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Air (vital stuff): Strategies for Getting It Into (and out of) Multifamily Buildings

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

In an increasing market for multifamily, energy-efficient and high-performance building shells, efficient ventilation strategies become paramount in maintaining health and comfort without sacrificing high level project goals such as Passivhaus Certification. So what is the best approach to creating a well-ventilated multifamily building? As with most issues in design, it depends…. This session will discuss ventilation approaches to be considered from large central air handlers, to individual systems in each dwelling, to options in between. The pros and cons of several strategies will be presented with ample time to pose questions and debate methods. How important is distribution? Is heat recovery necessary? Should occupants have control? How much air is enough? What do you do with ancillary spaces? These questions and more will be addressed through outlining general concepts and presenting case studies

Learning Objectives

At the end of the this course, participants will be able to:

1. Participants will be able to calculate the ventilation rates for multifamily dwellings based on International Mechanical Code and Passive House requirements.

2. Participants will know the optimal distribution of supply and exhaust locations within a dwelling.

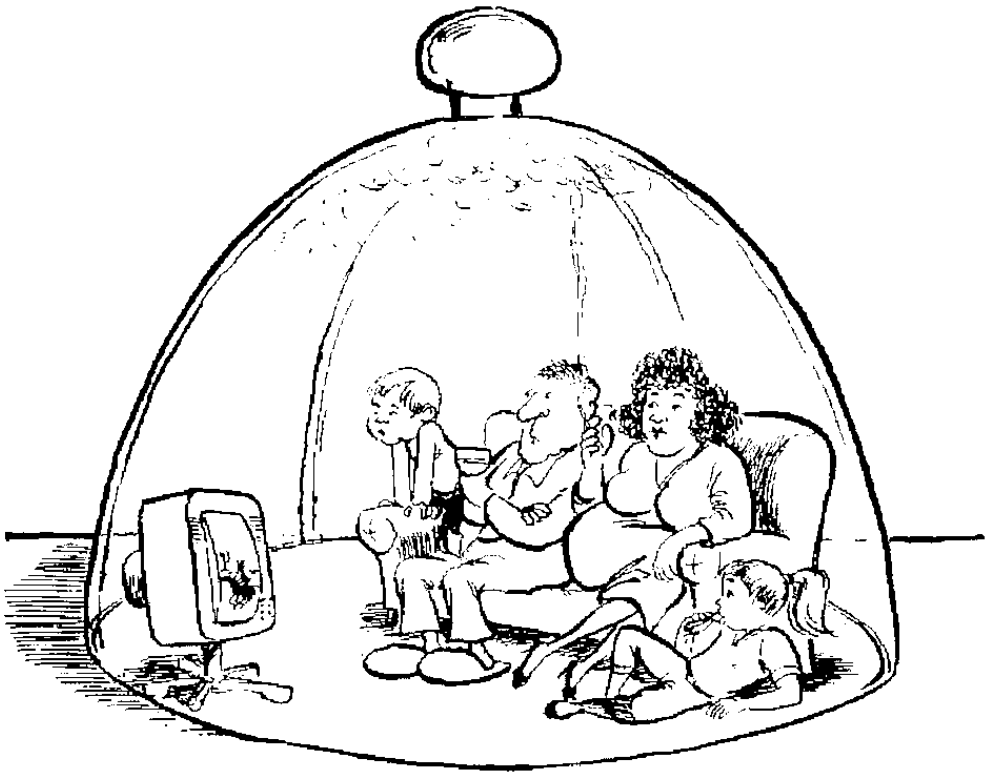
3. Participants will be able to assess the different equipment strategies for providing multifamily ventilation and weigh the pros and cons of each.

4. Participants will evaluate the ventilation needs of the non-dwelling ancillary spaces of a multifamily building and apply appropriate ventilation strategies.

Why Multifamily?

- Population growth
- Growth of households
- More people in urban areas – limited land
- Housing expense
- Ecologically efficient
- Energy efficient

Why Ventilate?



- Air Humidity
- CO_2 Concentration
- VOC's
- Smells
- Allergens
- Temperature

Learning Objective One

1. Calculating Mechanical Code, Passive House, and ASHRAE airflow rates

Ventilation: How much air do we need?

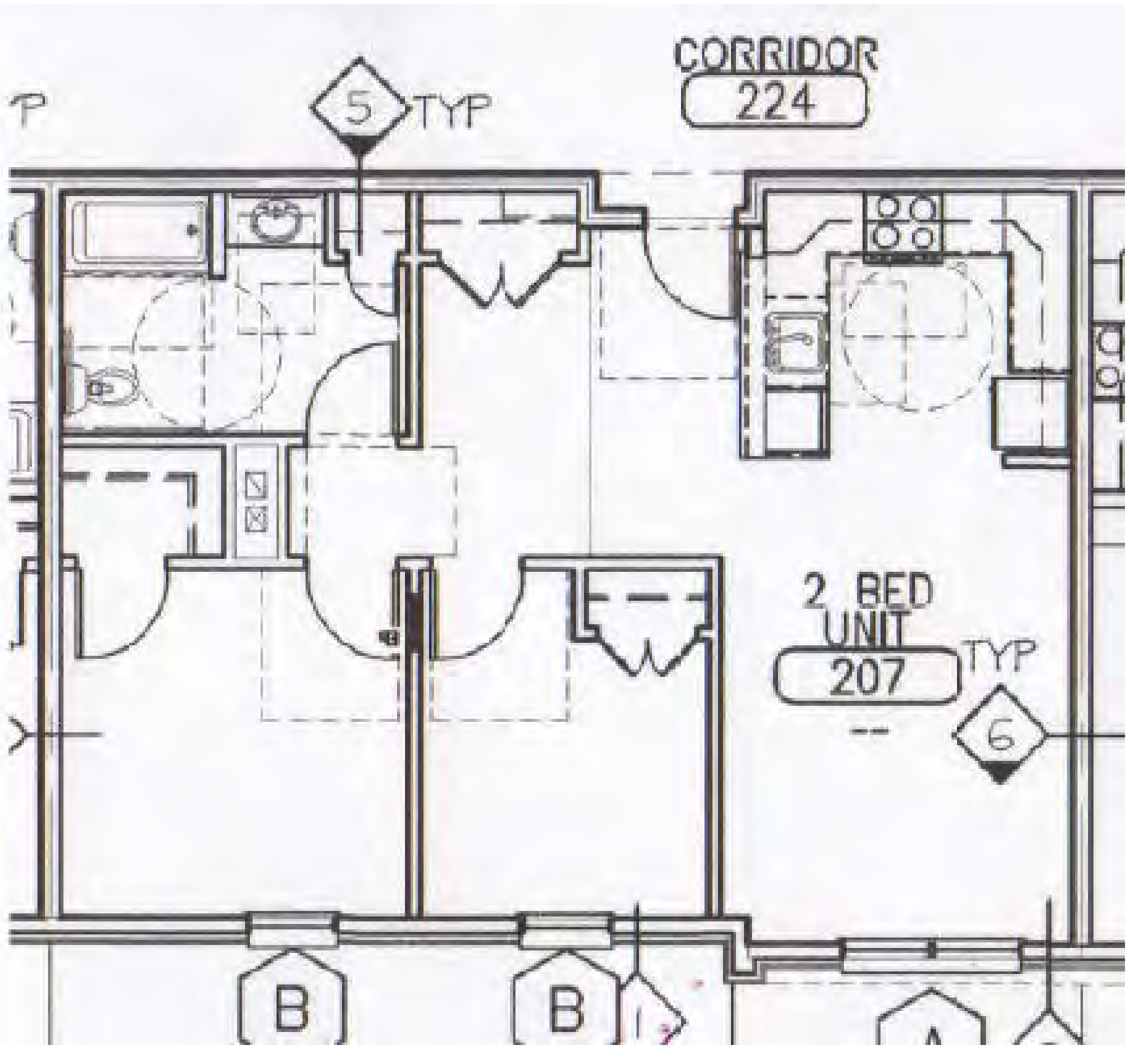
Depends upon who you ask…

International Mechanical Code (IMC) 2015

ASHRAE Standard 62.2
Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
2016 Version

Passive House Institute (PHI)
Passive House Institute U.S. (PHIUS)

Example Apartment for Ventilation



800 SF TFA
8.2 FT Ceilings
2 bedrooms
1 Bathrooms

IMC 2012 Airflow

Referenced by the International Building Code (IBC)
Adopted by all the Northeast States

7.5 CFM per person (number of bedrooms +1)
AND 0.03 CFM/SF
Kitchen exhaust: 25 CFM continuous
Bathroom exhaust: 20 CFM continuous

7.5(2+1) + 0.03(800) = **47 CFM**
Kitchen + Bathrooms **45 CFM**

Passive House Airflow

Airflows required for a certifying Passive House project

0.30 Air Changes per Hour (ACH) of TFA
18 CFM Per Person (1 person/420 SF)

Kitchen exhaust:	35 CFM
Bathroom exhaust:	24 CFM
Half Bath	12 CFM

800 SF * 8.2FT = 6,560 CF at 0.30 ACH (*1.3)	**33 CFM (43 CFM)**	
(800/420) People* 18 CFM/P	**34 CFM**	
Kitchen + Bathrooms	**59 CFM**	**MAX**
77% of maximum	**45 CFM**	
54% of maximum	**32 CFM**	

ASHRAE Standard 62.2-2016 Airflow

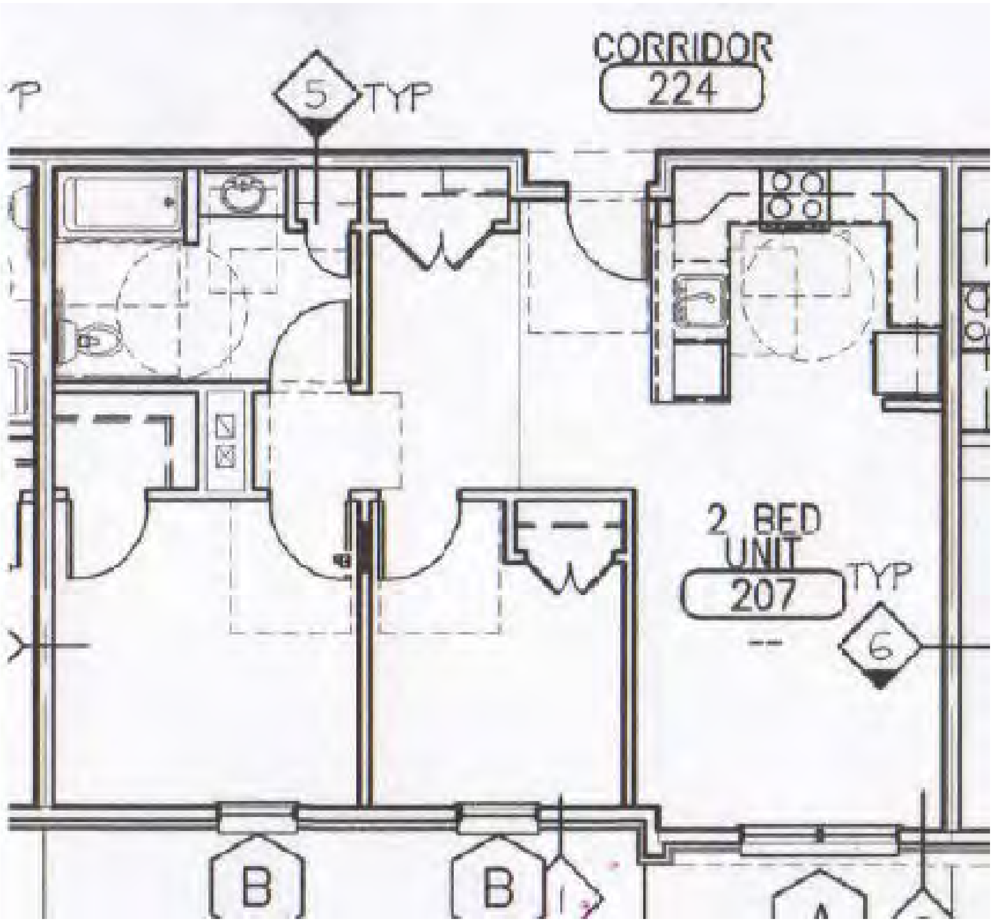
Airflows required for a LEED Project and some incentive programs

7.5 CFM per person (number of bedrooms +1)
AND 0.03 CFM/SF

For a **"Nonenclosed"** kitchen
Kitchen exhaust: 100 CFM intermittent hood
Bathroom exhaust: 20 CFM continuous

7.5(2+1) + 0.03(800) =	**47 CFM**
1 Bathrooms	**20 CFM**
Range hood for Kitchen	**100 CFM** (on demand)

Example Apartment for Ventilation



800 SF TFA
8.2 FT Ceilings
2 bedrooms
1 Bathrooms

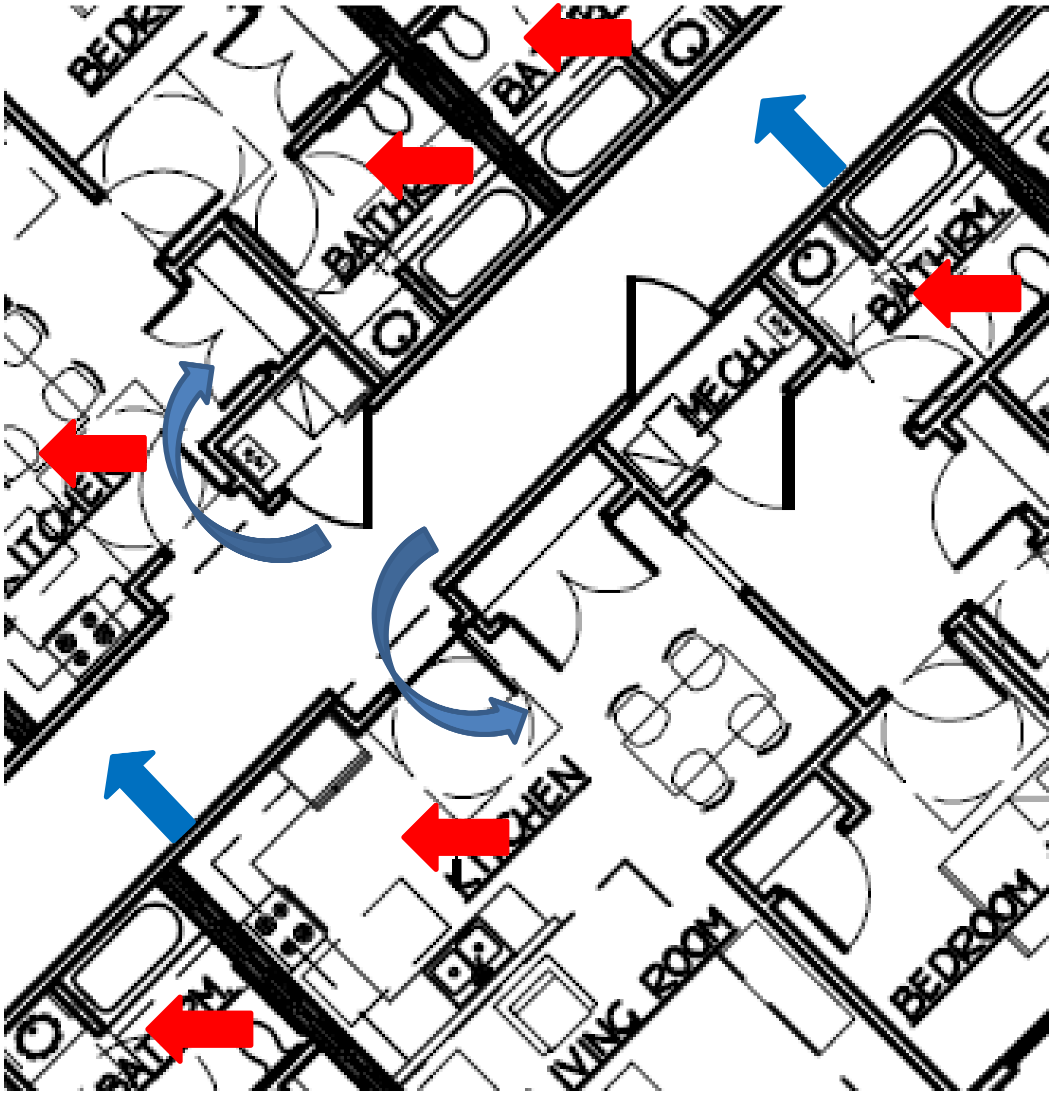
Standard	Supply	Exhaust
IMC	47 CFM	45 CFM
PHI	34 CFM	59 CFM
62.2-2016	47 CFM	20 CFM*

* With 100 CFM intermittent range hood

Learning Objective Two

1. Calculating Mechanical Code, Passive House, and ASHRAE airflow rates
2. Optimal distribution of supply and exhaust locations

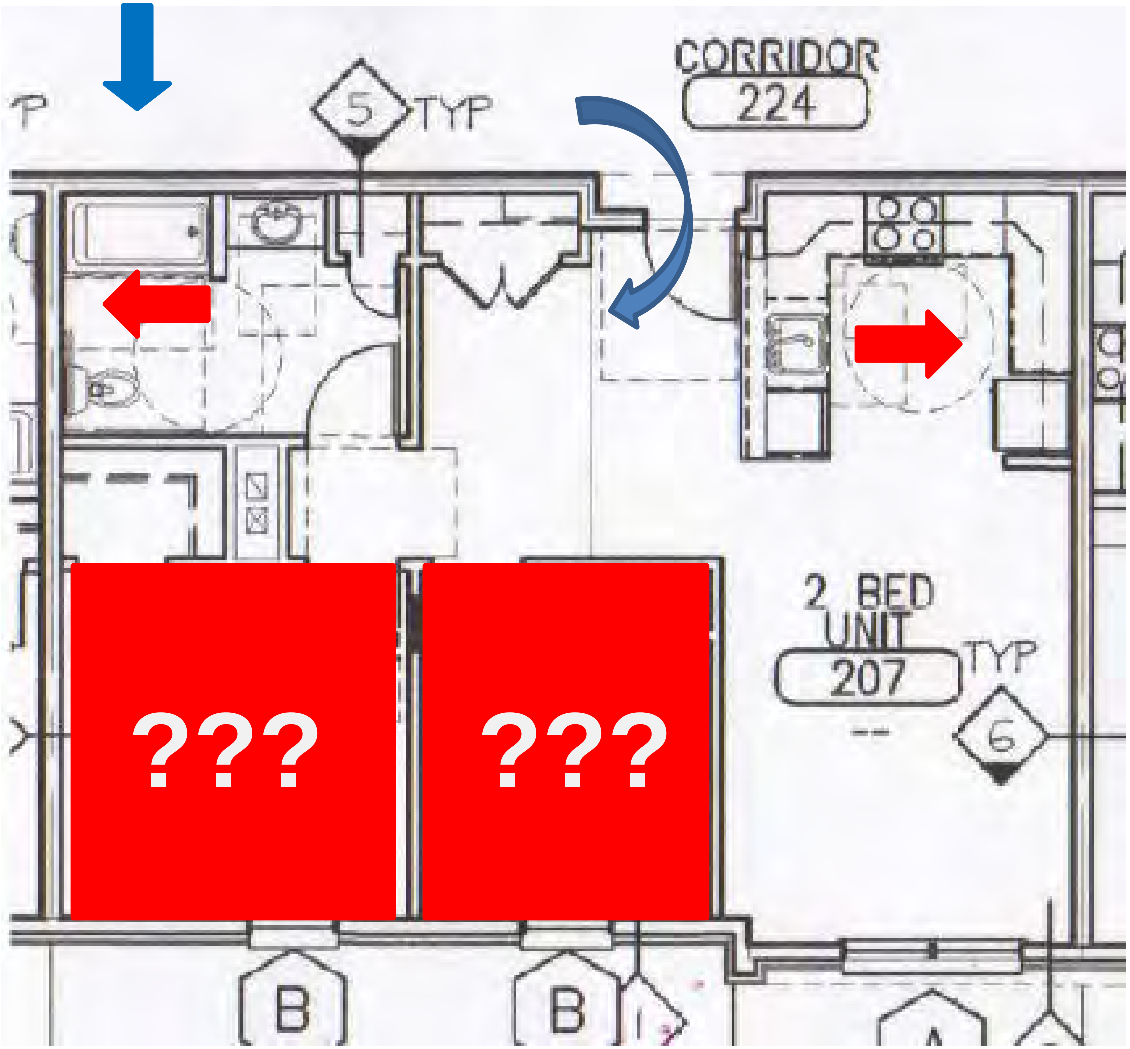
Traditional System Layout



Exhaust Air Locations
- Bathrooms
- Kitchen

Supply Air Locations
- Corridors

Traditional System Layout



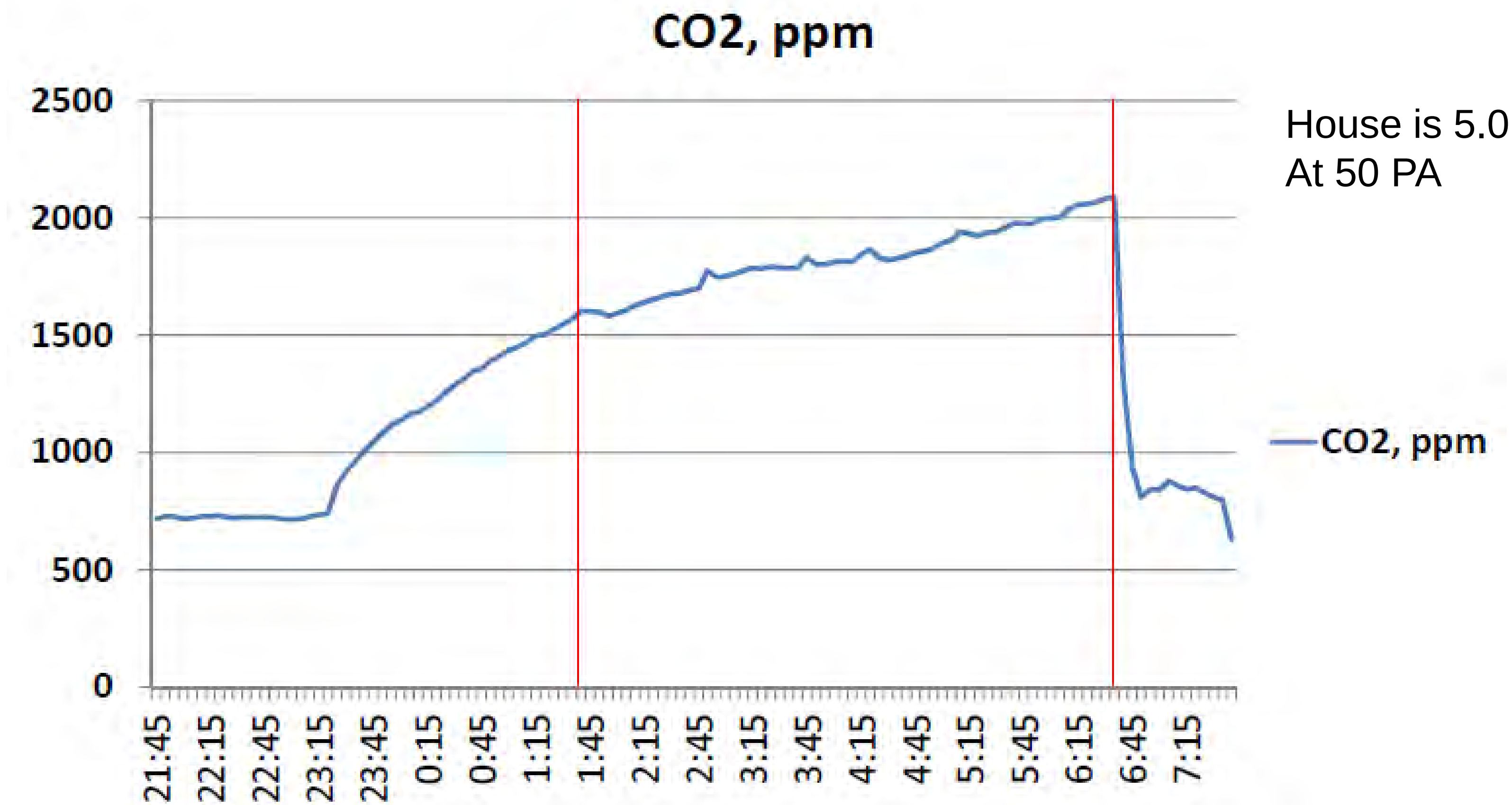
Exhaust Air Locations
- Bathrooms
- Kitchen

Supply Air Locations
- Corridors

Air Transfers into Apt

What's the ACH in the Bedrooms?

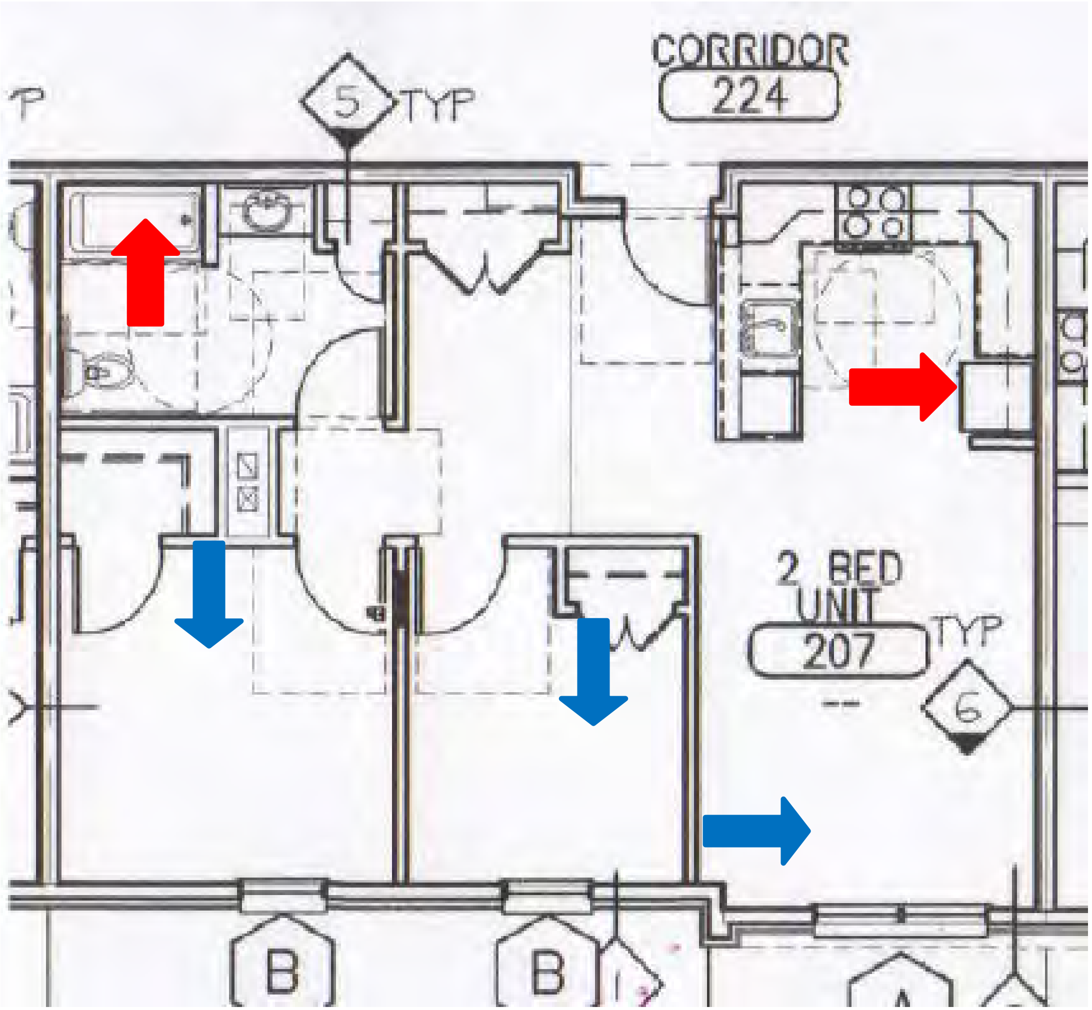
Unventilated Bedrooms Get Stale



House is 5.0 ACH
At 50 PA

- Bedroom occupied at 11:15 pm with door closed
- Exhaust fan turned on at 1:30 am at 88 CFM (ASHRAE 62.2 Rate for house is 62 CFM
- Exhaust fan off at 6:00 am
- Door open at 6:30 am

Typical Balanced System Layout



Exhaust Air Locations
- Bathrooms
- Kitchen
- Laundry
- Moisture/Odor Laden Areas

Supply Air Locations
- Bedrooms
- Offices
- Living/Family Rooms*
- Remote Rooms

* Depending upon layout

Learning Objective Three

1. Calculating Mechanical Code, Passive House, and ASHRAE airflow rates
2. Optimal distribution of supply and exhaust locations
3. Multifamily equipment strategies

Exhaust Fan vs. HRV Energy Usage

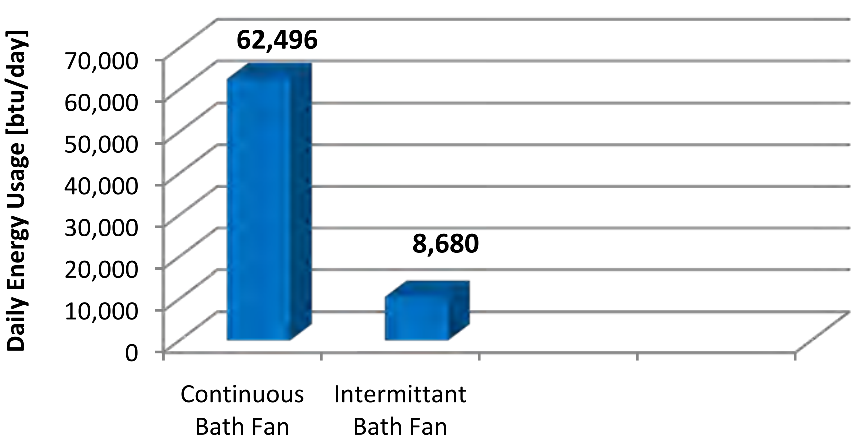
Exhaust Fan case, 60 CFM continuous:

Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours) = **62,496 Btu/Day**

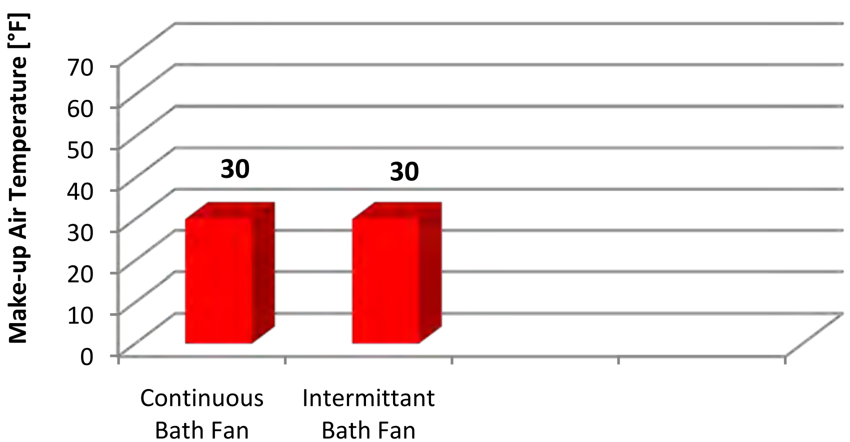
Exhaust Fan Case, 50 CFM intermittent (2 hours per day)
and 100 CFM intermittent (1 hour per day):

Energy Usage = (1.085)(100 CFM)(70°F - 30°F)(2 hours) = **8,680 Btu/Day**

Ventilation Thermal Energy Usage



Make-up Air Temperature

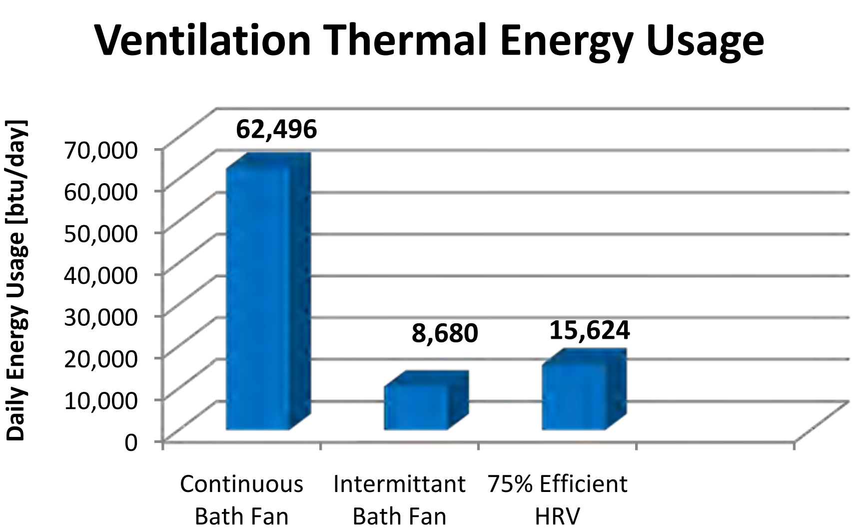


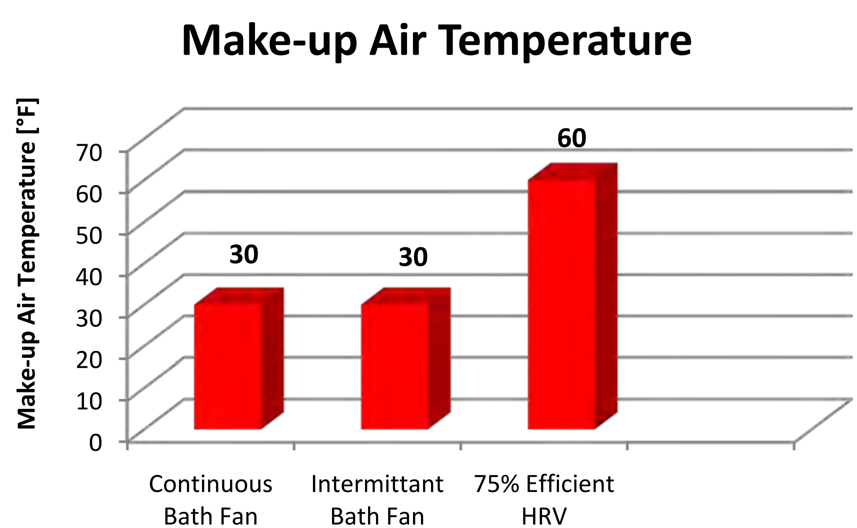
Exhaust Fan vs. HRV Energy Usage

75% Efficient HRV case, 60 CFM continuous:

Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours)(1 – 0.75) = **15,624 Btu/Day**

Make-up air temperature = 30°F + (70°F - 30°F)*(0.75) = **60°F**





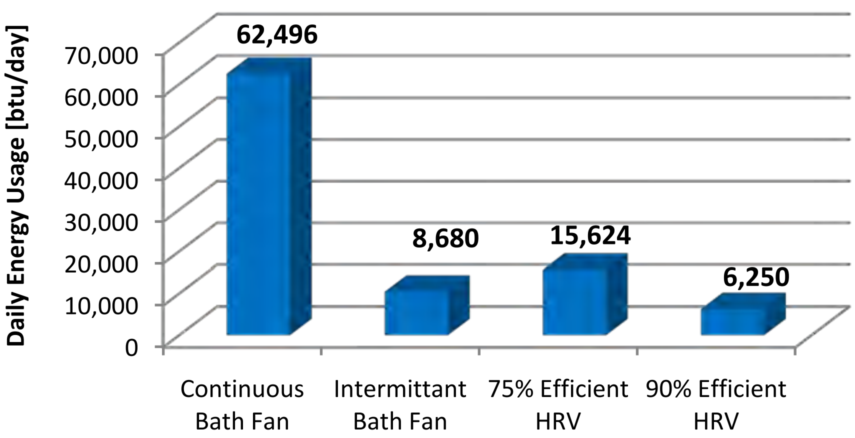
Exhaust Fan vs. HRV Energy Usage

90% Efficient HRV case, 60 CFM continuous:

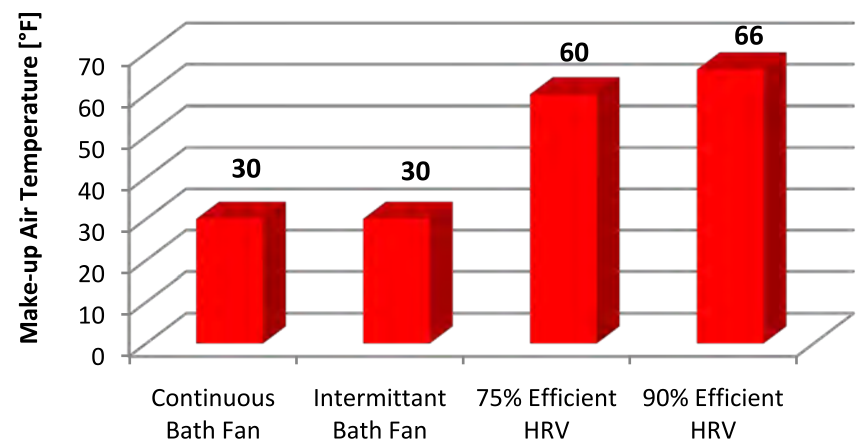
Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours)(1 – 0.90) = **6,250 Btu/Day**

Make-up air temperature = 30°F + (70°F - 30°F)*(0.90) = **66°F**

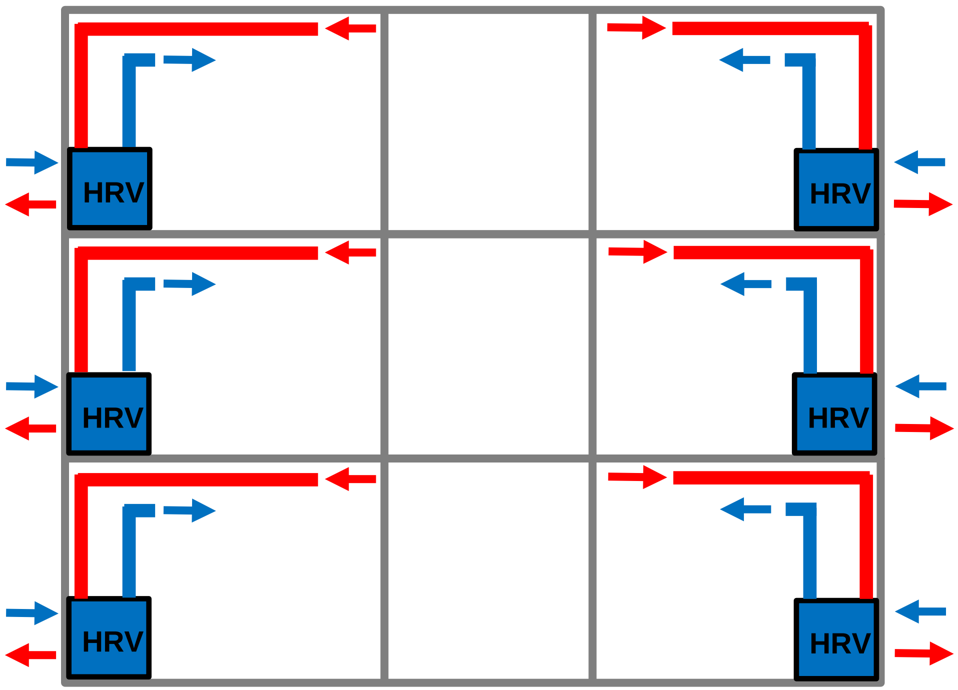
Ventilation Thermal Energy Usage



Make-up Air Temperature



Multi-Family Options



Individual Apartment Units

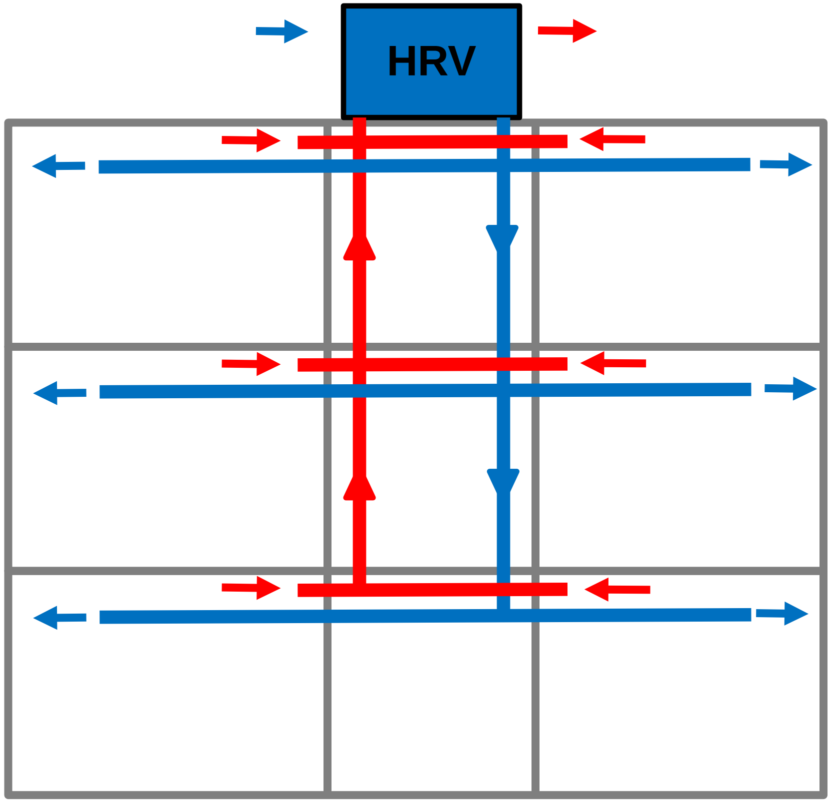
Pros

- Better Compartmentalization
- Minimize Stack Effect
- Individual Control
- Easy Boost Capacity
- Good for Condominiums
- Minimize Duct Runs
- Minimize energy usage
- Energy paid by occupant

Cons

- Multiple Wall Penetrations
- Dispersed Maintenance
- May be more expensive

Multi-Family Options

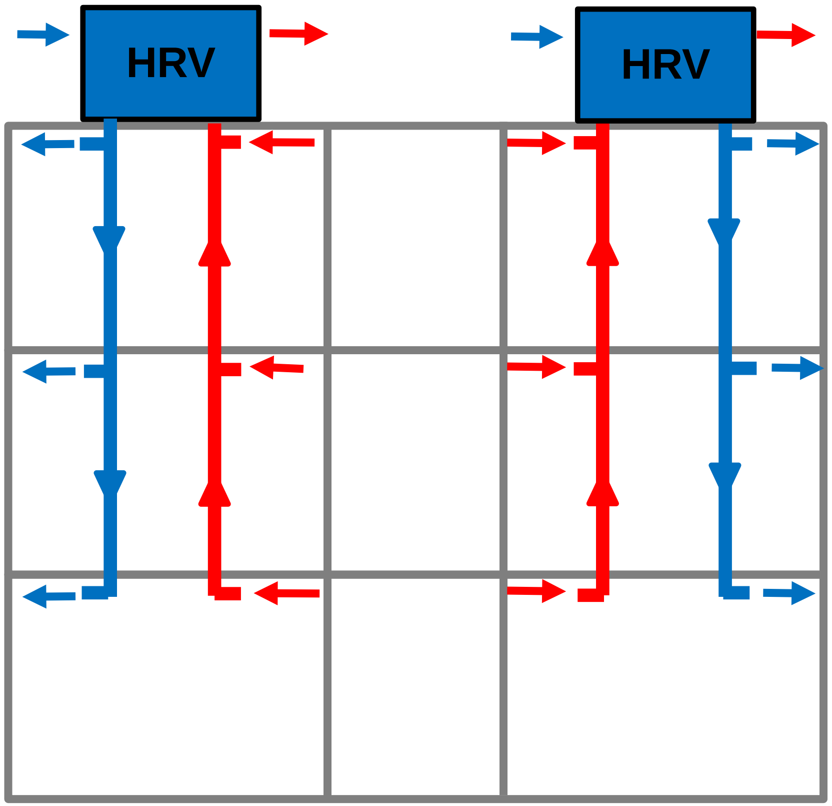


Central Ventilation Units

Pros
- Central Maintenance
- May be less expensive
- Minimize Penetrations

Cons
- Central Ductwork & Fire Dampers
- Fighting Stack Effect
- Loss of Floor Space for Shafts
- More Complex to Boost
- Harder to Balance
- Higher energy usage
- Energy paid by building owner

Multi-Family Options

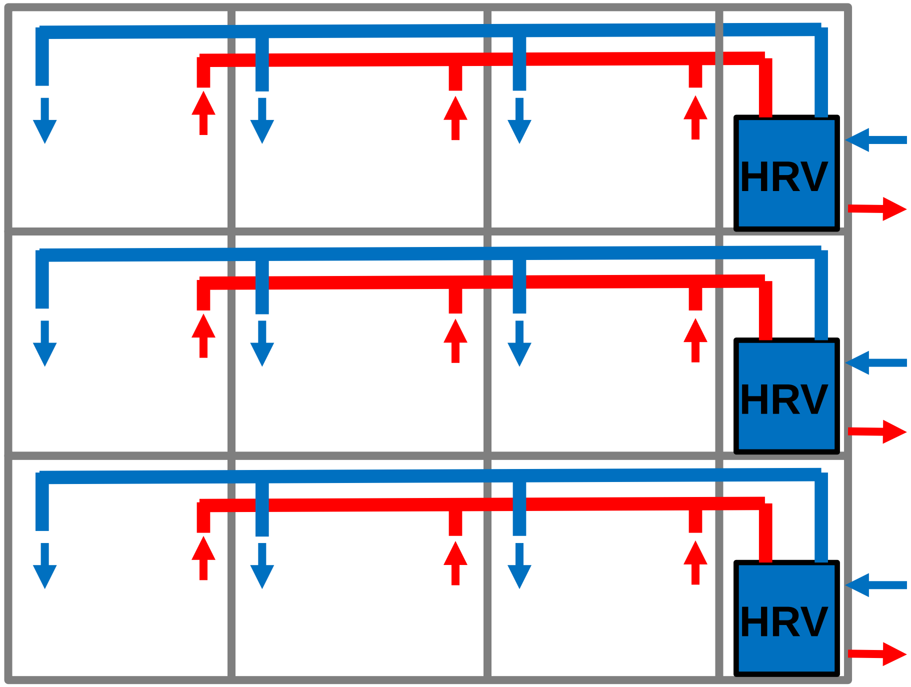


Semi-central Ventilation Units
Vertical Configuration

Pros
- Consolidated Maintenance
- May be less expensive
- Minimize Penetrations
- Reduce Ductwork
- Reduce Energy Usage

Cons
- Central Ductwork & Fire Dampers
- Fighting Stack Effect
- Loss of Floor Space for Shafts
- More Complex to Boost
- Harder to Balance
- Energy paid by building owner

Multi-Family Options



Semi-central Ventilation Units
Horizontal Configuration

Pros

- Consolidated Maintenance
- Minimize Stack Effect
- Eliminate Shafts
- May be less expensive
- Minimize Penetrations
- Reduce Energy Usage
- Possibly Eliminate Fire Dampers

Cons

- Central Ductwork
- More Complex to Boost
- Harder to Balance
- Energy paid by building owner

Central vs Dispersed Airflow Rates

Passive House max airflow: **59 CFM**

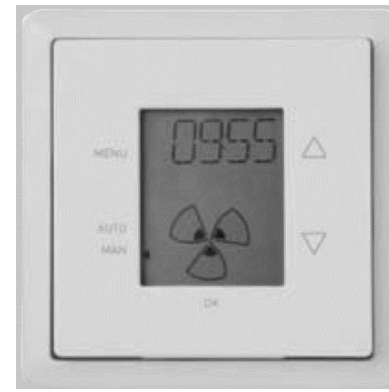
Individual unit per apartment = Controllability

High speed (boost mode) operation: 60 CFM

Normal Speed operation (77% max): 45 CFM

Low speed operation (0.3 ACH): 30 CFM

Absent mode operation: 15 CFM



Central/Semi Central System = One Speed or Simple Boost

Single Speed, Full Time operation: 60 CFM

Simple Boost: 45/60 CFM

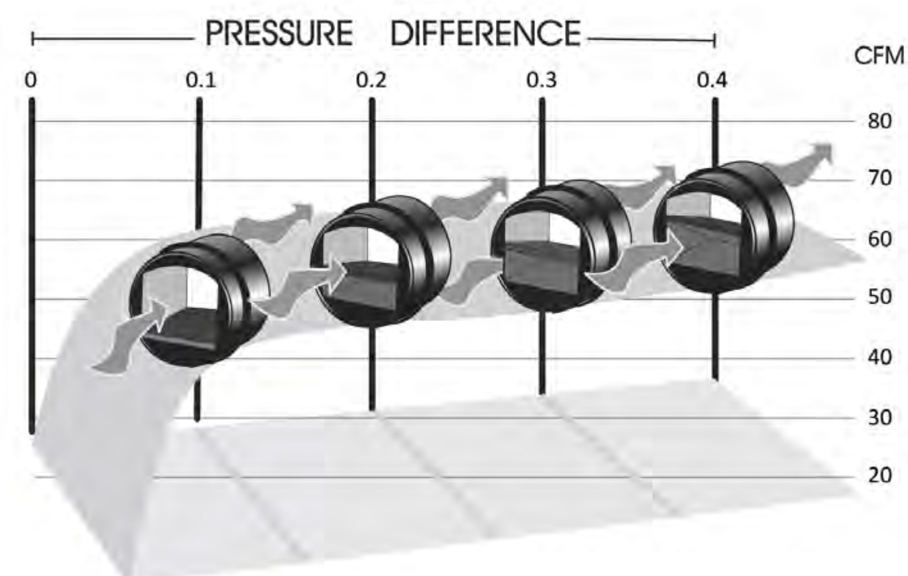
More Air = More Energy

- Higher thermal load to heat it
- Higher electrical load to move it

Constant Airflow Regulators (CARs)

Self Balancing Dampers

- Help to combat stack effect
- Stay in balance over time
- Work in a range of duct static pressure



Multi-stage Constant Airflow Regulators (CARs)

High-Low Self Balancing Dampers

- Same benefits of single CAR dampers
- Allows for boost operation
- Can specify high and low flow rates.

Learning Objective Four

1. Calculating Mechanical Code, Passive House, and ASHRAE airflow rates
2. Optimal distribution of supply and exhaust locations
3. Multifamily equipment strategies
4. Addressing non-dwelling ancillary spaces

Non-dwelling Ancillary Spaces

Variety of other occupancies possible in a multifamily project:

- Corridors
- Trash rooms
- Janitor’s closets
- Gathering rooms
- Bathrooms
- Storage areas
- Laundry
- Gym

IMC and ASHRAE 62.1 Standards are appropriate to follow
And (mostly) parallel with each other.

Non-dwelling Ancillary Spaces

Corridors:

- 0.06 CFM / SF

Trash Rooms:

- 1.00 CFM / SF Exhaust

Janitor’s Closets:

- 1.00 CFM / SF Exhaust

- A good strategy to supply into the corridors and exhaust from the trash rooms & janitors closets.
- Dedicated HRV for this purpose at continuous rate.

Non-dwelling Ancillary Spaces

Gathering Rooms:

- 5 CFM/Person + 0.06 CFM/SF

Public Bathrooms:

- 25 CFM/unit Exhaust single occupant
- 50 CFM/unit Exhaust multi occupant

- A good strategy to supply into gathering room and exhaust from the adjoining bathrooms.
- Dedicated HRV(s) for this purpose
- Good occupancy for CO_2 control – low rate to meet bathroom requirements and ramp up with increased occupancy.

Non-dwelling Ancillary Spaces

Laundry Rooms:
- 7.5 CFM/Person + 0.06 CFM/SF

- Likely can be tied into an HRV system with other spaces.
- Per IMC, dryer exhaust over 200 CFM must have make-up air!
- Possible strategy to build dryer bank into a make-up air plenum behind the machines.
- Interconnect make-up air dampers to open with dryer operation

Non-dwelling Ancillary Spaces

Gyms:
- 20 CFM/Person + 0.06 CFM/SF

Storage Rooms:
- 0.12 CFM/SF

Office Spaces:
- 5 CFM/Person + 0.06 CFM/SF

- Can likely be tied into HRV with other spaces
- Gym may utilize dedicated HRV with CO_2 control since high rates and intermittent usage likely.

In Summary

- Design airflows to flow rates dictated by project goals – Passive House, ASHRAE or IMC but always comply with IMC at minimum.

- Fully distributed systems of balance ventilation are key for good indoor air quality and a healthy dwelling.

- Heat recovery ventilation saves substantial energy.

- Individual systems in each dwelling are best practice but may not fit into every project’s particular constraints.

- Ancillary spaces must be addressed and incorporated into overall ventilation strategy.

Questions???

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This concludes The American Institute of Architects Continuing Education Systems Course

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