Proper Applications & Sequences for Constant Volume Pressure Dependent Zoning Systems

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History

- VAV systems came into favor for mid and large size facilities in the 1960s and 1970s
  - Save energy
  - Improve comfort
  - Take advantage of building diversity
  - Cooling needed year round for true interior core zones
- Sequence
  - Main AHU provides morning warm-up heat until RAT setpoint is satisfied – all zones at 100% design airflow
  - AHU switches to 55°F discharge air controlled cooling – zones modulate CFM to controls space temp
  - No AHU heat remainder of day – individual zone reheat or baseboard as needed

History (con't)

- What about the small buildings?
  - IGVs and refrigerant capacity controls
    - Not available on packaged RTUs
    - AHUs - too expensive
  - Expensive zone level CFM/pressure measurement
  - Lack of consistent cooling load for interior zones

The Name Game

- Constant Volume Zoning
  - Refers to primary air source (RTU, AHU, etc.)
- Pressure Dependent Zoning
  - Zone CFM is dependent upon system pressure
- Auto-changeover VAV
  - Unlike standard VAV, RTU/AHU switches from cooling to heating during the day
- Bypass VAV
  - No IGV or VFD
- Shut-off VAV
- Variable Volume and Temperature (VVT)®
- Parker

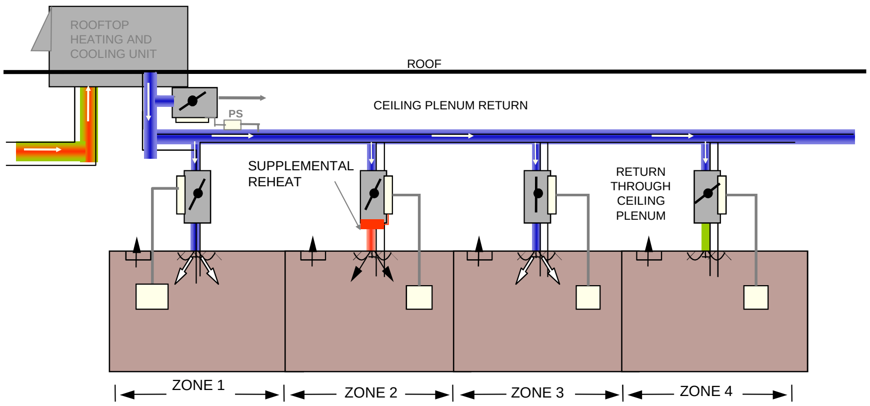
Variable Volume and Temperature

- VVT is called is called variable volume because it delivers a variable volume of air to each zone, as load dictates
- VVT is called variable temperature because the temperature of the air supplied by the central unit varies with time

General Application

- Several zones per system (RTU/AHU)
- Small to medium zone
- 1/4 - 2 1/2 tons per zone
- 100 - 1000 CFM per zone
- Typically 3 to 15 zones per system (most manufacturers limit at 32)
- 3 to 25 tons per system
- Buildings up to 40,000 sq. ft.

Conceptual Layout



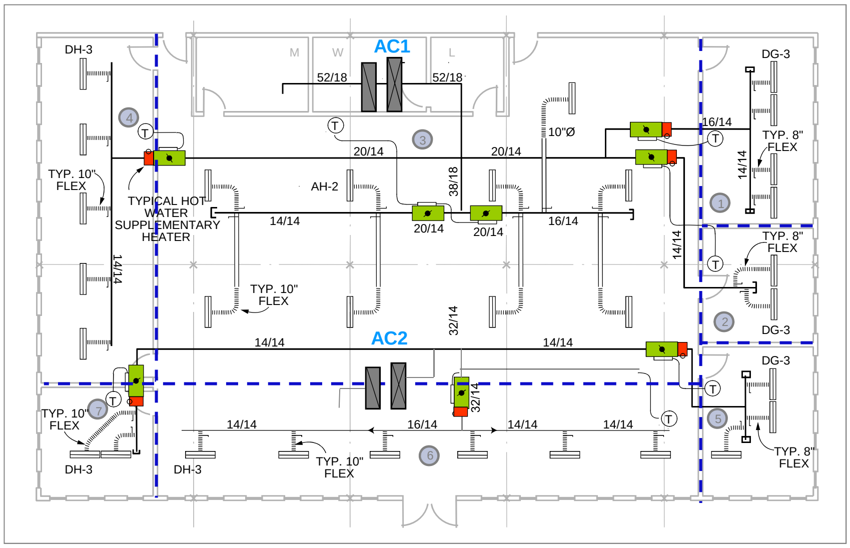
VVT System Design Steps

- Figure block cooling/heating loads
- Do preliminary equipment selection
- Determine control zones
- Figure zone cooling/heating loads and CFM requirements
- Select and position diffusers
  - Some say oversize by 25% to reduce noise
  - Some say size as normal to insure adequate throw
- Select and position dampers
  - Size to handle zone peak CFM at 900-1200 FPM

VVT System Design Steps (con't)

- Layout bypass system
- Position thermostats
- Size ductwork
  - Main supply and return = unit CFM
  - Branch = zone peak CFM
- Select supplementary heaters
- Final equipment selection
  - Do not oversize equipment!
- Define control wiring requirements and routing
  - Control riser wiring drawings

Typical Layout

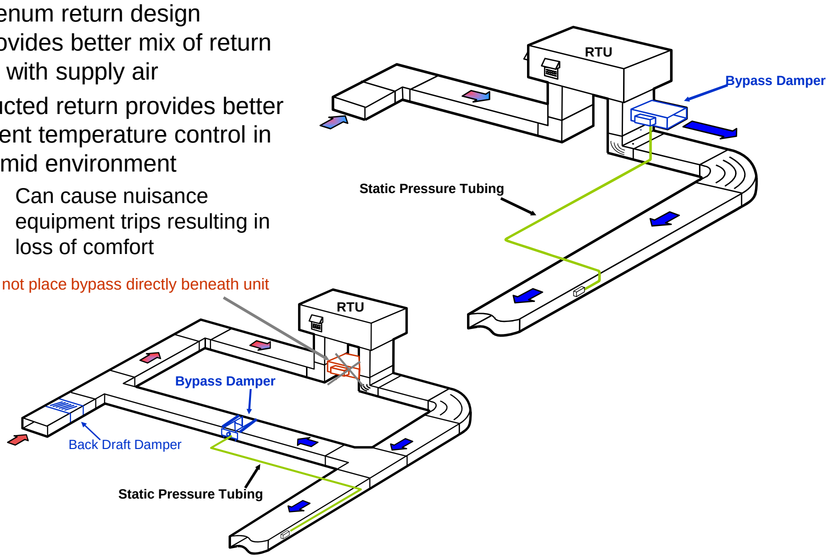


Bypass - System Pressure Control

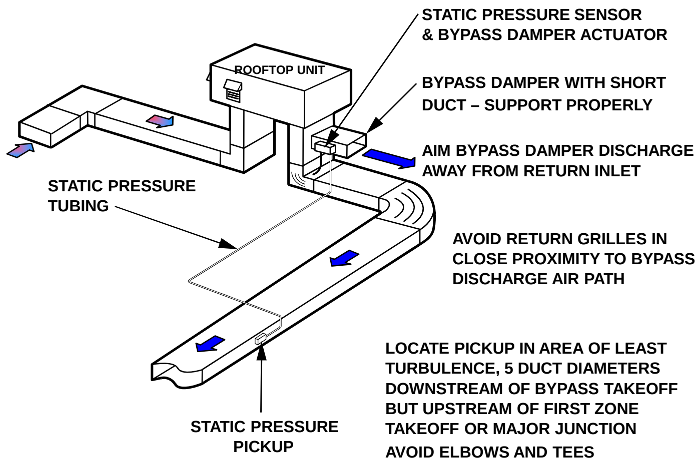
- Maintains system static pressure to insure adequate airflow into the zones and avoids over pressurization
- Size bypass adequately
  - Bypass CFM = unit CFM - smallest zone CFM
  - Minimum of 75% of unit CFM
  - Select at 1500 FPM
- Avoid short-circuiting
- Facilitate mixing of bypass air with return air
  - Plenum return preferred method
- VFD is acceptable if air source has hydronic heating and cooling ONLY

Return Air Path and Bypass

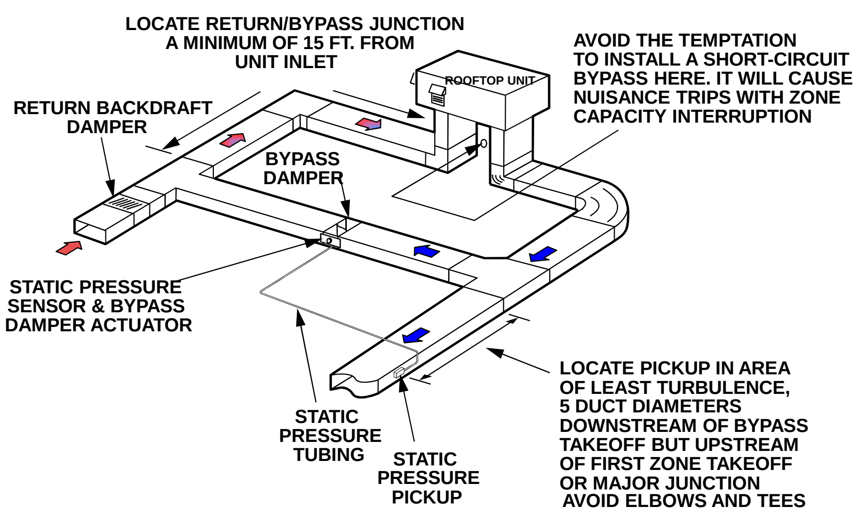
- Plenum return design provides better mix of return air with supply air
- Ducted return provides better latent temperature control in humid environment
  - Can cause nuisance equipment trips resulting in loss of comfort



Ceiling Plenum Return Layout



Ducted Return Layout



Leaving Air Temperature Protection

- As more air bypasses, the RTU/AHU discharge temperature will continue to drop (cooling mode) or rise (heating mode)
- System should stage down mechanical equipment regardless of zone temperatures being satisfied
  - Cool - 2nd stage at 50ºF and 1st stage at 45ºF
  - Heat - 2nd stage at 120-130ºF and 1st stage at 130-140ºF

System Mode Selection

- One (adj.) or more zones must be calling to start heating or cooling – usually 25% of total # of zones
- All zones must satisfy to clear mode
  - Allow auto changeover from heating/cooling if opposite mode has greater demand for 30 (adj.) minutes
- Bypass damper at 100% open/bypass until duct temp increases above 65ºF (heat) or decreases below 80ºF (cool)
  - Allows supply air to be preconditioned before delivery to zones
- Minimum heat and cool run time
  - 3 minutes acceptable for most HVAC equipment
  - Heat pumps should be 5 minutes

Zone Ventilation Control

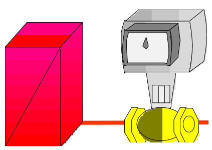
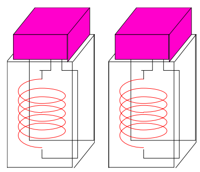
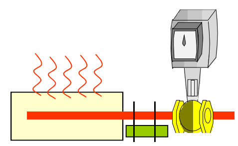
- Allows damper to modulate to provide ventilation airflow when:
  - When system not in heat or cool mode
  - Zone does not have demand
  - Supply air temp is neutral (between 65°F and 80°F)
- Damper must be allowed to fully shut when RTU/AHU is operating in an undesired mode
  - Do not implement minimum zone damper positions

CO2-based Demand Controlled Ventilation (DCV)

- Like a VAV, VVT should be zone level DCV
  - RA CO2 not acceptable for zoned systems
- A wall-mounted CO2 sensor can cover up to 5,000 ft^2 of open space
- Zone should first open zone damper to satisfy CO2 setpoint utilizing air already in the duct system
- OA damper should respond to the zone with the largest deviation from zone CO2 setpoint

Supplemental Heat

- Ducted and non-ducted heat types include:
  - 2 position (open/closed) hot water heat
  - 1 to 3 stages of electric heat
  - Modulating hot water heat
  - Modulating electric heat – Solid State Relays (SSR)
  - Combination 2 position baseboard w/ ducted staged heat
- Zone should call for supplemental heat before calling for RTU/AHU heat
- Lockout based on OAT
- Overhead heating - size reheat for 90ºF discharge

Fan Powered Boxes

- Not common on VVT type systems
- Can be used for perimeter or other zones with heating loads
- Sequence same as when used on VAV
  - Series fans run continuously
    - Downsize AHU supply fan selection
  - Parallel fans run as the 1st stage of zone heat and use warm plenum air

Internet Accessible

- View and modify data
- Perform system diagnostics
- Send alarm messages
- Dedicated PC for BAS not required

…around the world!

Air Balancing

Please see the supplemental document. Use in conjunction with industry standard balancing guidelines, as published by TABB or other reputable balancing organizations.

- Command the bypass damper closed and VVT dampers open
- Adjust supply fan to achieve the desired system CFM
- Adjust the maximum damper position to provide the required design maximum airflow to each zone – start with zones closest to RTU/AHU
- Set the fan speed setting for each box (fan powered boxes only)
- Calibrate the duct static pressure transducer for the bypass
- Calibrate the building static pressure transducer for the exhaust fans (if applicable)

Air Balancing (con't)

- Set the OA minimum position for the RTU/AHU
- Set the duct static pressure setpoint for the bypass controller
- Set the building static pressure setpoint for the exhaust fans (if applicable)
- Set the damper position for reheat (if applicable) for each box
- Route a courtesy copy of the balancing report to controls contractor so any setting changes can be preserved during future service calls.

Do's and Don'ts

- Don't apply to HVAC units over 20 tons
- Don't reduce the quantity of RTU/AHUs as compared to single zone constant volume system
- Don't oversize RTU/AHU
- Do install a TXV
- Don't mix core interior zones on the same system as exterior zones
  - Same rule for mixing exposures (east and west on the same unit, etc.)
  - Exception: If you install <u>and run</u> supplemental heat in all of the perimeter zones
- Don't install the bypass damper too close to the HVAC unit
- Don't locate the bypass discharge near plenum return grills
- Do specify the complete scope of air balancing
- And the most common problem…….
  - Don't specify or implement minimum damper positions

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Thanks to:

Carrier
Turn to the Experts.