

Passive Building Puzzles

BUILD BETTER TOGETHER

Ducted Range Exhaust, Trash Chutes and Dryer Exhaust, Oh My!



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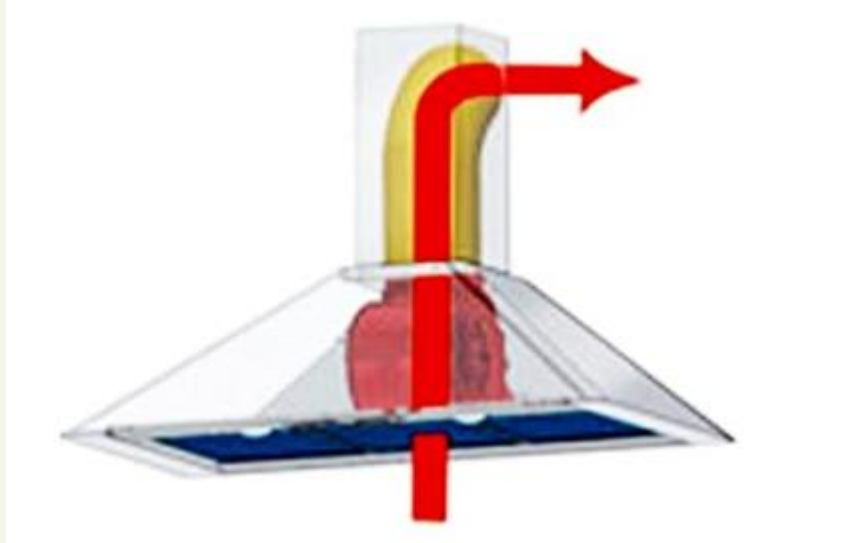
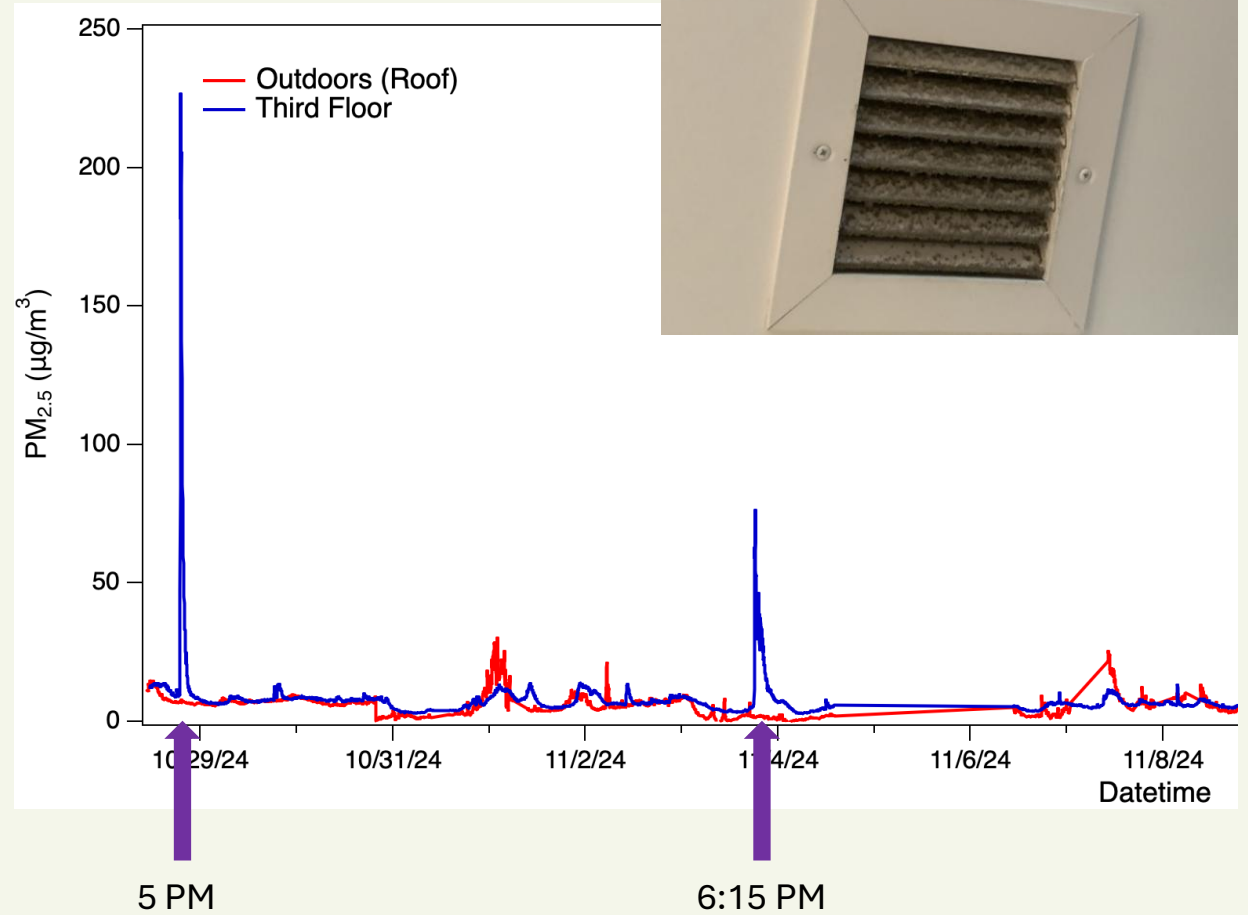
Presentation Matrix

CONSIDERATIONS	Effective Design	Measured Impacts
Ducted Range Exhaust	?	?
Dryer Exhaust	?	?
Trash Chutes	?	?

Building Pressurization

Radical Idea! – Maybe we should measure pressure when the intent is to positively or negatively pressurize a building?

Why Ducted Range Exhaust?



Ducted Domestic Range Exhaust

Code / Life Safety Concerns

- See section 505 of International Mechanical Code (or local code)
- Ductwork must not compromise fire barriers
- Ductwork must be sheet-metal (unless downdraft hood)
- Must include a backdraft damper
- Make-up air *required* if hood over 400 cfm
- Make-up air may be required at lower volumes by Phius depending on the details for the project (see Phius calculator)

Phius Calculator

v25.1.0 - 2025.08

Phius - Intermittent Exhaust & Make-Up Air Estimator		
Result		
Is Make-Up Air Required?	YES	
Building Airtightness Information		
Building Envelope Area	11,260	total square feet
Airtightness Limit / Result	0.05	cfm50/sf
Flow Exponent from Airtightness Test	0.75	-
In-Unit Exhaust Dryers		
# In-Unit Dryers		total count
# Bedrooms with access to In-Unit Dryers		total count
In-Unit Dryer Flow Rate		cfm / dryer
Common Area Exhaust Dryers		
# Common Dryers		total count
# Dwelling Units with access to Common Dryers		total count
# Bedrooms with access to Common Dryers		total count
Common Dryer Flow Rate		cfm / dryer
In-Unit Exhaust Kitchen Range Hoods		
# In-Unit Range Hoods	12	total count
Range Hood Flow Rate	120	cfm / hood
Common Area Exhaust Kitchen Range Hoods		
# Common Range Hoods		total count
Range Hood Flow Rate		cfm / hood
Calculations		
Occupants per In-Unit Dryer	-	average count
Occupants per Common Dryer	0	average count
Airtightness Limit	563	cfm50
Conversion CFM50 > CFM5	0.1778	-
Unbalanced Exhaust Allowance	100	cfm
Estimated Peak Coincident Exhaust	720	cfm

Required Inputs	Result
Calculated - do not override	Label

Instructions

1. Input building specific information.
 2. **In-Unit Exhaust Dryers:** If present, enter the total number of in-unit dryers provided as well as the number of bedrooms with access to those dryers.
 2. **Common Exhaust Dryers:** If present, enter the total number of common dryers provided as well as the number of bedrooms with access to those dryers.
 3. **In-Unit Range Hoods:** If present, enter the total number of in-unit range hoods provided.
 4. **Common Range Hoods:** If present, enter the total number of common area range hoods provided.
 5. **Result:** In the event a **YES** result populates, a dedicated make-up air system must be provided and tied to the intermittent direct exhaust system(s) installed.
- Process Tip:** The tighter the airtightness of the building, the more likely an intermittent exhaust system will need make-up air. Phius encourages project teams to test the tolerance the airtightness limit / result has on the unbalanced exhaust allowed before make-up air is required.

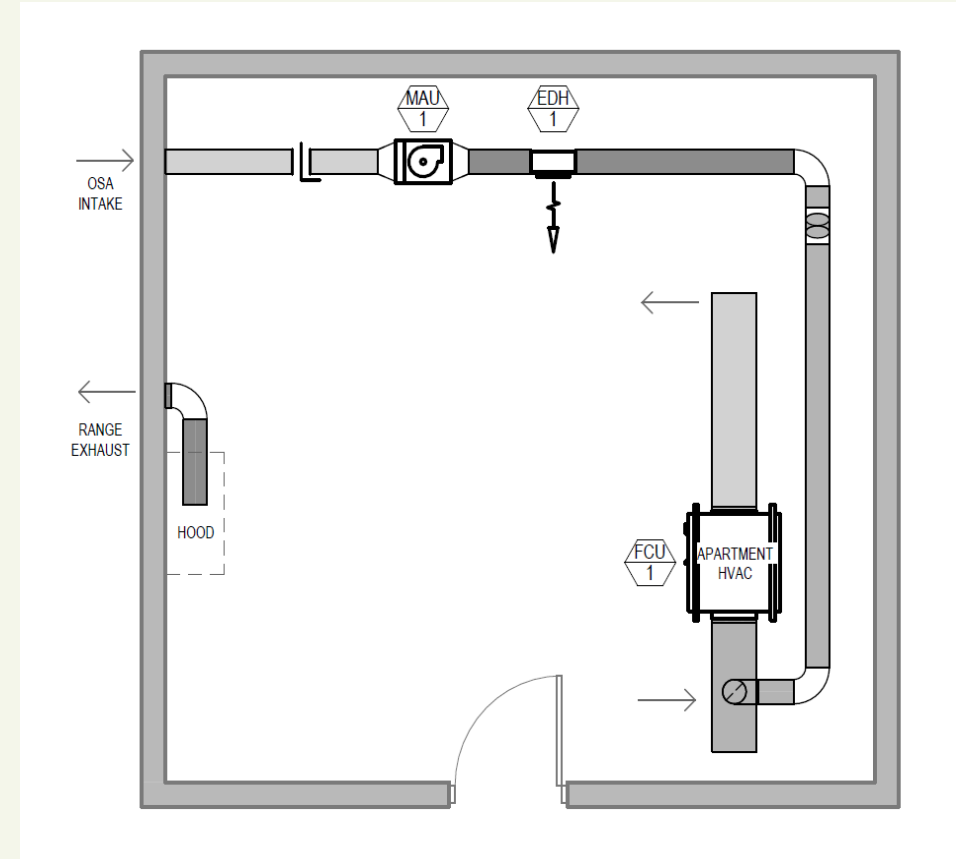
Calculations: Provided for reference. The unbalanced exhaust allowance is the maximum exhaust allowed to keep the building within a 5Pa pressure difference.

Ducted Range Exhaust

– Make Up Air Strategies

Dedicated MAU per unit

- Controls pressurization
- Can heat MAU if needed
- Requires more heat at apartment HVAC, unless heat separately
- Requires wall penetration per unit
- Costly
- Increased energy consumption
- Good for single-family

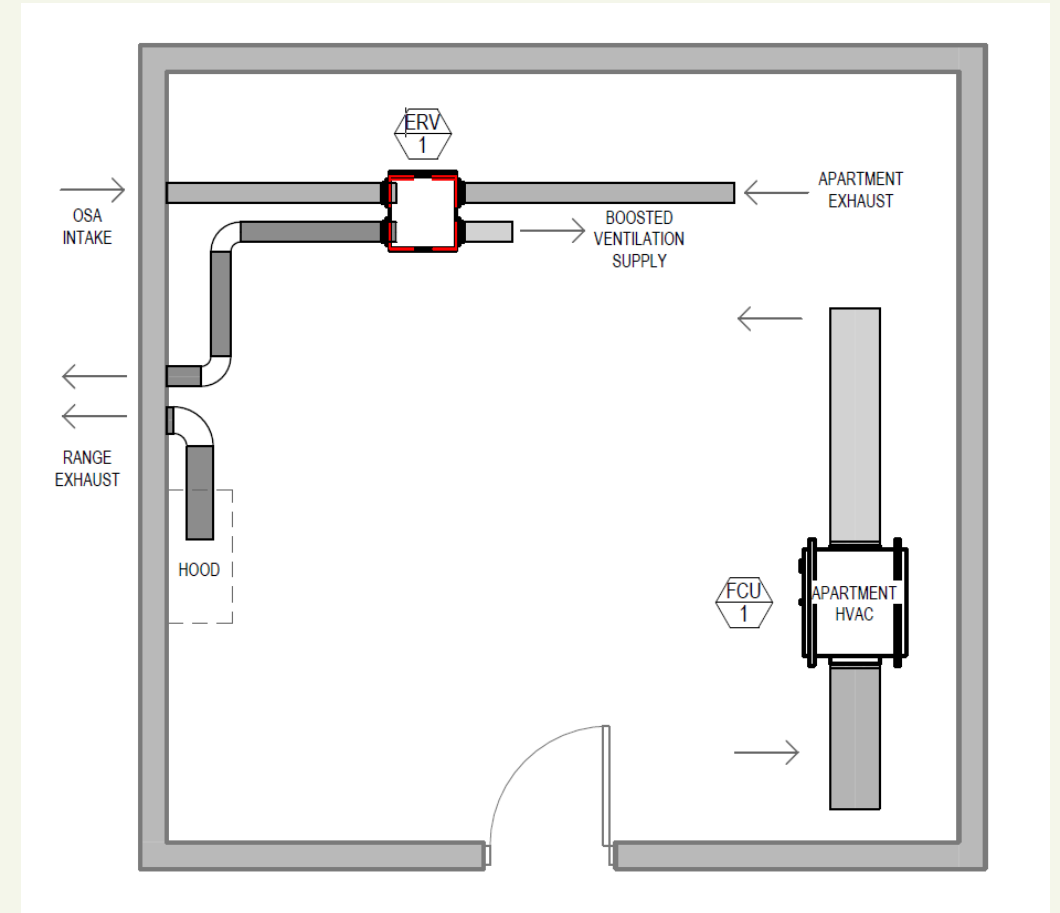


Ducted Range Exhaust

– Make Up Air Strategies

Boosted ERV

- Controls pressurization
- ERV may temper make-up air
- Requires wall penetration per unit
- Requires one ERV per unit
- May temporarily reduce bathroom exhaust
- Increases load on apartment HVAC
- Good for single-family

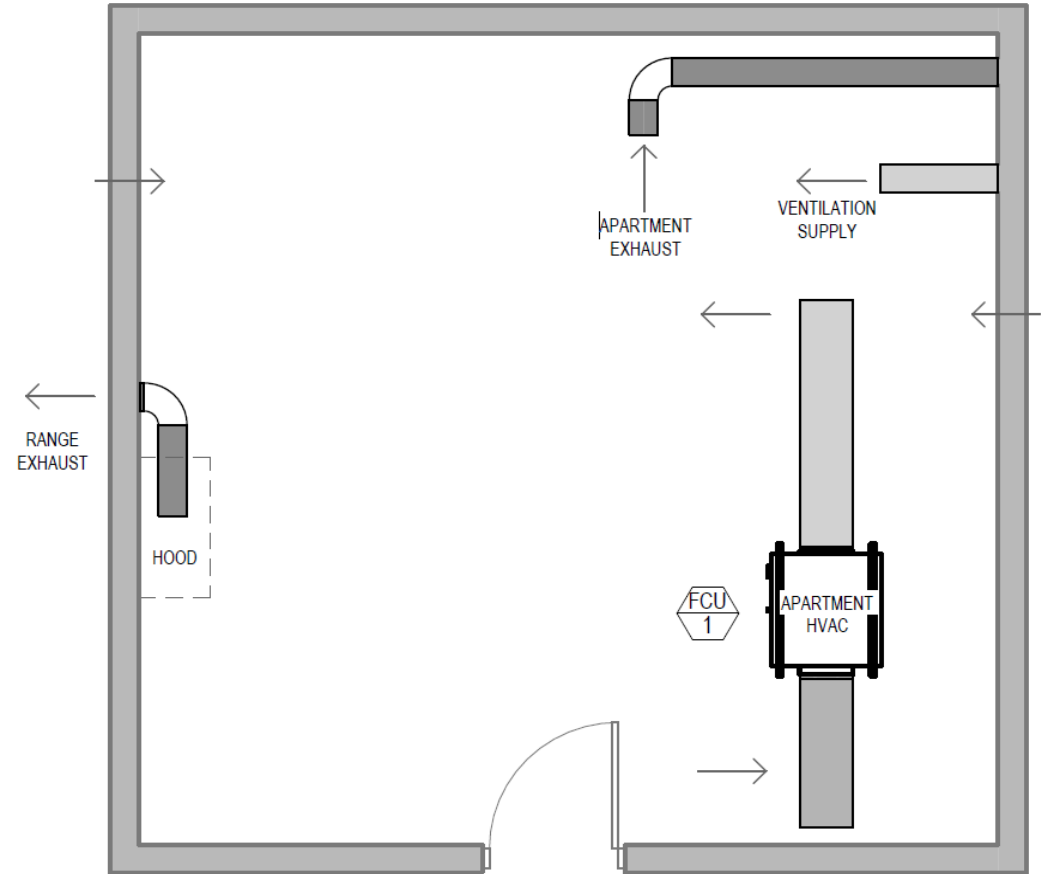


Ducted Range Exhaust

– Make Up Air Strategies

Slightly Pressurized Building

- Hood must be tested to meet ASHRAE 62.2 minimum requirement of 100 cfm
- No additional penetrations required
- No additional equipment required
- Works with any ventilation strategy



Crack Calculations

Room Leakage Spreadsheet

Job: Example
Date: 10/1/2026
By: G. Staengl

//Reference: ASHRAE Handbook - HVAC Applications 53.7

Aire Temp: 75 F
RH: 50 %
Specific Volume: 13.7 cuft/lb

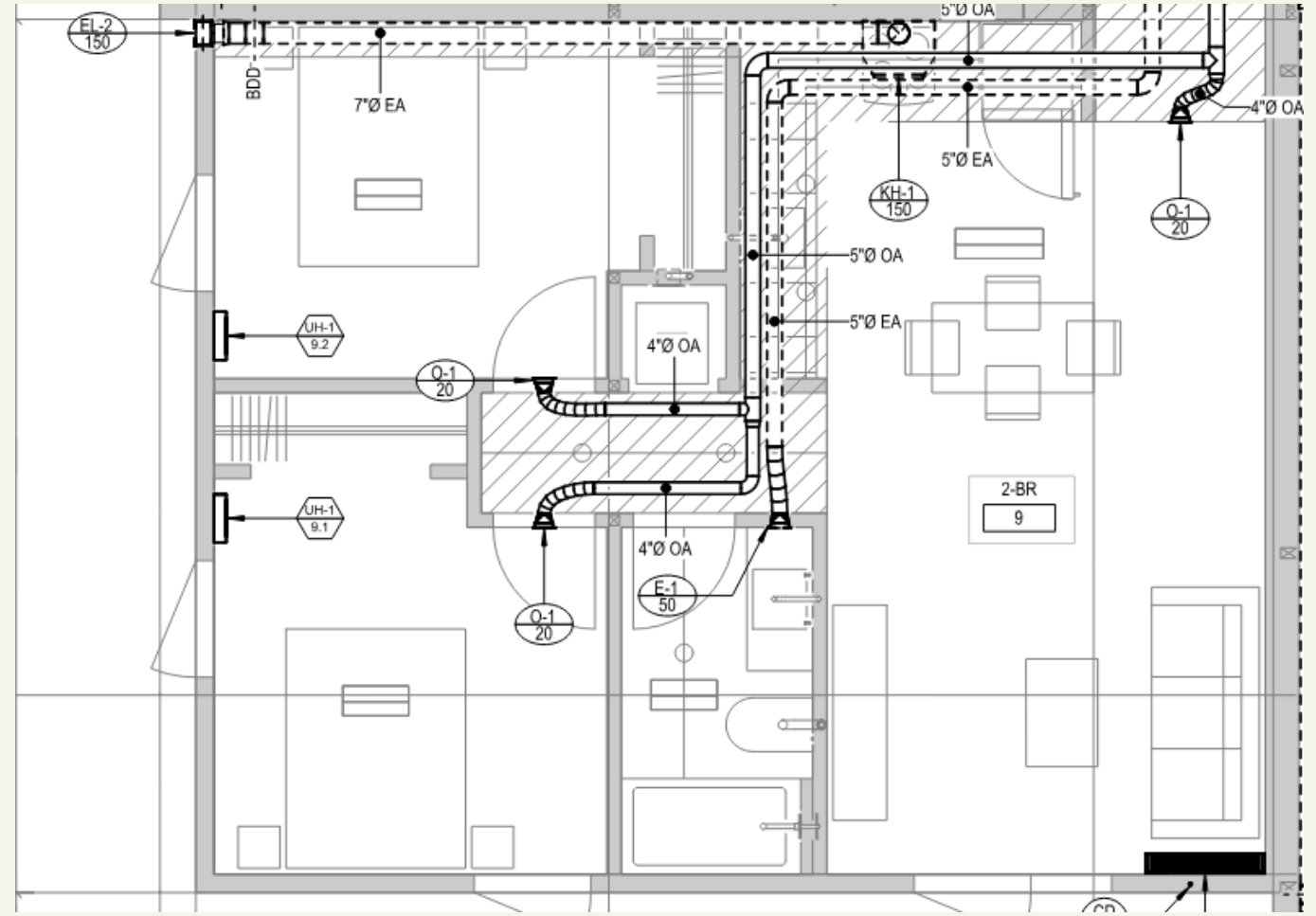
Door Dimensons				Door Crack Assumptions				Design Presure Diff [in H2O]	Expected Flow [CFM]
	#	Width [in]	Height [in]	Bottom [in]	Sides [in]	Top [in]	Crack Area [sqft]		
Doors	1	36	79	0.0625	0.125	0.125	0.18	0.05	108.6
Compartmentalization - Leakage	1						0.11	0.05	67.0
								12.4545 Pa	
								Total	175.7

Apartment Shell Area: 1220 sqft
Leak Rate 0.134 cfm50/sqft **Allowable 0.3 CFM50**
Leakage Rate (CFM50): 163.48 [cfm@ 50 Pa](#)
Calculated Area: 0.11 sqft

Ducted Range Exhaust

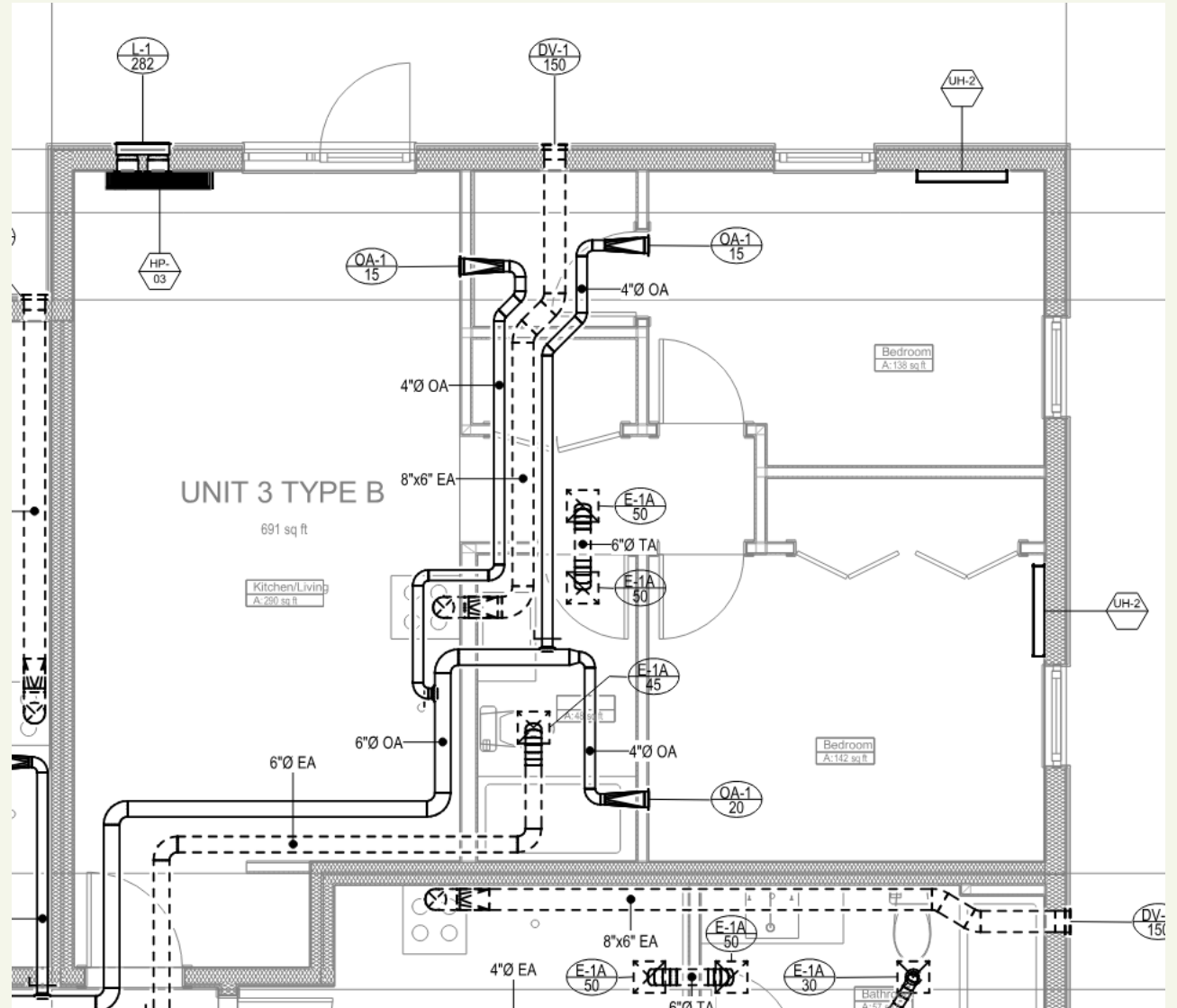
– Design Considerations

- Maintaining Acceptable Balance
- Compartmentalization testing requirement: 0.3 cfm @ 50 pascals
- Fan mounted in apartment door (so front door leakage not tested)



Red Cedar / Willow

- Multi-family building in Seattle
- Ducted range hood
- Backdraft damper at perimeter
- Supplied 5 cfm extra to each apartment, and 20-30 cfm extra to each floor corridors.
- Total excess supply air: 145 cfm
- Compartmentalization testing: $0.134 \text{ cfm}^{50} / \text{sqft}$



Red Cedar / Willow

Blower Door Test Results

Pa	cfm	ft2	cfm/ft2 @ 50Pa
-51.5	395	15201	0.026
+50.2	1129	15201	0.074
Average	762	15201	0.050



Red Cedar / Willow

Supply	Range Hood Off	Range Hood	Range Hood
		Low	High
South BRM (cfm)	17.2	18	20.3
North BRM (cfm)	18.3	20.1	21.7
LRM (cfm)	30.5	33.2	35.1
Total (cfm)	66	71.3	77.1
Exhaust			
	Bath (cfm)	56.1	53.3

Hood Flow (high): **160 CFM**
Rated Flow (high): 200 CFM

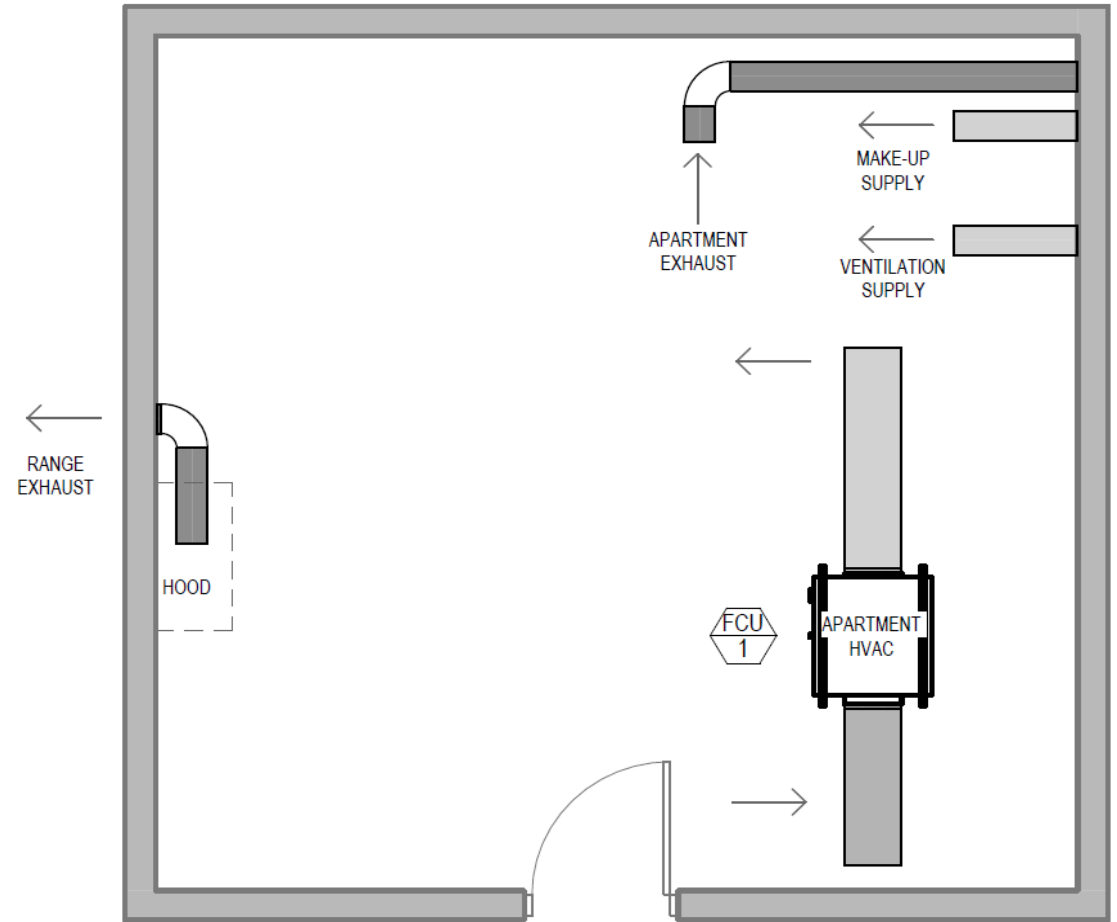


Ducted Range Exhaust

– Make Up Air Strategies

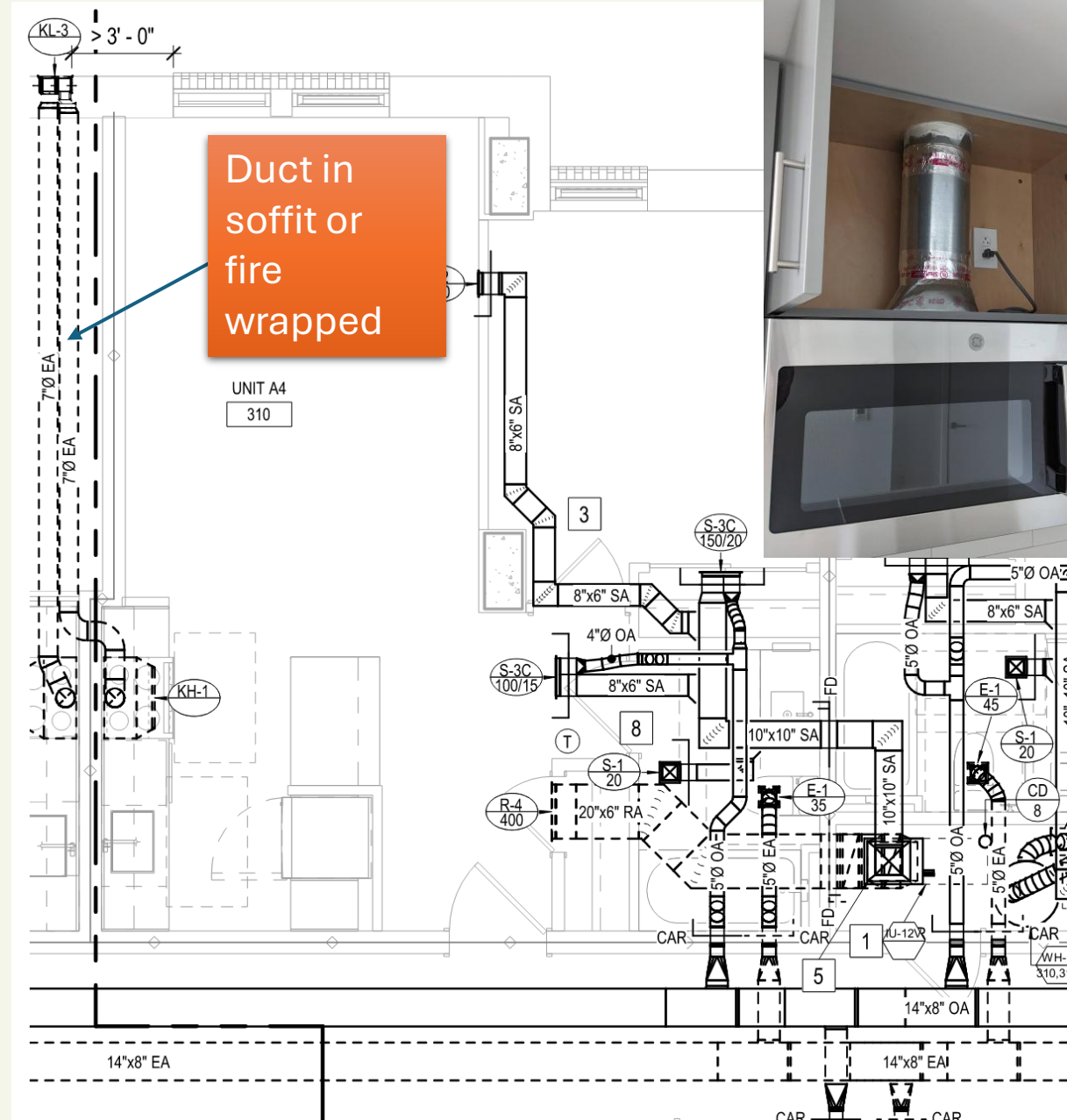
Separate Make-Up Air Supply Duct

- No additional penetrations required
- Requires additional ductwork
- Requires additional space in corridor ceiling for ductwork
- Backdraft damper at each apartment
- This infrastructure will increase cost



Faircliff Plaza

- Ducted Range Hoods
- Tight fitting backdraft damper at hood
- Range exhaust in soffit or fire wrapped



Faircliff Plaza

Taped Tests	CFM50	CFM50/sf Enclosure
Depressurization	6019	0.060
Pressurization	6968	0.069
Average	6493	0.064

The target CFM50 rate for PHIUS compliance for the “taped” test is 8,090 CFM50, so the results are 1,600 CFM50 below the allowable leakage rate, passing the taped test.

The average results were below the untaped target of 11,629 CFM50, therefore the building passes the whole building tests.

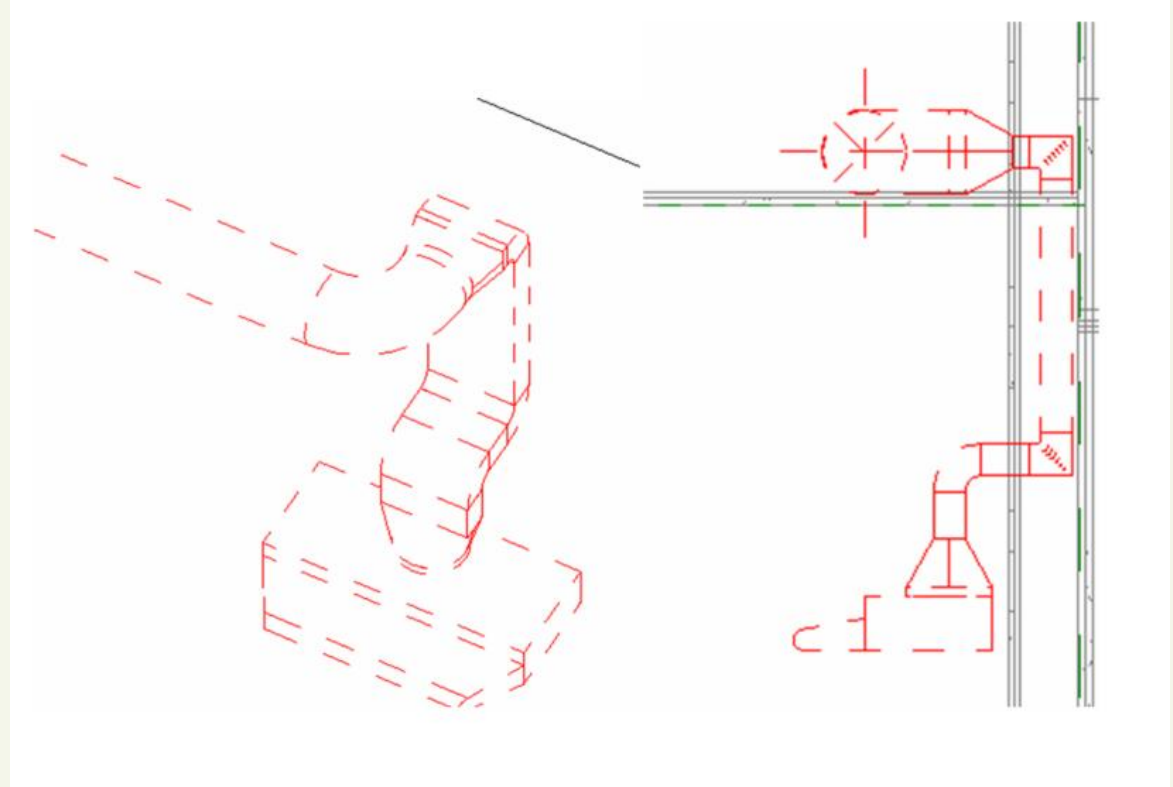
Untaped Tests	CFM50
Depressurization	8132
Pressurization	8030
Average	8081

Exhaust Ductwork

IBC 2021 Code Exception 717.6.2

Exception 2 (Check your local code)

- Allows elimination of fire damper in membrane penetration if duct does not enter another dwelling unit.



Ducted Range Flow Measurement



A "less than" moving experience...

Ducted Range Photos



Ducted Range and BD Testing

With exhaust duct diameter of 6" and back draft damper:

- 100 cfm to 200 cfm50 leakage in a positive pressure BD test
- 5 cfm to 15 cfm50 leakage in a negative pressure BD test
- Combined effect ~ 50 to 100 CFM per Kitchen hood.

Ducted Range Exhaust + Motorized Dampers

Motorized dampers drop the expected leakage to 0 to 5 cfm50 per kitchen hood or make-up air duct.



Ducted Range? Easier option - Just Don't Do it?



- Wallace St Phius Certified DER renovation – removed ducted exhaust.

Dryer Exhaust / Make-up Air

Considerations:

- Dryer exhaust ductwork is a serious fire hazard – minimize runs and bends, and eliminate dryer ductwork if possible
- Must be in a shaft if penetrating multiple floors
- No dampers or screens are allowed in dryer exhaust ductwork
- Must meet **mechanical code** and **manufacturer's requirements**
- Backdraft damper required

Dryer Lint fires

- Cornell University Apartment Laundry Room Fire (2019)
- A fire in an apartment laundry room was traced to lint accumulation associated with the dryer system. Fire officials reported that lint buildup contributed to ignition and fire spread in the laundry area.

A blaze filled a Summerhill apartment laundry room Saturday afternoon after flames were sparked by a buildup of lint.

Courtesy of Thomas Basher



Dryer Lint fires

- NFPA Statistics

- The National Fire Protection Association reports that U.S. fire departments responded to an estimated **15,970 home structure fires annually** involving clothes dryers and washing machines, with **92% involving dryers**. The most common first fuel ignited was **lint, dust, or fibers**. [\[nfpa.org\]](https://www.nfpa.org)

- What These Fires Usually Look Like

- In multifamily buildings, the typical sequence is:
- Dryer exhaust airflow becomes restricted.
- Lint accumulates in the duct, booster fan, termination hood, or transition duct.
- Exhaust temperatures rise.
- Lint begins smoldering.
- Fire propagates through the exhaust duct and may spread into concealed spaces.
- For a building enclosure consultant, the worst cases are often long vertical dryer exhaust risers serving multifamily buildings, particularly where maintenance is inconsistent.

Ducted Dryer and BD Testing

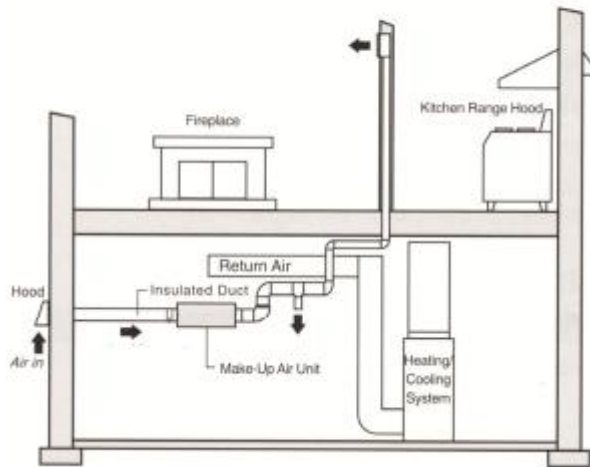
With exhaust duct diameter of 4" and back draft damper:

- 50 cfm to 100 cfm50 leakage in a positive pressure BD test
- 5 cfm to 10 cfm50 leakage in a negative pressure BD test
- Combined effect ~ 30 to 60 CFM per Dryer

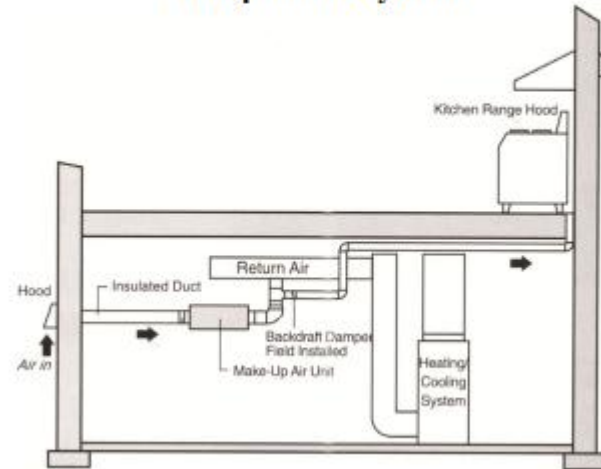


Dryer (and other) Make Up Air Unit

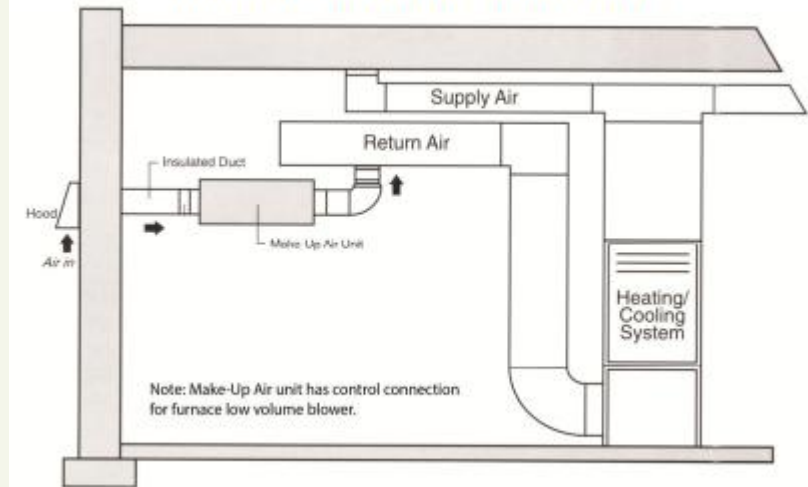
Make-Up Air Independent System



Make-Up Air Combined Return Tie-In & Independent System

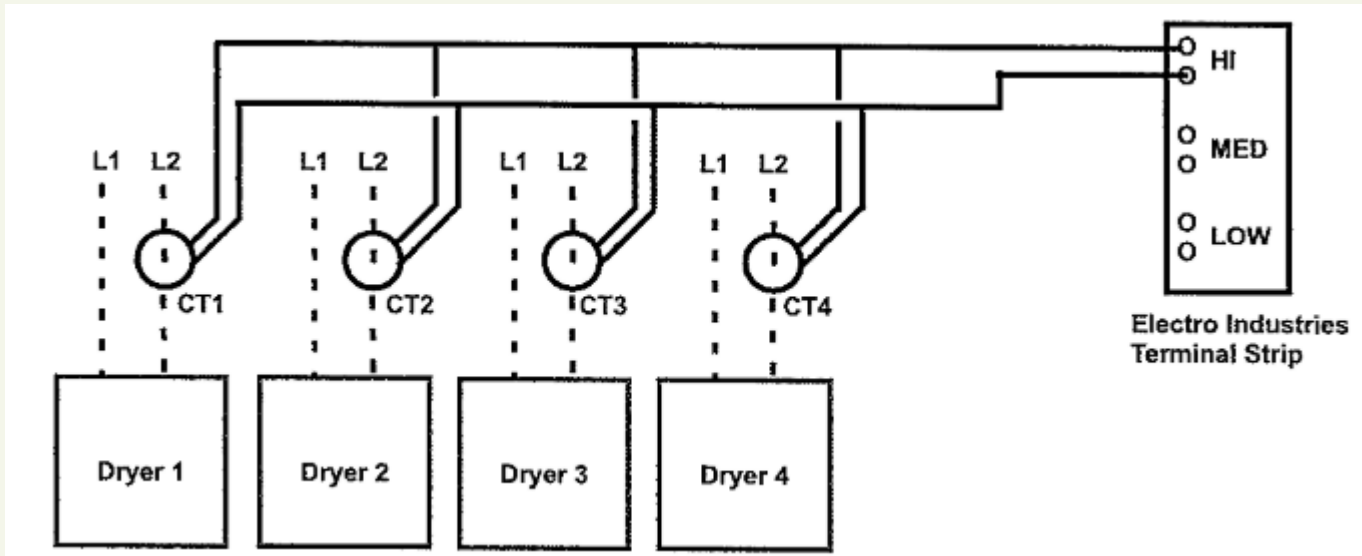


Make-Up Air Return Tie-In System



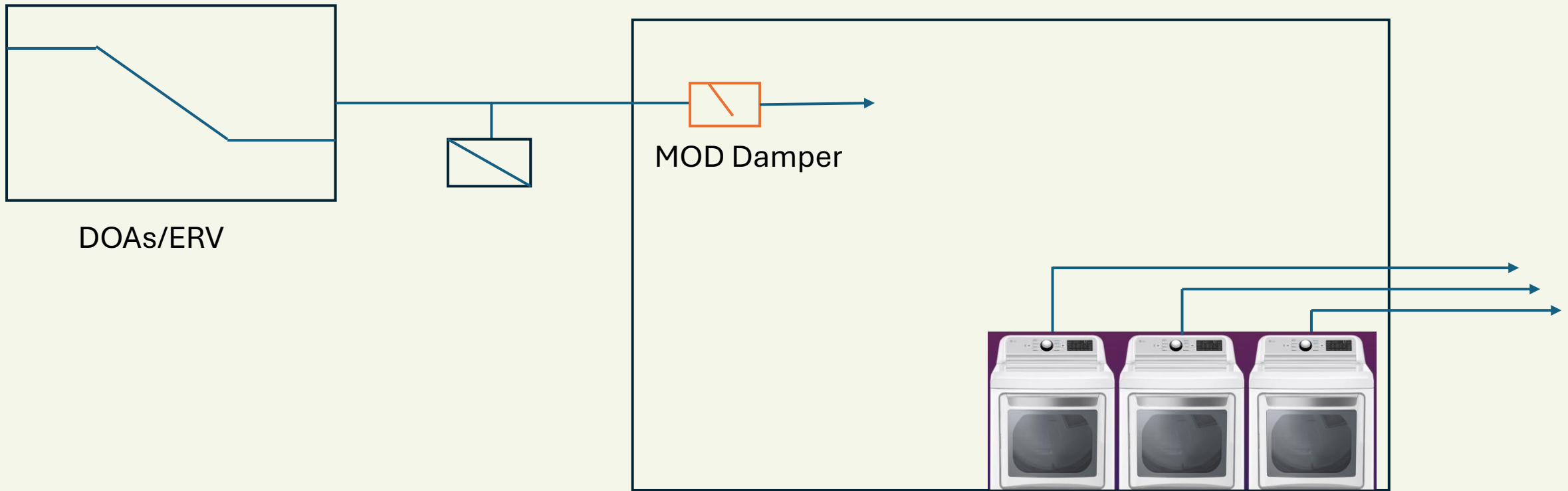
Dryer (and other) Make Up Air Unit

- Unit ramps up as dryers come on



Dryer (and other) Make Up Air from DOAs

- Variable volume damper



Dryer Exhaust

Maybe get rid of it?



SAMSUNG HP DRYER



LG ALL-IN-ONE

Trash Chutes

Purpose:

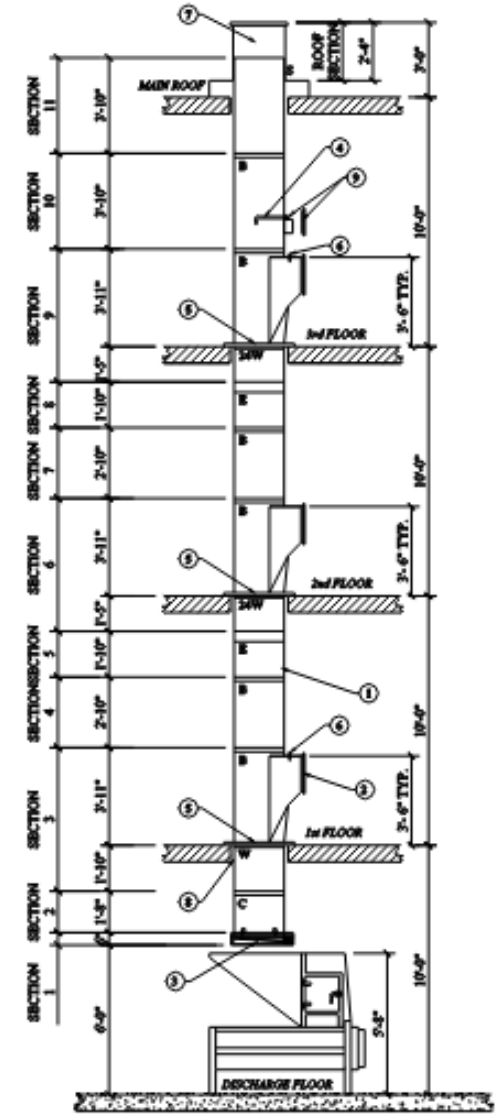
- Safe transport of trash to dumpster / compactor

Codes: Building Code

Standards: NFPA-82

Hazards:

- Shaft between floors – **fire communication**
- Venting to assist trash flow
- Venting for **odors**
- Mitigation of **explosion risk**



Trash Chute Blast Caps! Why?

Trash Chute Explosions

Actual "trash chute explosions" are much rarer than trash chute fires. Most documented events involve one of three mechanisms:

- **Example 1: Methane Explosion in Waste Collection Areas**
- When organic waste decomposes in a chute or compactor room, methane can accumulate. If ventilation is inadequate and an ignition source is introduced, a deflagration can occur. This tends to occur at the bottom collection room or compactor rather than in the shaft itself.



Example 2: Aerosol Can Explosions

Many high-rise trash chute fires start when:

- aerosol cans,
- propane cylinders,
- paint cans, or
- batteries
- are discarded into the chute.
- The heat from an existing fire causes the container to rupture, producing a pressure wave that witnesses often describe as an "explosion."

Example 3: Combustible Dust Deflagration

This is probably the closest analogue to what you're asking from a pressure-testing perspective.

Fine combustible particles suspended in air inside a confined volume can explode if:

- fuel is present,
- oxygen is present,
- particles are dispersed,
- ignition occurs,
- confinement exists.

This is the same mechanism responsible for industrial dust explosions investigated by the U.S. Chemical Safety Board.
[\[csb.gov\]](https://www.csb.gov), [\[csb.gov\]](https://www.csb.gov)

A trash chute containing:

- dried paper dust,
- lint,
- pulverized cardboard,
- organic debris,

can theoretically experience a dust deflagration if sufficient fine particulate becomes airborne and an ignition source is introduced.

Trash Chutes

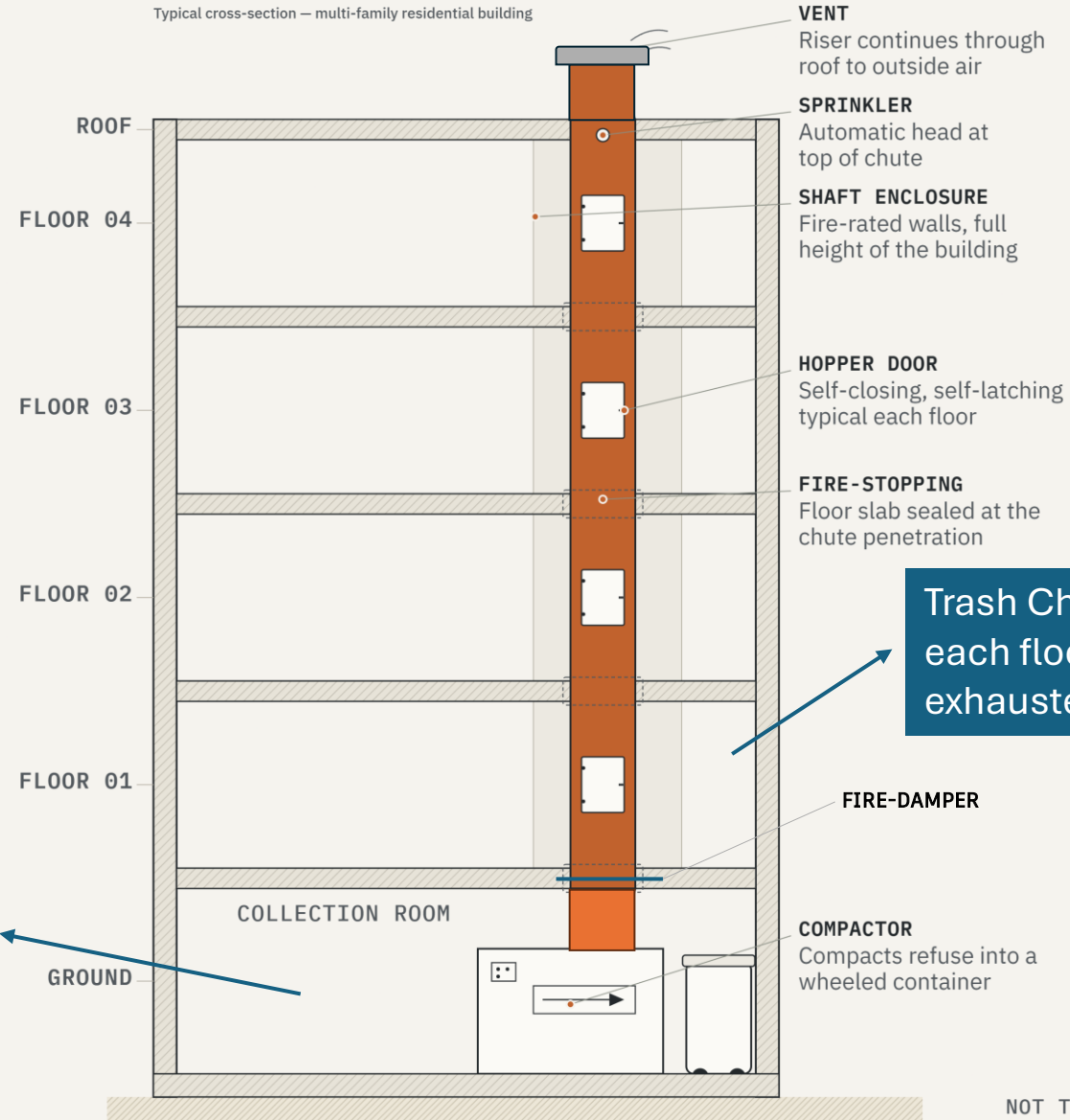
Passive Building Challenges

- Building depressurization
- Stack effect leakage
- Make-up air requirements
- Cold air moving through chute impacting envelope

Trash Collection room exhausted at 1 cfm/sqft

TRASH CHUTE

Typical cross-section — multi-family residential building



NOT TO SCALE

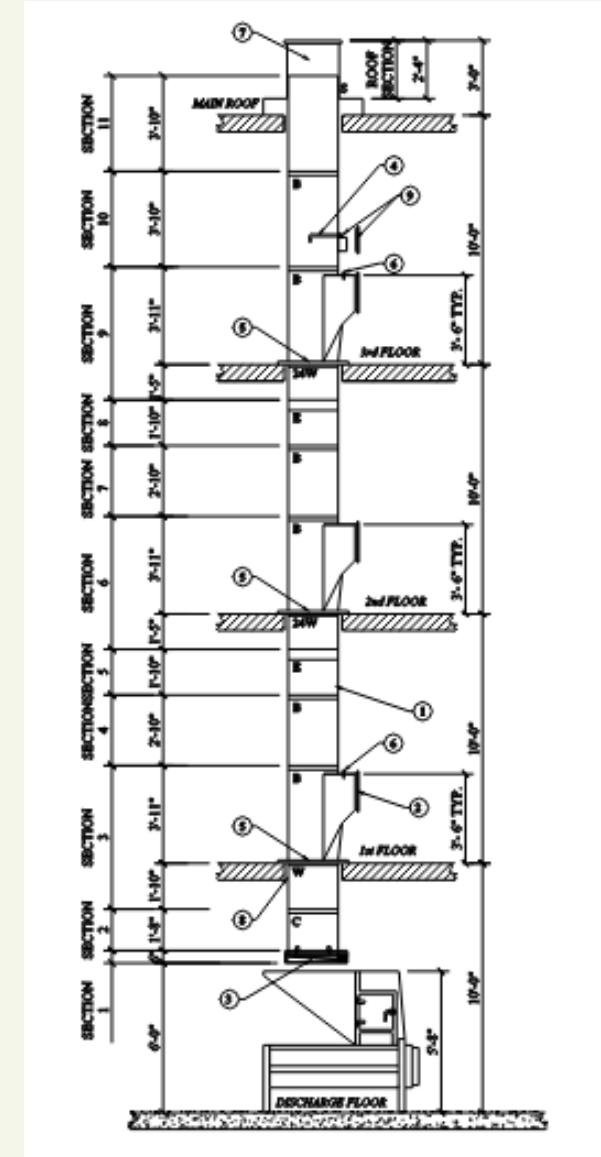
Trash Chutes

Best Practices

- Minimize chute access room size to reduce exhaust requirement
- Minimize trash room size
- HRV for trash room exhaust?
- Negatively pressurize trash room to pull fresh air from trash chute vent

Future Changes

- Can we cap the chute? (Washington State Code)
- Exhaust trash room to draw air through trash room door



Trash Chute Example 1 – side pull...



Trash Chute Example 1

- Continuous exhaust fan means we can seal the roof top penetration for the whole building air tightness test – Yay!



Trash Chute Example 1

- Blast caps?!
ok....



Trash Chute Example 1



Who put that there! Uh oh... where is most of the air for this continuous exhaust fan coming from ...

Trash Chute Vents and BD Testing

For sharp edged orifice air leakage:

- ~8 cfm 50/s.f.
- 190 cfm50 for a 24" diameter trash chute with a 1 " gap at the top.

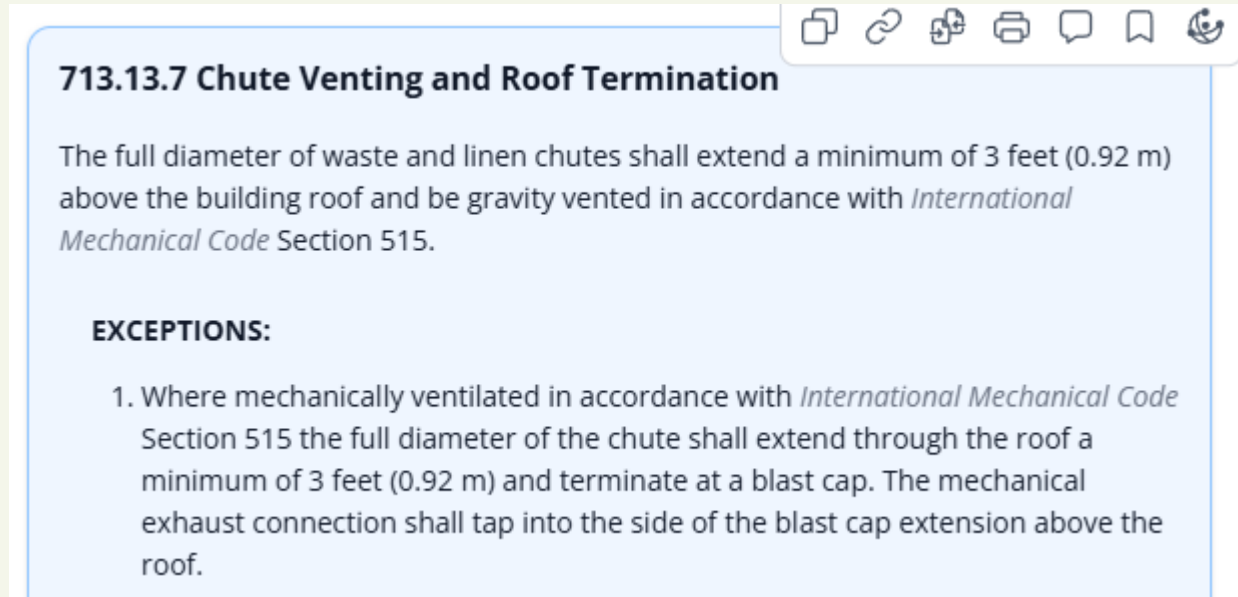
Trash Chute Example 2 - Inline pull!



I can get behind this

Trash Chute Example 3 – no vent!

- Washington State Mechanical code has eliminated the requirement to vent a Trash Chute when there is continuous exhaust ventilation.



The screenshot shows a digital document viewer interface. At the top right, there is a toolbar with icons for copy, link, share, print, comment, bookmark, and refresh. The main content area has a light blue background and contains the following text:

713.13.7 Chute Venting and Roof Termination

The full diameter of waste and linen chutes shall extend a minimum of 3 feet (0.92 m) above the building roof and be gravity vented in accordance with *International Mechanical Code* Section 515.

EXCEPTIONS:

1. Where mechanically ventilated in accordance with *International Mechanical Code* Section 515 the full diameter of the chute shall extend through the roof a minimum of 3 feet (0.92 m) and terminate at a blast cap. The mechanical exhaust connection shall tap into the side of the blast cap extension above the roof.

WASHINGTON STATE BUILDING CODE 2021

Example 4 – No Trash Chute!

- Lowest cost
- Easiest to air seal

QUESTIONS?

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