



# Non-Standard

Lessons from Commercial passive house HVAC design

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**STAENGL**  
ENGINEERING







# Care First Animal Hospital

- First Passive House Animal Hospital
    - 25,000 sq ft animal hospital
    - 25,000 sq ft office
    - 50,000 sq ft parking
  - Under construction
  - Complicated special systems
    - Vacuum
    - Medical Gas
    - Separate Hair Trap Sanitary Mains
    - Boost Exhaust System
    - Special Animal Cage Exhaust
    - Isolation Rooms
    - Operating Rooms
    - Odor Control
    - Power Washing System
- Voluntary Complexity-





# Seminary Hill Cidery

- First Passive House Cidery
- Complete and in operation
- Special Systems
  - Production area at 60 degrees
  - Cidery Equipment
  - CO2 heavy process
  - High variance in occupancy
- Voluntary Simplicity-







# Responsive Ventilation

- Be very thoughtful about how ventilation responds to demand.
  - Occupancy, processes, time of day
- Pick controls that are simple and effective at turning down (or off) the systems.
  - CO2 sensors for occupancy
  - CO and NO2 sensors in parking garages
  - Time clocks for bathrooms
  - Pressure Sensors for make-up air
  - Switches or hood inter-ties for kitchens
  - Switches for boosting ventilation
  - Contaminate sensors for processes
- Switches when nothing else works well





# Pressure Compensating Make-up Air

- Unpredictable Exhaust
  - Laundry
  - Boost Systems
  - Vacuum Systems
  - Animal Cages
- Use strategies that balance the building dynamically
  - Tracking Pairs of balancing dampers
  - Pressure sensors in the spaces that control ventilation dampers or make-up fans
  - Interlocked equipment

Make-up Air Unit

Exhaust Fan

Kitchen Hood

*Leftover energy in dining exhaust goes outside*

# Kitchen Hood Makeup

Don't waste a valuable airstream

ERV

(MERV 13 filter on Supply)

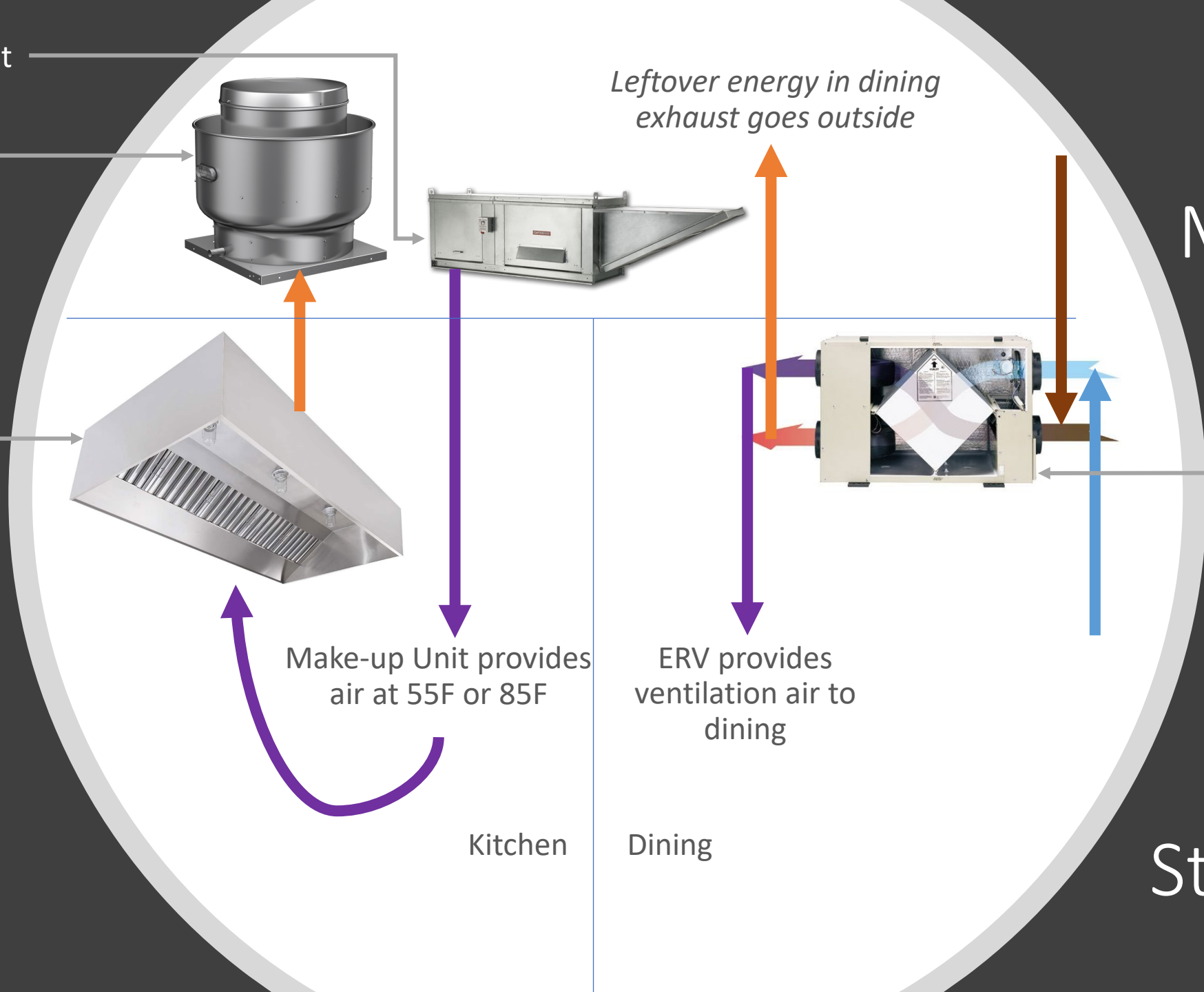
Make-up Unit provides air at 55F or 85F

ERV provides ventilation air to dining

Kitchen

Dining

# Standard



Make-up Air Unit

Exhaust Fan

Kitchen Hood

*Leftover energy in dining exhaust pre-tempers make-up air or provides all needed make-up air... 100% Effective ERV?!*

**One Less Louver!**

# Kitchen Hood Makeup

Don't waste a valuable airstream

ERV

(MERV 13 filter on Supply *and* Exhaust)

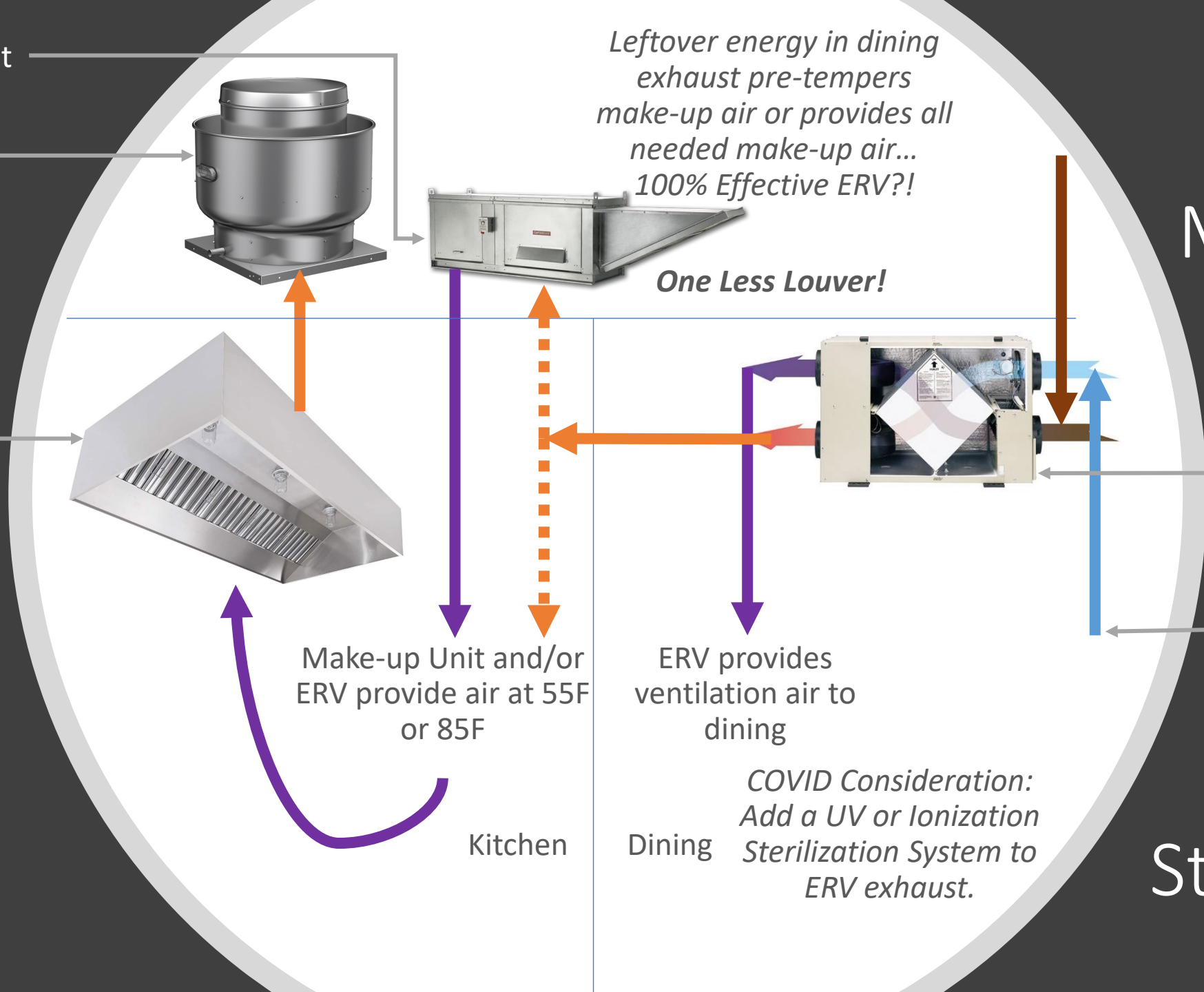
**Don't connect Bathroom Exhaust!**

Make-up Unit and/or ERV provide air at 55F or 85F

ERV provides ventilation air to dining

*COVID Consideration: Add a UV or Ionization Sterilization System to ERV exhaust.*

# Non-Standard



Kitchen

Dining





# Large Louvers

- Large ventilation systems in Commercial buildings often do not run all the time.
  - Louvers cannot be blanked off for intermittent equipment during blower door tests.
  - Backdraft dampers will open in one test direction and make for very awful air tightness numbers.
  - Recommend using motor operated dampers that shut completely.
  - Low leakage or insulated if possible.





# Acute Contaminates

- Cider process involves a lot of CO<sub>2</sub>... No data was available for how much.
  - Oxygen is cider's enemy
  - Carbon Dioxide is people's enemy
- Main ventilation system was sized for the steady state: 800 ppm CO<sub>2</sub>
- Alarms were installed for personnel safety : > 5000 ppm



# Acute Contaminates

- Carbon Dioxide sunk to the floor, 1400 ppm in certain operations, **8700 ppm** in others without a supplemental system!
- Opening garage doors doesn't remove the CO2 fast enough
- Supplemental systems were needed during certain operations
  - Huge, permanent exhaust fans would leak air forever.
  - Portable, Plug-in exhaust fans with snorkels are brought out during these operations





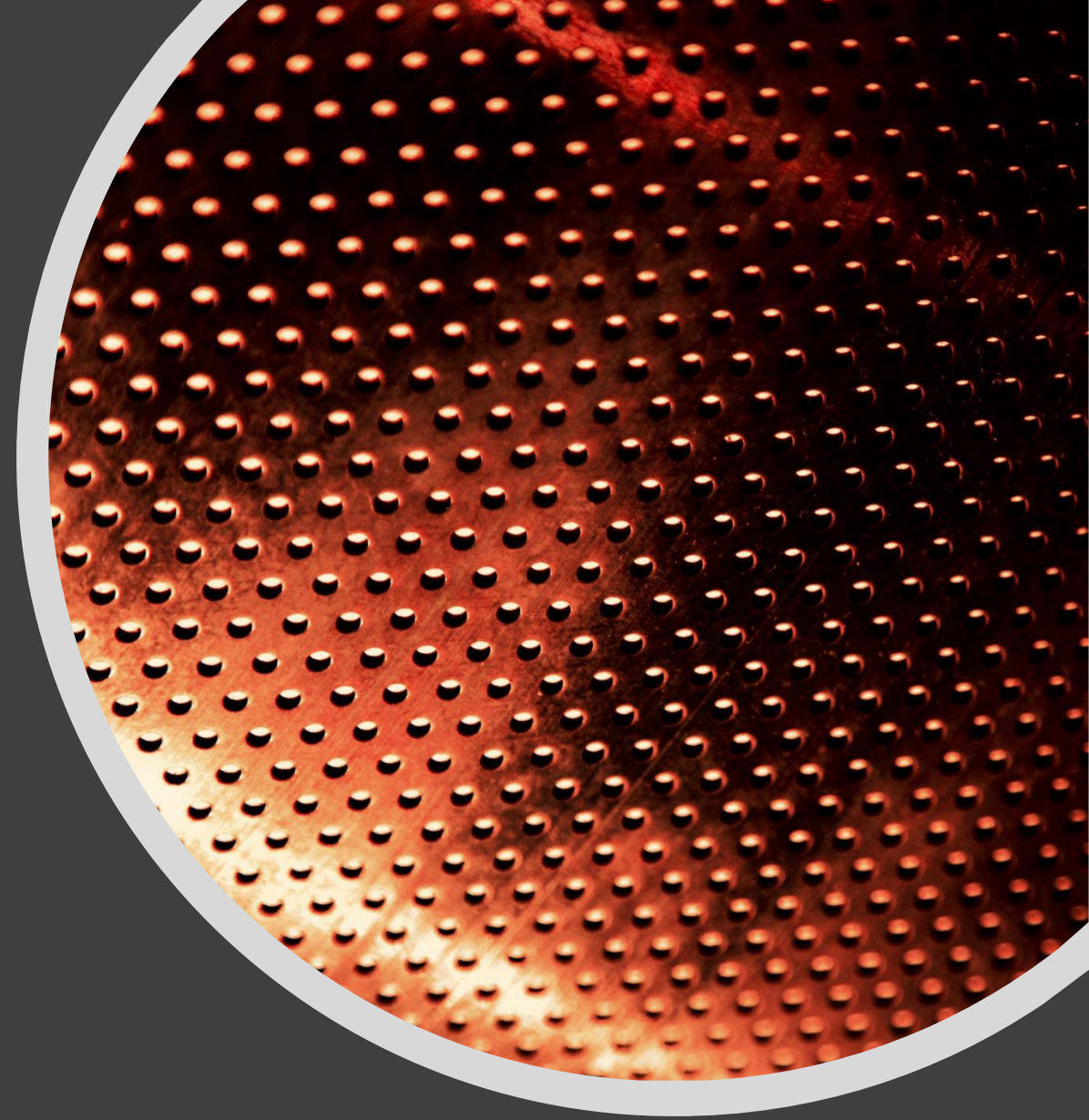
# Divergent Space Design Temperatures

- Some processes require temperatures out of range for air-to-air heat pumps
  - Refrigerators, production areas, special prep areas
  - Inverter heat pumps shut down when space temperatures get out of range
- Good old-fashioned hydronics (chilled and hot water) have been taught new tricks
  - Air-to-water heat pumps are 4x more efficient in heating than boilers.
  - Chilltrix for instance has impressive performance.
  - On board controllers can now be used instead of a complex BAS.



# Backup Heat

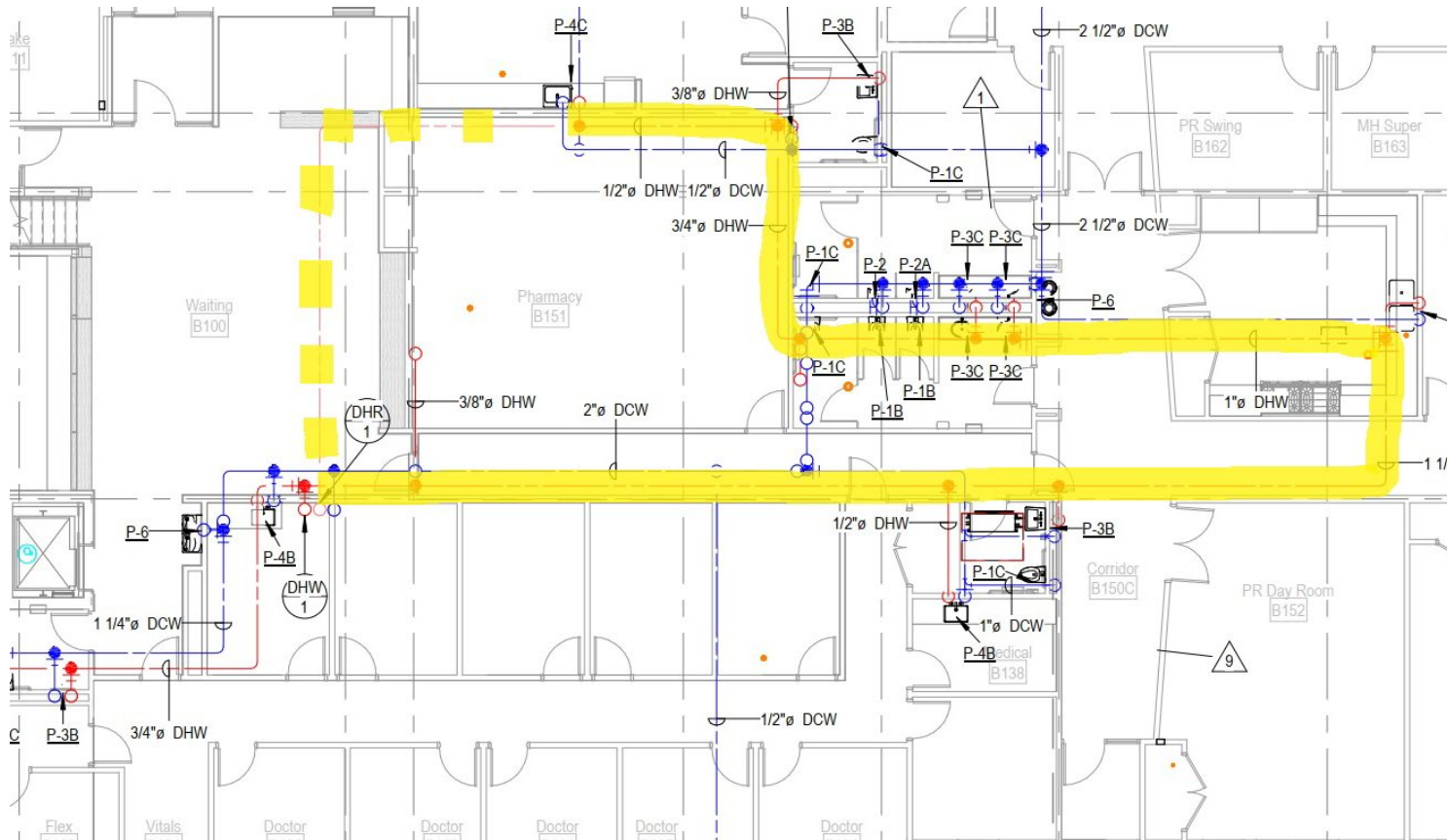
- Larger Wheel-type ERVs often require a source of backup heat for freeze protection
- Pre-heat position always wins vs post-heat
  - Pre-heater stops ERV defrost mode
  - ERV defrost mode can also trigger a heat pump defrost cycle, so post-heater must be sized for entire design day airflow delta-T.
  - Post heaters are such high capacity that either natural gas or increased electrical service size is required.
  - Pre-heater is smaller and more efficient, allowing for electric coils
- Keep hounding DOAS manufacturers to integrate pre-heaters into packaged units.





# Domestic Hot Water

## Still Important



- Time-to-tap is still important
- Fixtures are often all over the place
  - Locate all fixtures really close to water heaters & use instant water heaters for fixtures that are too remote.
  - Thermostatic balancing valves
  - Resort to clever hot water loop layouts that catch all fixtures.
- In buildings with high water use, always use heat pumps to generate the bulk of it
  - Tank style heat pump water heaters are simple and work well in light commercial.
  - Duct their cooling/dehumidification to places that usually need it like Kitchens, interior spaces, offices, unconditioned storage
- More detail in Galen Staengl's session tomorrow



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