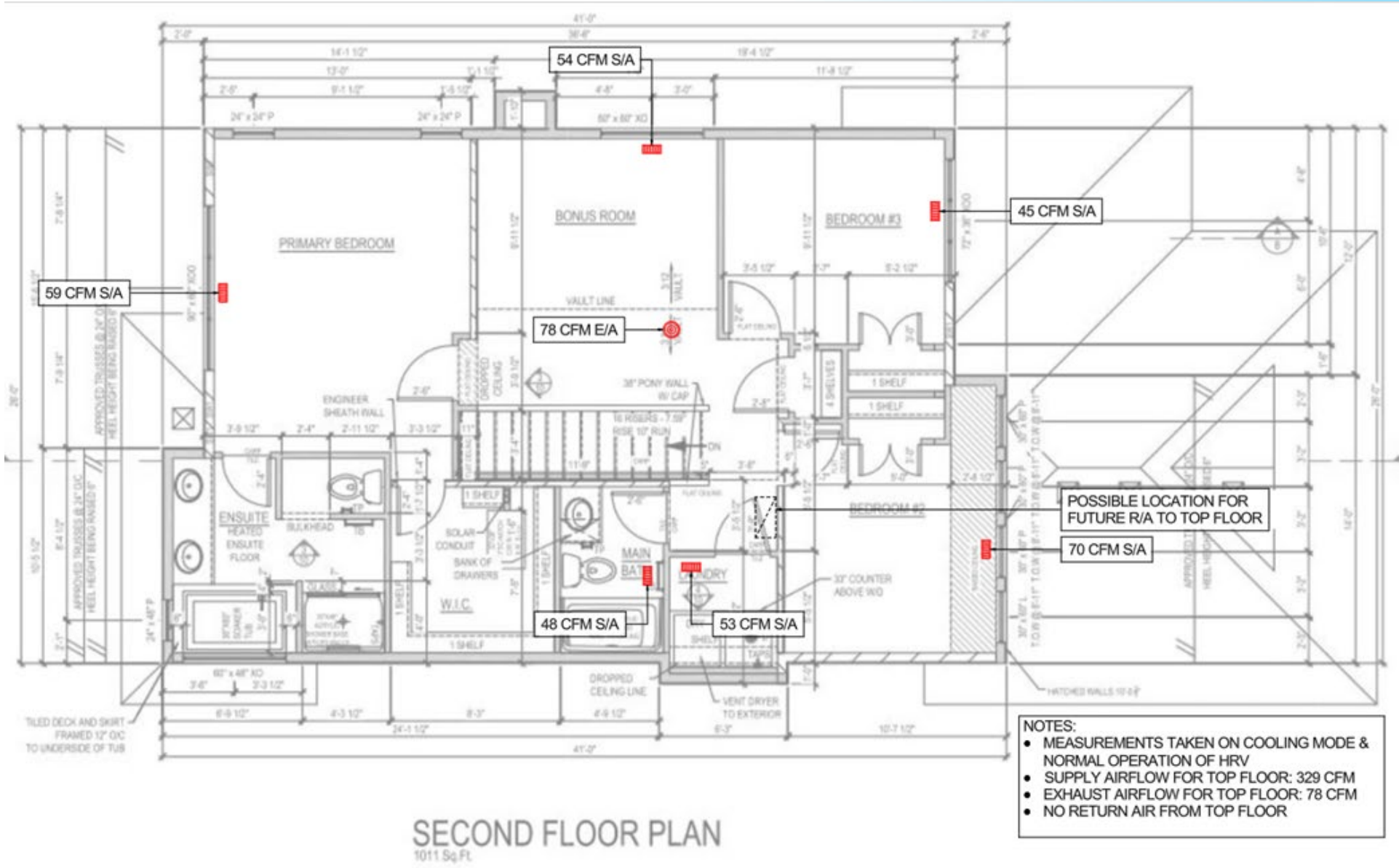
329 cfm

Return Air:

0 cfm

Exhaust Air:

78 cfm



SUPPLY AIRFLOW RESULTS

		HEAT LOSS (DESIGN)		HEAT GAIN (DESIGN)		INSTALLED (MEASURED ON COOLING)	DIFFERENCE FROM MEASURED TO HEAT LOSS	DIFFERENCE FROM MEASURED TO HEAT GAIN
ROOM #	ROOM NAME	LOSS [BTUH]	AIRFLOW [CFM]	TOTAL [BTUH]	AIRFLOW [BTUH]	AIRFLOW [CFM]	AIRFLOW [CFM]	AIRFLOW [CFM]
1	Basement	2,346	125	4	0	0	-125	0
2	Kitchen	1,651	88	3,094	151	30	-58	-121
3	Dining & Great Room	2,367	127	5,588	273	249	122	-24
4	Pantry	210	11	15	1	0	-11	-1
5 →	Mudroom & Hall	584	31	12	1	96	65	95
6	Foyer	864	46	568	28	50	4	22
7 →	Half Bath	281	15	8	0	62	47	62
8	Ensuite	1,011	54	1,296	63	0	-54	-63
9	WIC	272	15	81	4	0	-15	-4
10 →	Main Bath	182	10	54	3	48	38	45
11 →	Laundry	212	11	38	2	53	42	51
12	Bedroom 2	1,750	94	2,154	105	70	-24	-35
13	Bedroom 3	1,030	55	867	42	45	-10	3
14	Bonus, Hall, & Stairs	836	45	1,172	57	54	9	-3
15	Primary Bedroom	1,674	89	1,759	86	59	-30	-27
	TOTAL	**15,270**	**816**	**16,710**	**816**	**816**	-	-

EXHAUST & RETURN AIR

Question:

In a single-family dwelling unit that is equipped with a heat recovery ventilator (HRV) and a forced air furnace, can an exhaust grille satisfy the requirement for a return air grille on the upper most floor level?

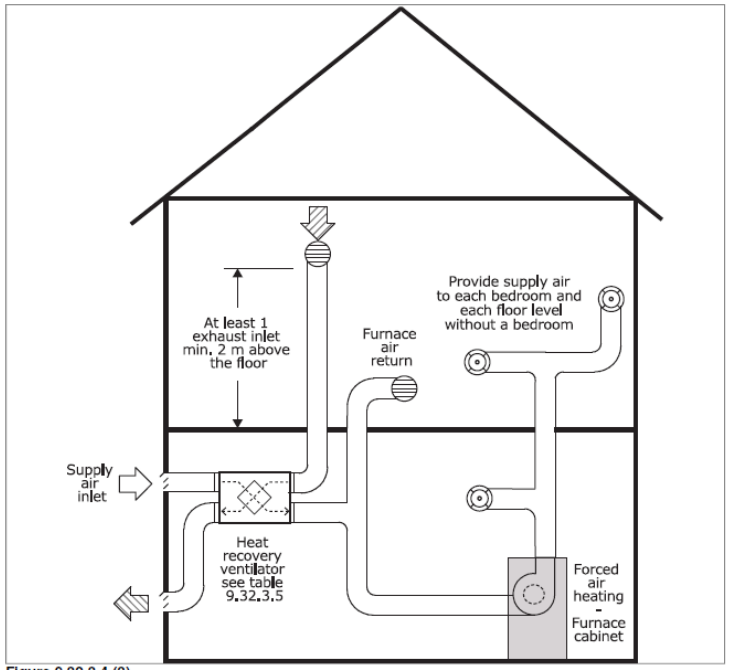
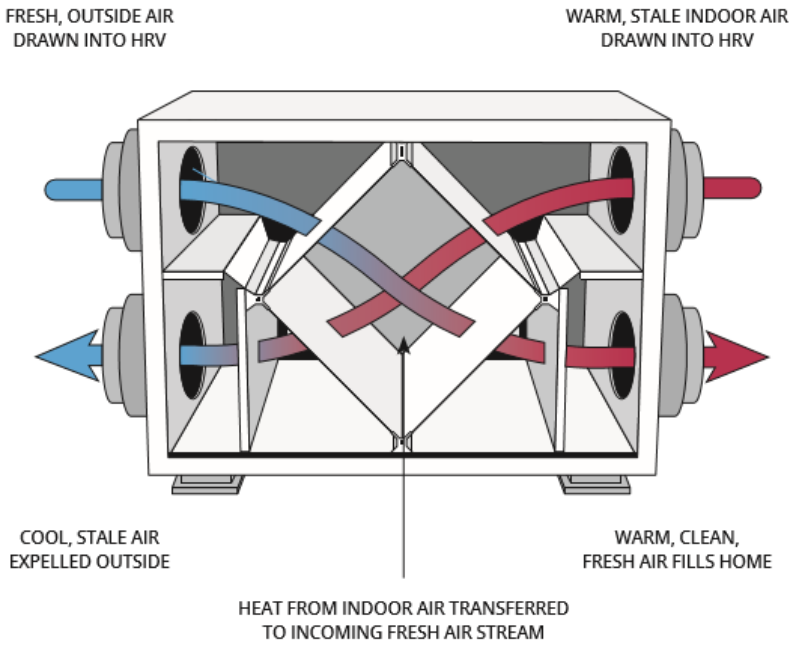


Figure 9.32.3.4.(3)
Forced-Air Heating System with Heat Recovery Ventilator Supply Air Distribution



EXHAUST & RETURN AIR

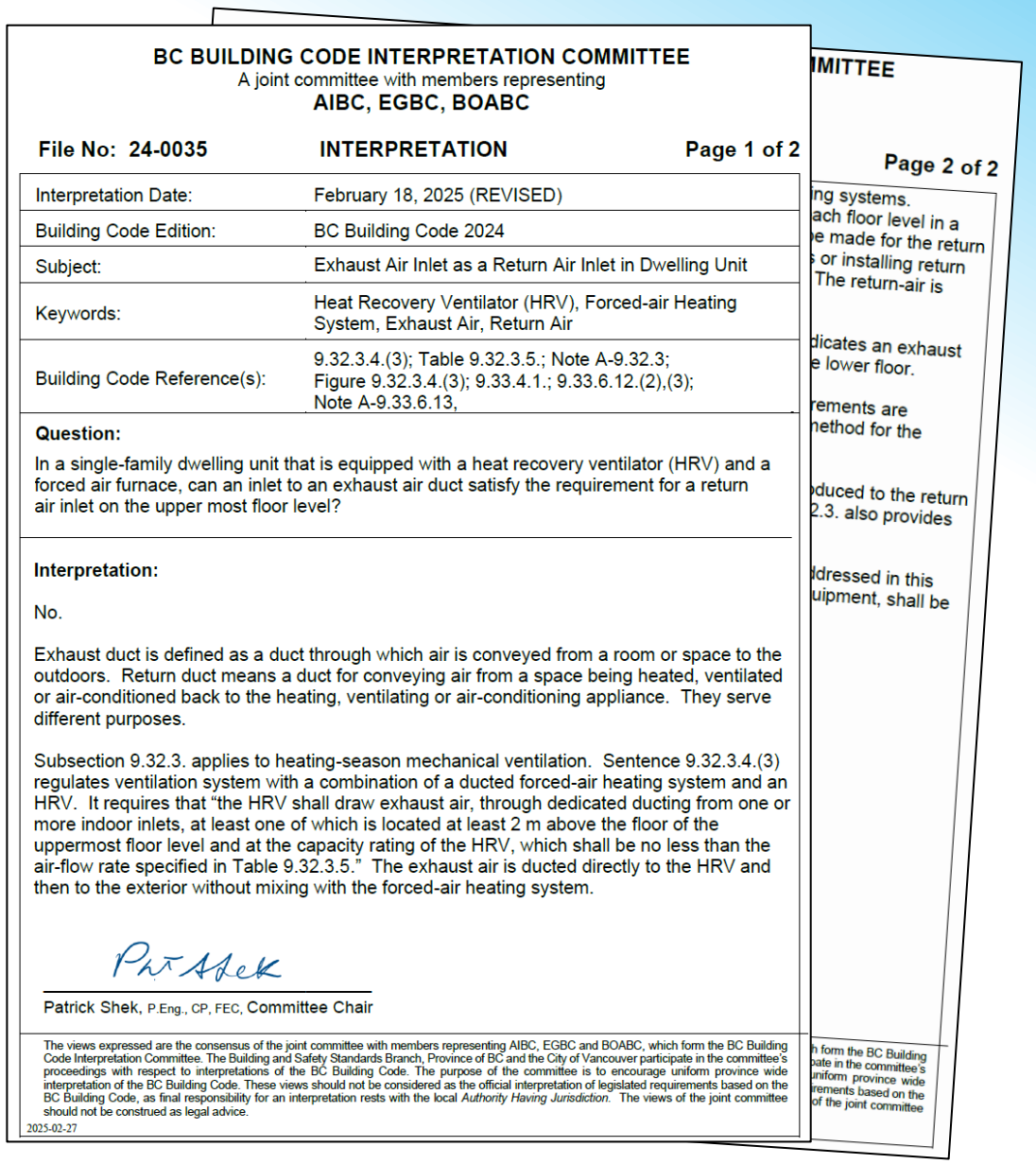
Interpretation:

NO!

Return air must be present on all floors in a centrally ducted system, per BCBC **9.32.3.4. (3)**

- Exhaust & return air serve different functions

- File No: 24-0035, Feb 18, 2025



BC BUILDING CODE INTERPRETATION COMMITTEE
A joint committee with members representing
AIBC, EGBC, BOABC

File No: 24-0035 **INTERPRETATION** **Page 1 of 2**

Interpretation Date:	February 18, 2025 (REVISED)
Building Code Edition:	BC Building Code 2024
Subject:	Exhaust Air Inlet as a Return Air Inlet in Dwelling Unit
Keywords:	Heat Recovery Ventilator (HRV), Forced-air Heating System, Exhaust Air, Return Air
Building Code Reference(s):	9.32.3.4.(3); Table 9.32.3.5.; Note A-9.32.3; Figure 9.32.3.4.(3); 9.33.4.1.; 9.33.6.12.(2),(3); Note A-9.33.6.13,

Question:

In a single-family dwelling unit that is equipped with a heat recovery ventilator (HRV) and a forced air furnace, can an inlet to an exhaust air duct satisfy the requirement for a return air inlet on the upper most floor level?

Interpretation:

No.

Exhaust duct is defined as a duct through which air is conveyed from a room or space to the outdoors. Return duct means a duct for conveying air from a space being heated, ventilated or air-conditioned back to the heating, ventilating or air-conditioning appliance. They serve different purposes.

Subsection 9.32.3. applies to heating-season mechanical ventilation. Sentence 9.32.3.4.(3) regulates ventilation system with a combination of a ducted forced-air heating system and an HRV. It requires that "the HRV shall draw exhaust air, through dedicated ducting from one or more indoor inlets, at least one of which is located at least 2 m above the floor of the uppermost floor level and at the capacity rating of the HRV, which shall be no less than the air-flow rate specified in Table 9.32.3.5." The exhaust air is ducted directly to the HRV and then to the exterior without mixing with the forced-air heating system.

Patrick Shek, P.Eng., CP, FEC, Committee Chair

The views expressed are the consensus of the joint committee with members representing AIBC, EGBC and BOABC, which form the BC Building Code Interpretation Committee. The Building and Safety Standards Branch, Province of BC and the City of Vancouver participate in the committee's proceedings with respect to interpretations of the BC Building Code. The purpose of the committee is to encourage uniform province wide interpretation of the BC Building Code. These views should not be considered as the official interpretation of legislated requirements based on the BC Building Code, as final responsibility for an interpretation rests with the local *Authority Having Jurisdiction*. The views of the joint committee should not be construed as legal advice.

2025-02-27

IMITTEE

Page 2 of 2

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EXHAUST & RETURN AIR

Airflows can be balanced using exhaust rather than return air in specific circumstances…

<u>However</u>; this is not appropriate for residential (Part 9) applications because it creates imbalanced systems and inconsistent temperatures through the building

This has been attempted many times and it always fails to produce a system that functions properly

CODE DEFICIENCY

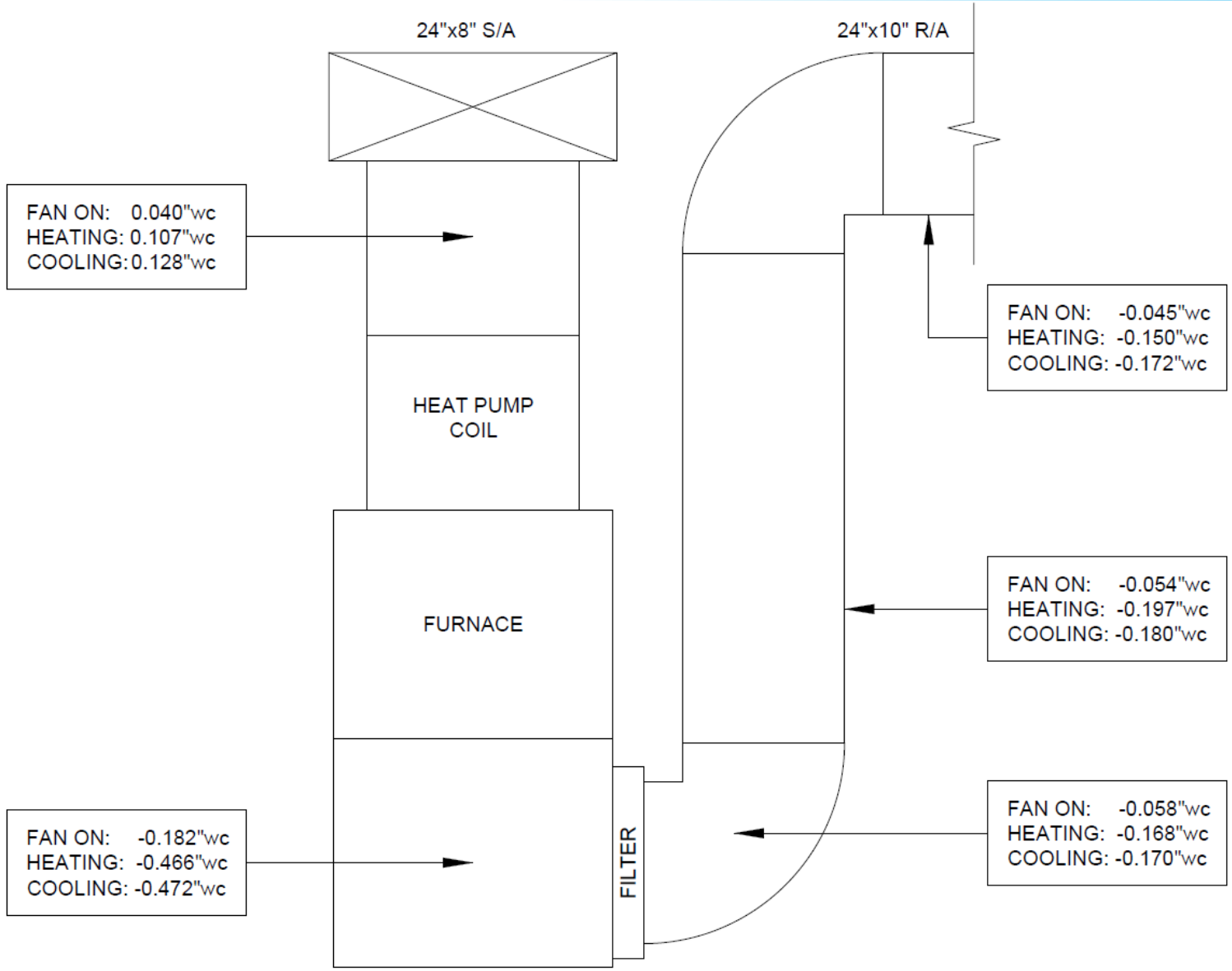
- Return air not provided to the top floor
  - Only a single return air grille was installed, located on the main floor
  - Most of the basement belongs to the suite, which electric baseboard heat

BCBC: 9.33.6.12. Return-Air Inlets

- 2) Except for unfinished areas and floor levels which are less than 900 mm above or below an adjacent floor level which is provided with a return-air inlet, at least one return-air inlet shall be provided in each floor level in a dwelling unit.

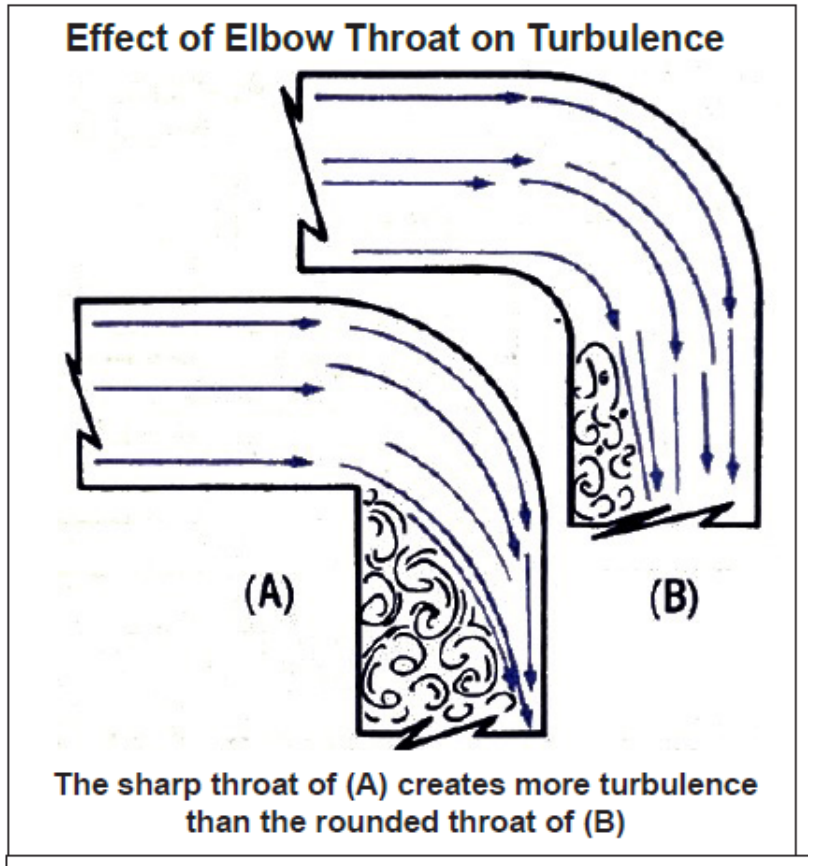
ESP MEASUREMENTS

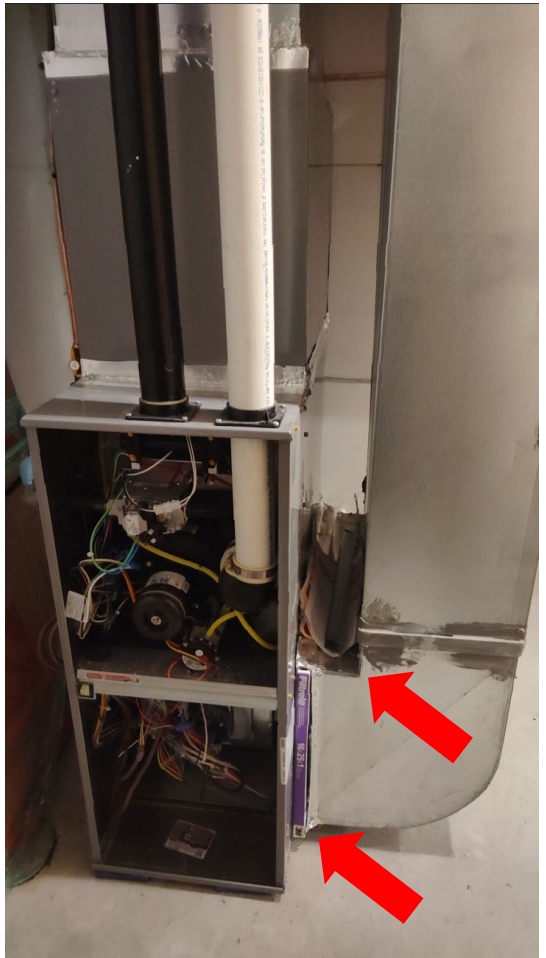
- External static pressures taken on site
  - Cooling: highest speed
- ESP from duct: 0.3"wc
  - High for a small system
- Don't forget the filter!



ELBOW SELECTION

- Elbows of return air drop have square throats
- Filter is only 1” in depth and is located directly beside the fan inlet



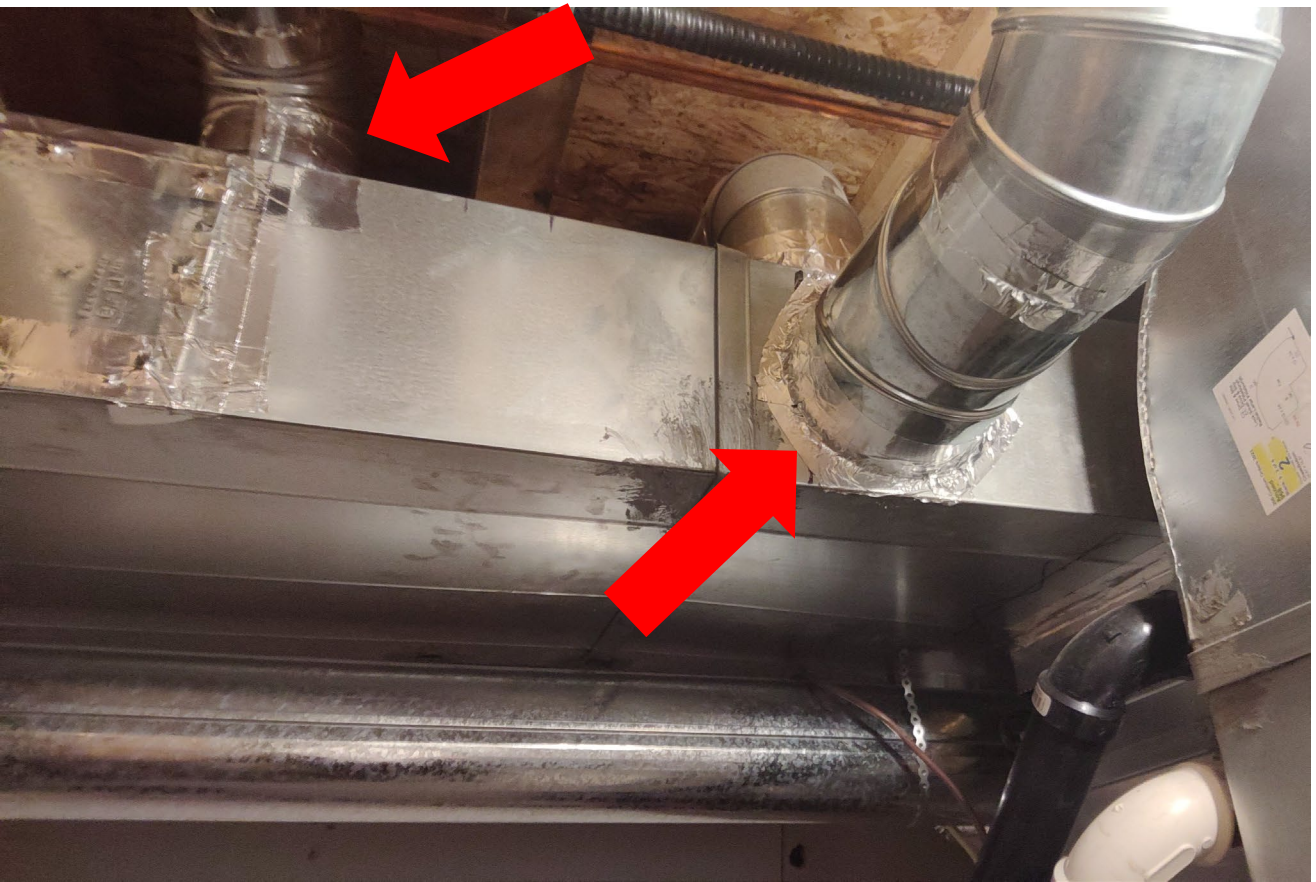


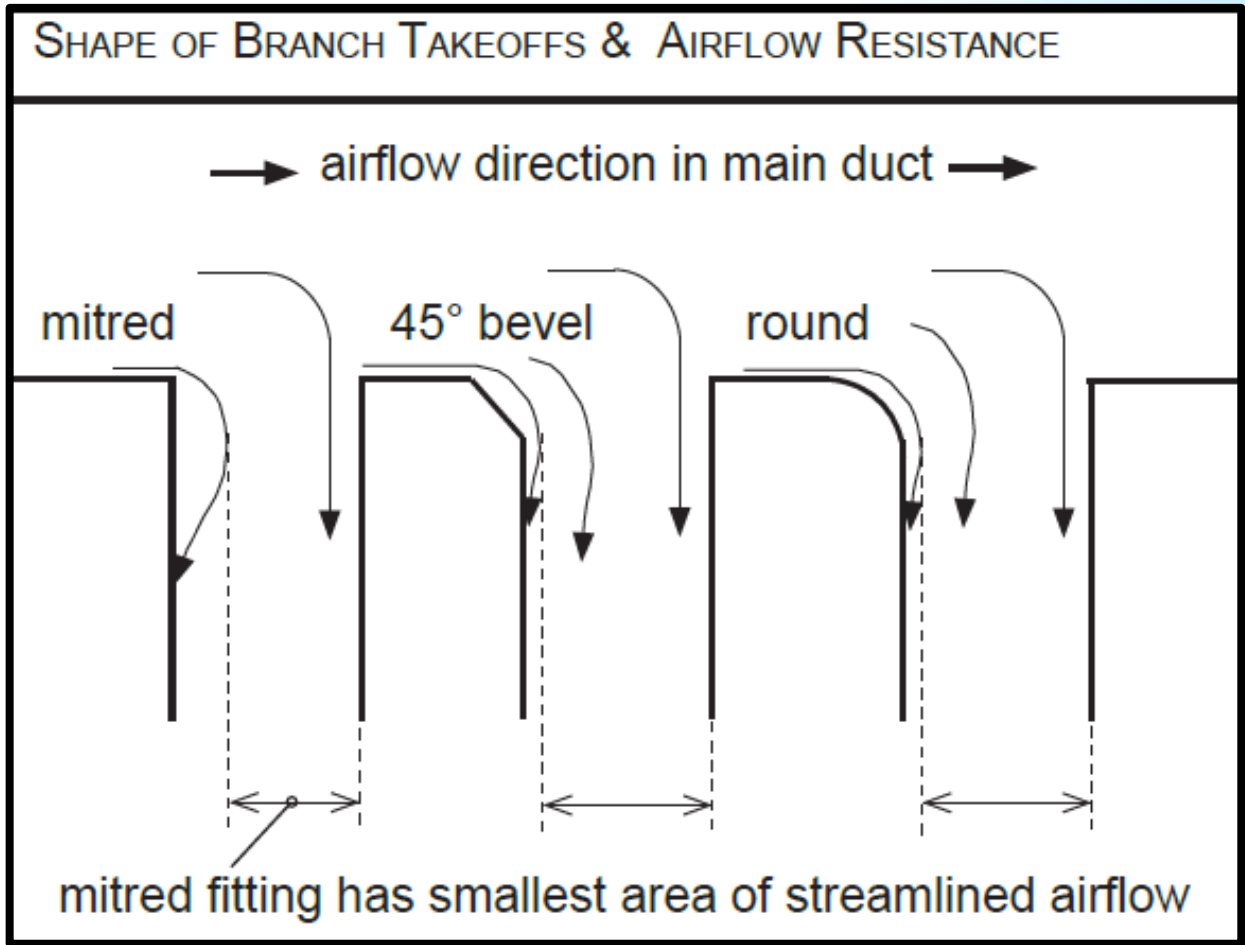
PLENUM TAKE-OFFS

- No plenum take-offs
- Return air duct tapped into trunk without a beveled fitting

BRANCH TAKE-OFFS

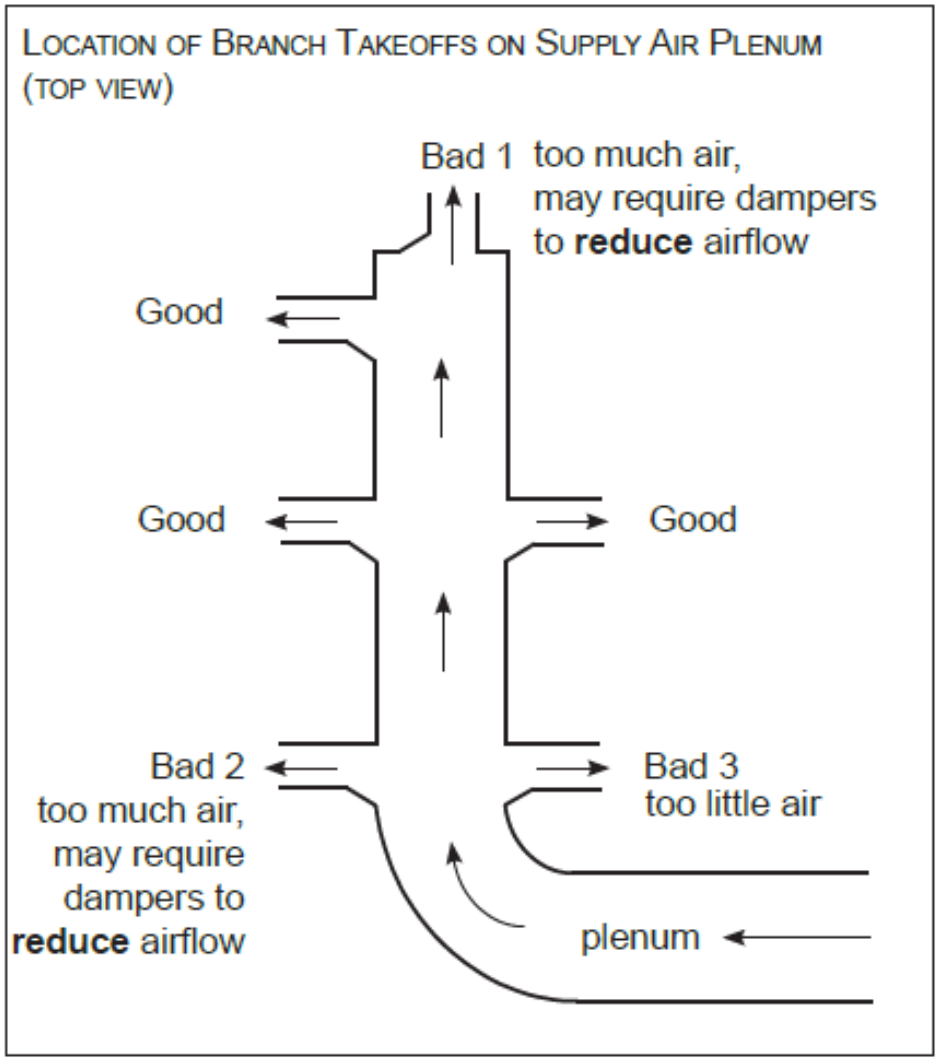
- No take-offs on trunks or branches
  - Dove-tailed pipes into trunks
- Elbow gores not sealed





BEST PRACTICE

- Supply air branches connected off the end caps

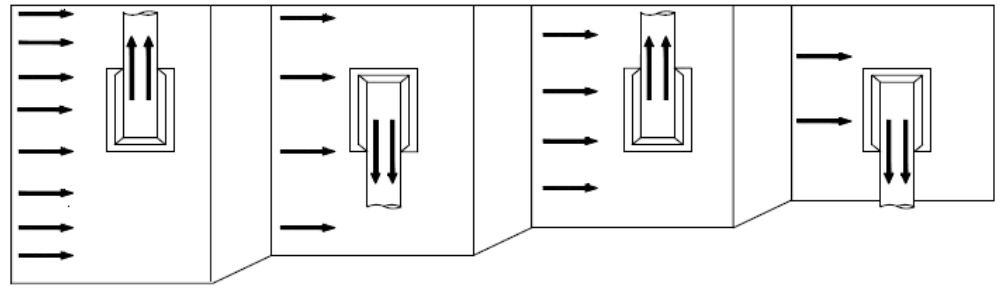


BEST PRACTICE

- No reducing cross sections on mechanical room ducts

Trunk Duct - With Reducing Cross Sectional Area

Velocity	1000 FPM	1000 FPM	1000 FPM	1000 FPM
Pv	0.07"WC	0.07"WC	0.07"WC	0.07"WC

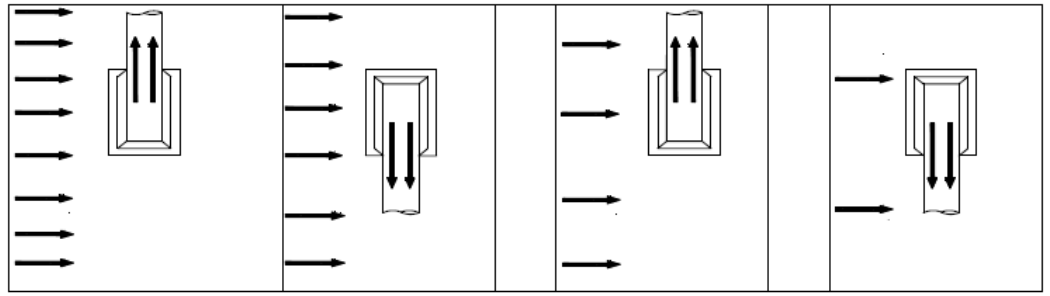


Ps	0.15"WC	0.15"WC	0.15"WC	0.15"WC
Pt	0.22"WC	0.22"WC	0.22"WC	0.22"WC

Note: Pt remains constant along the length of the duct. Because duct is short, fat and straight.

Trunk Duct - Without Reducing Cross Sectional Area

Velocity	1000 FPM	750 FPM	500 FPM	250 FPM
Pv	0.07"WC	0.03"WC	0.02"WC	0.01"WC



Ps	0.15"WC	0.19"WC	0.20"WC	0.21"WC
Pt	0.22"WC	0.22"WC	0.22"WC	0.22"WC

Note: Pt remains constant along the length of the duct. Because duct is short, fat and straight.

BEST PRACTICE

- P-trap on HRV not installed
  - Easily fixed code deficiency
- HRV is set to a single speed
  - No controller installer
- Exhaust location is poor
  - Exhaust from bathrooms

REMEDIATION

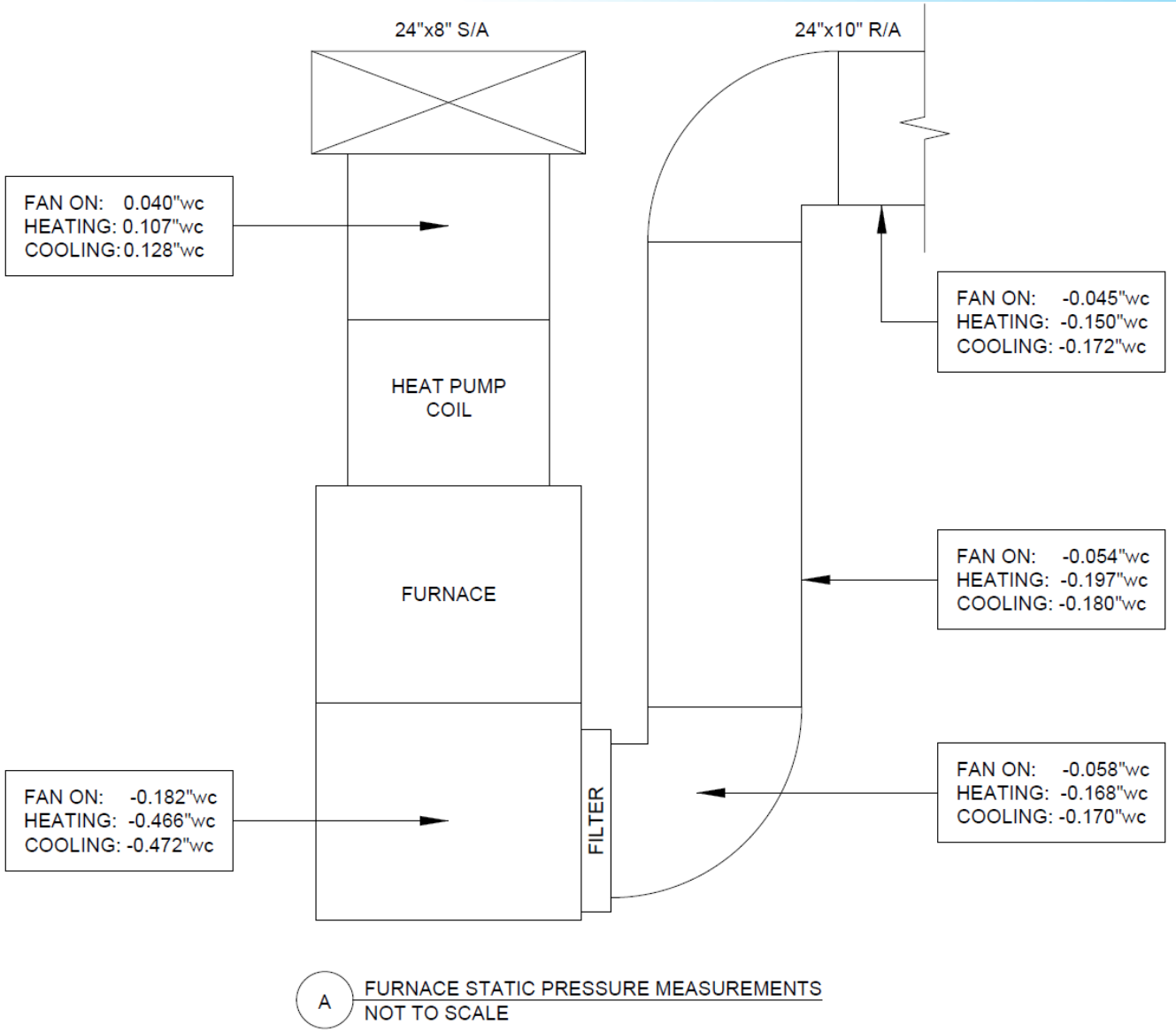
- Add return air to the top floor
  - Requires a chase in the mudroom
  - Looks possible on site, requires a lot of finishing work
  - Quote received for $7,000

- Who pays for the work?

IMPROVEMENTS

Improving system performance

- Seal visible ductwork
- Replace return air elbows with proper fittings
  - Turning vanes, or
  - Radius elbows
- Increase filter to 4" wide & relocate filter to return air drop



QUESTIONS & COMMENTS?

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