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VAV Advanced Controls

Controls logic for VAV air terminal units with Thermal Dispersion Sensors

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Intended Audience – HVAC Designers

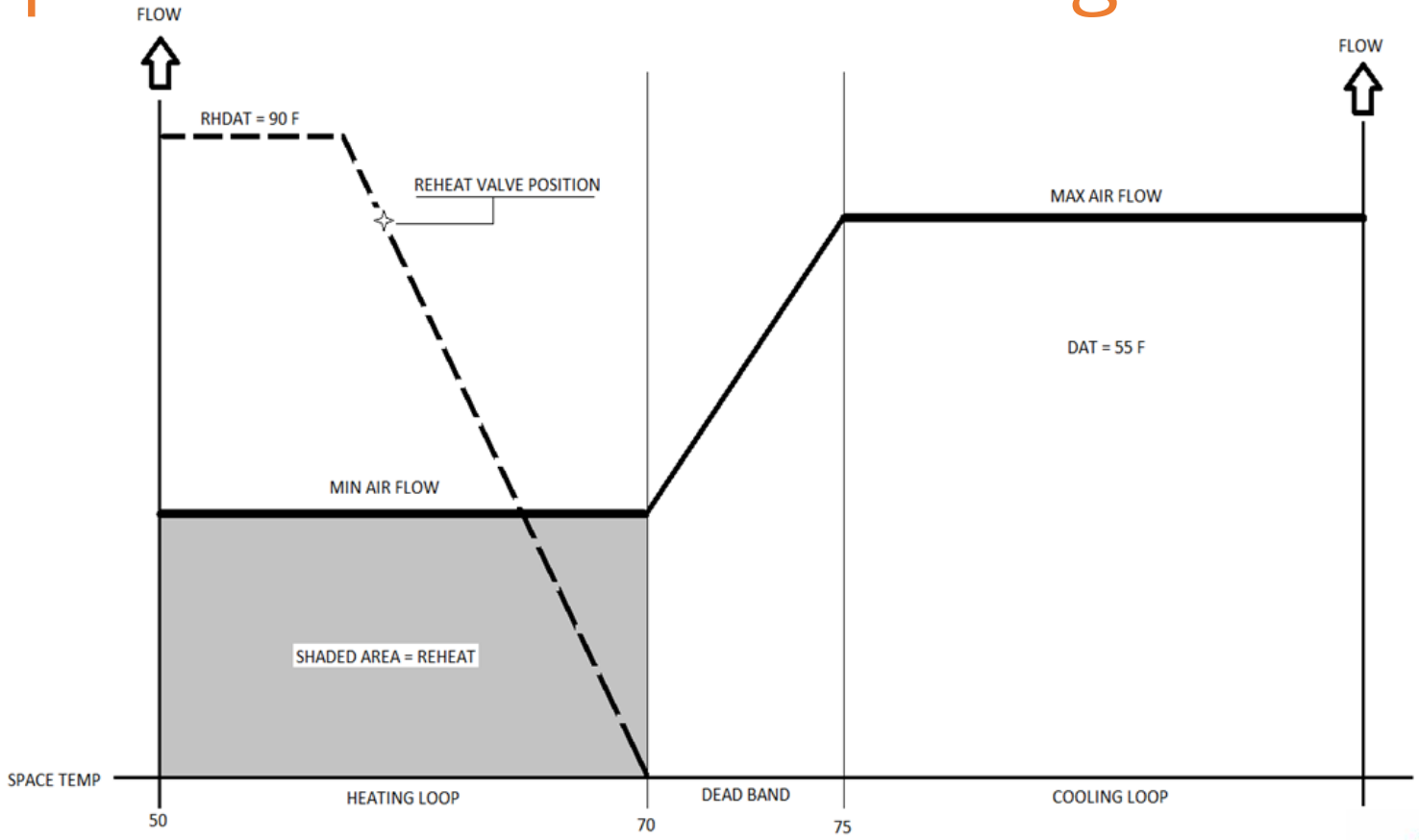
This controls logic guide for Advanced VAV air terminals with thermal dispersion type sensors focuses on single duct, variable air volume (VAV) systems intended to be used in commercial office buildings and similar spaces.

Proposed HVAC System Benefits

Goal is to assist HVAC designers in creating systems that will:

- ✓ Provide required occupant comfort
- ✓ Comply with required ventilation codes
- ✓ Capture ALL possible energy savings opportunities
- ✓ Exercise the best effort to limit the fan and reheat energy at part load

Typical VAV SD Controls Logic



Typical VAV SD Sequence

Basic control logic is described by the following sequence of operation:

1. When the zone is in cooling mode, while space temp is over 75 ˚F the cooling loop output is to be at its max air flow set point, while the hot water valve is closed.
2. When the zone is in the dead-band mode, the airflow setpoint shall be between cooling maximum and minimum airflow setpoints, while the hot water valve is closed.
3. When the zone is in the heating mode, the heating loop shall maintain space temperature at the heating air flow setpoint which is equal to minimum cooling air flow set point.
4. The hot water valve shall be modulated using a PID control loop to maintain the discharge temperature at setpoint.

Air Terminal MAX /MIN Flows

MAXIMUM Flow is defined by total internal loads

+ Lighting Loads
+ Plug Loads
+ Occupant Loads
= Internal Load

MINIMUM Flow setpoint "should" be > *the lowest of*:

- Controllable air flow setpoint
- Minimum ventilation requirement

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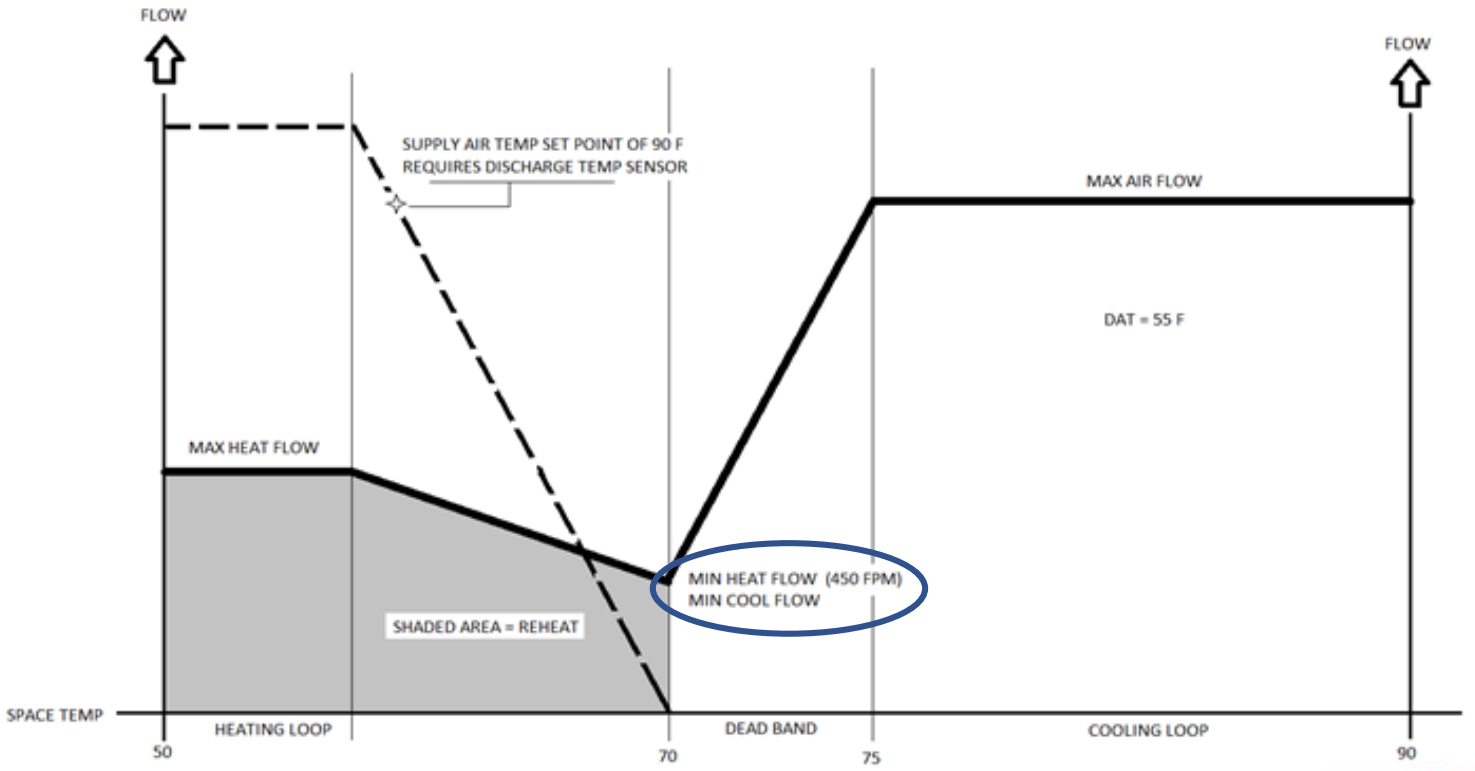
Controllable Airflow Setpoint

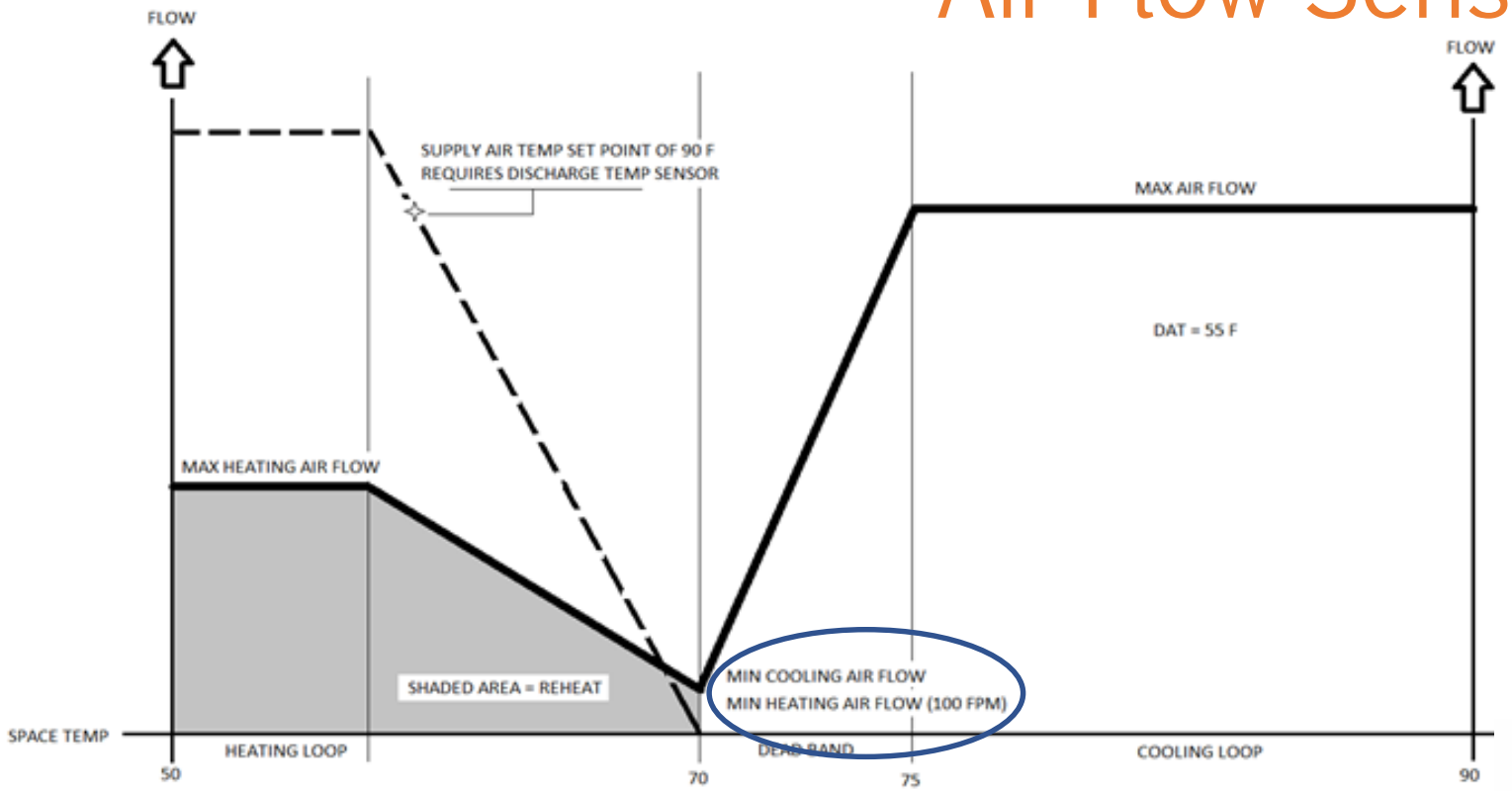
- Controllable airflow setpoint allowed by the terminal is called turn-down
- Depending on air flow sensor type -100 fpm or 450 fpm)

Reminder - the controllable minimum is a function of the design of the flow probe (amplification and accuracy) and the digital conversion of the flow signal at the controller (precision).

Min Controllability -Standard Air Flow Sensor



Min Controllability – Thermal Dispersion Air Flow Sensor



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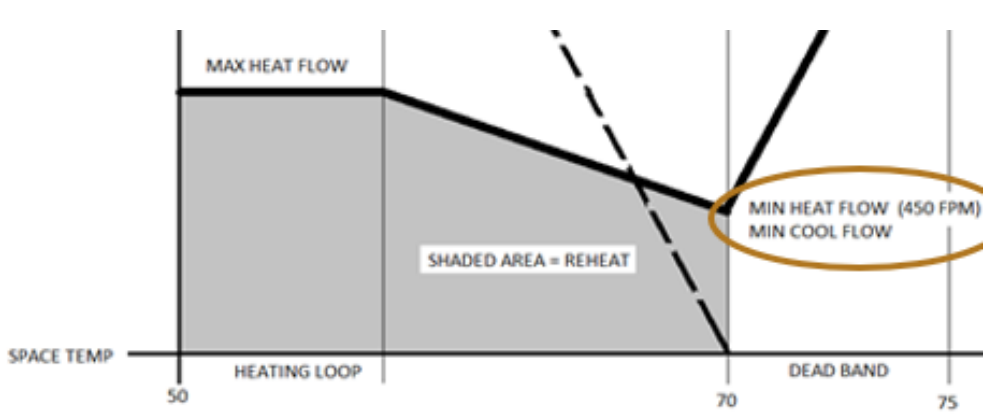
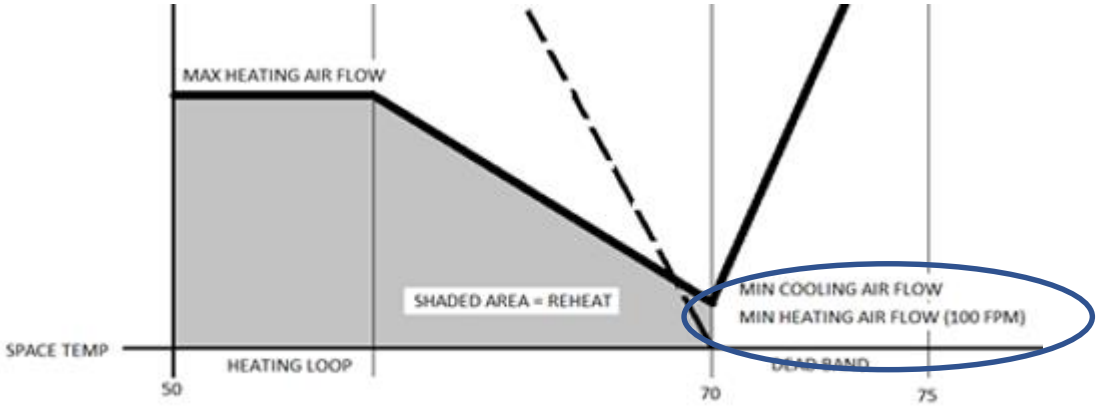
Standard vs Thermal Dispersion





While the shaded areas (which are proportional to the magnitude of the reheat energy) may not appear to be that different, it can be quite significant on an annual basis, since VAV boxes typically spend much of their time in the dead-band and mild heating modes.

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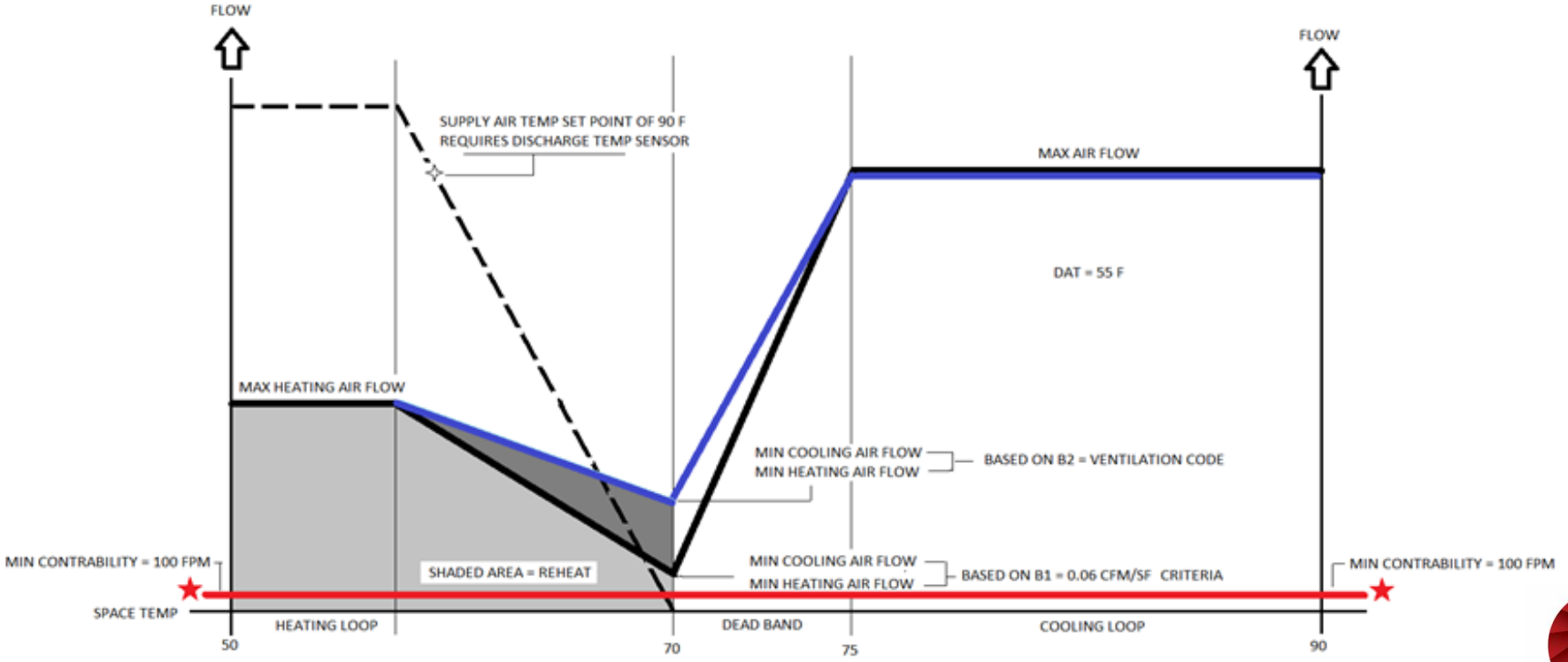
Minimum Ventilation Air Flow Requirement

Two components:

- B1 -Building or area pressure based –usually .06 cfm/sq ft
- B2 -Occupant based –defined by people needs and occupied space criteria

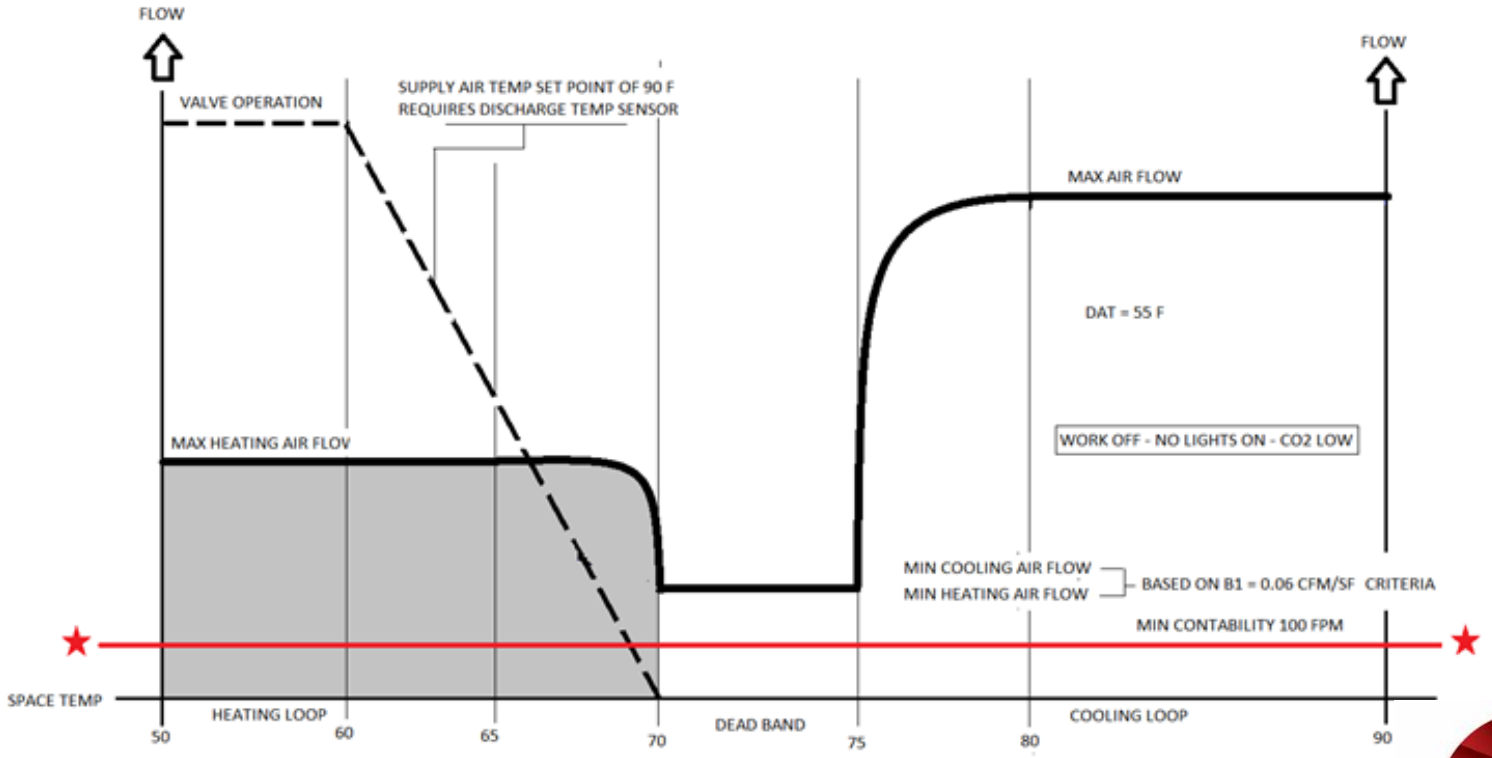


Occupant Based “Modes”

- WORK ON mode – 7:00am-7:00pm
  - People in space- OCCUPIED MODE
  - Office empty – UNOCCUPIED MODE called turn-down
- WORK OFF mode -7:00pm-7:00am

- WORK ON - Min airflow set pt = B1 or B2 cfm req. depending on OCC /UNOCC, CO^2 mode
- WORK OFF- Min airflow set pt = Only B1 cmf req.

Unoccupied Strategies



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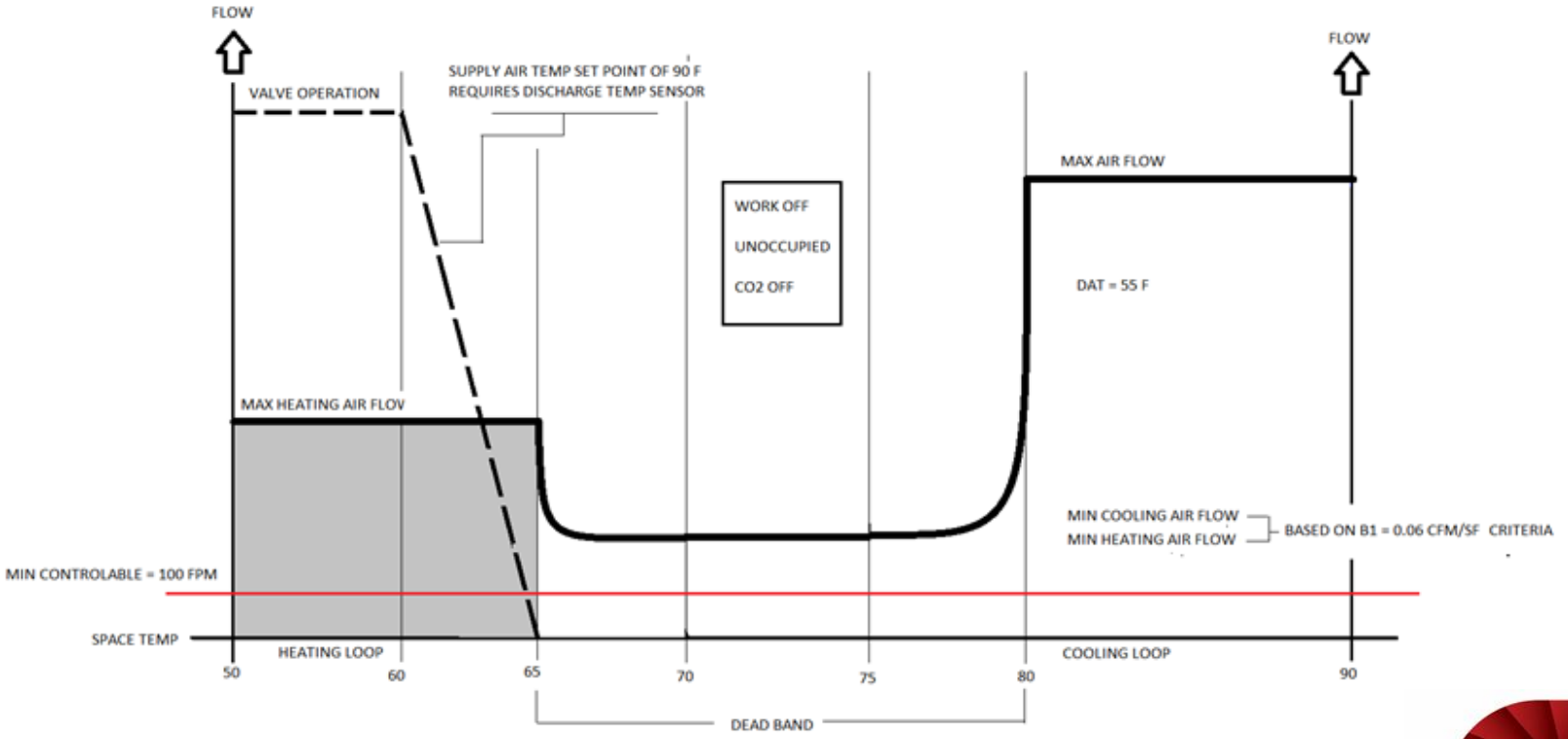
Unoccupied Strategies –Stretch Dead Band



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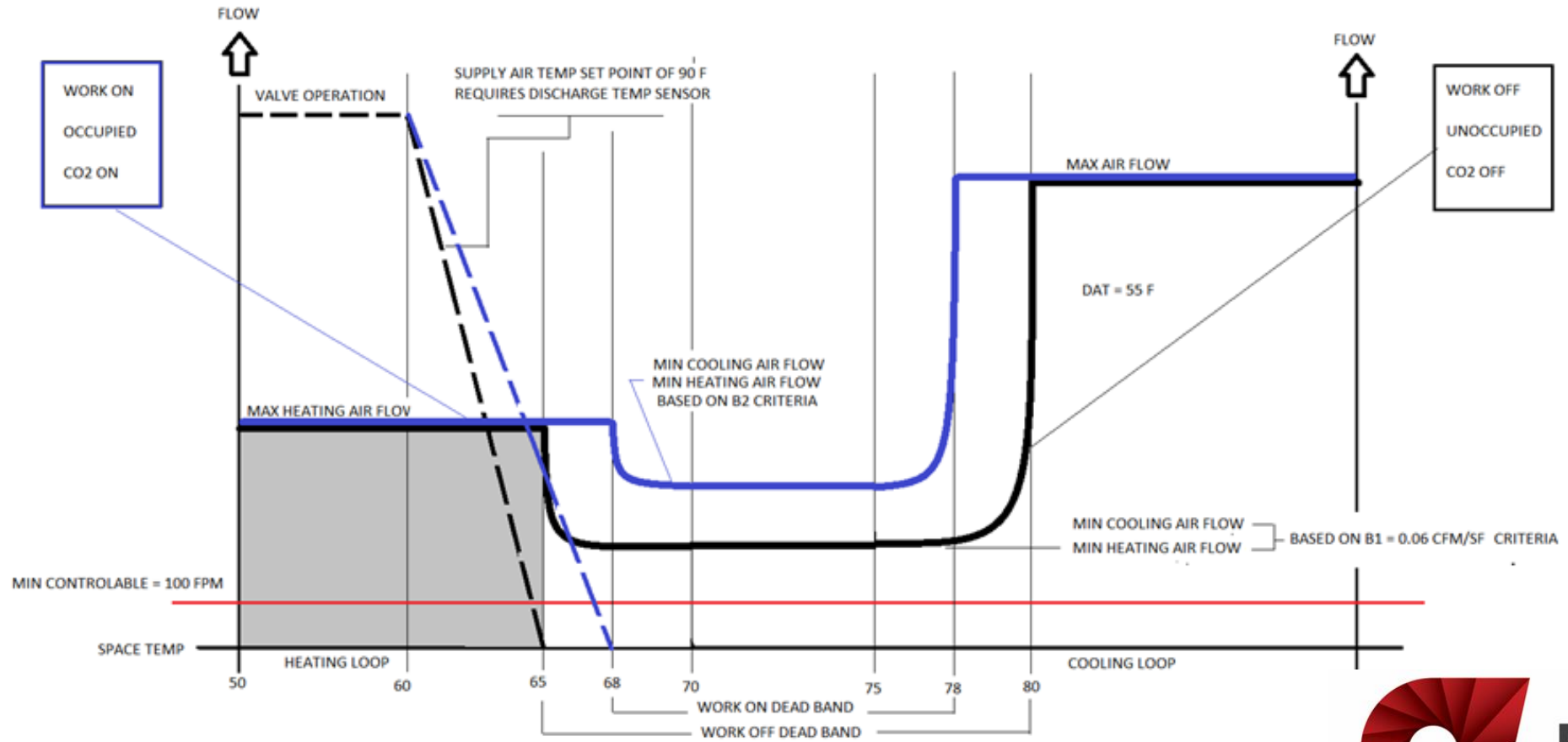
Work ON Mode

Must distinguish between OCCUPIED vs UNOCCUPIED mode

- Occupancy Controls – Occupancy/Vacancy sensors
  - Motion or Infrared
  - Typically required for lighting systems
  - Stable design, reliable, relatively inexpensive
- Demand Ventilation Controls – Space CO^2 sensors
  - Measures CO^2 in space
  - Somewhat slow reacting
  - Assumes higher CO^2 = occupancy
  - As Occupancy increases CO^2 & space temps increase, thus increasing min airflow from B1 to B2 at first and to max airflow depending on load

Controllable Min + Work On/Off Strategies



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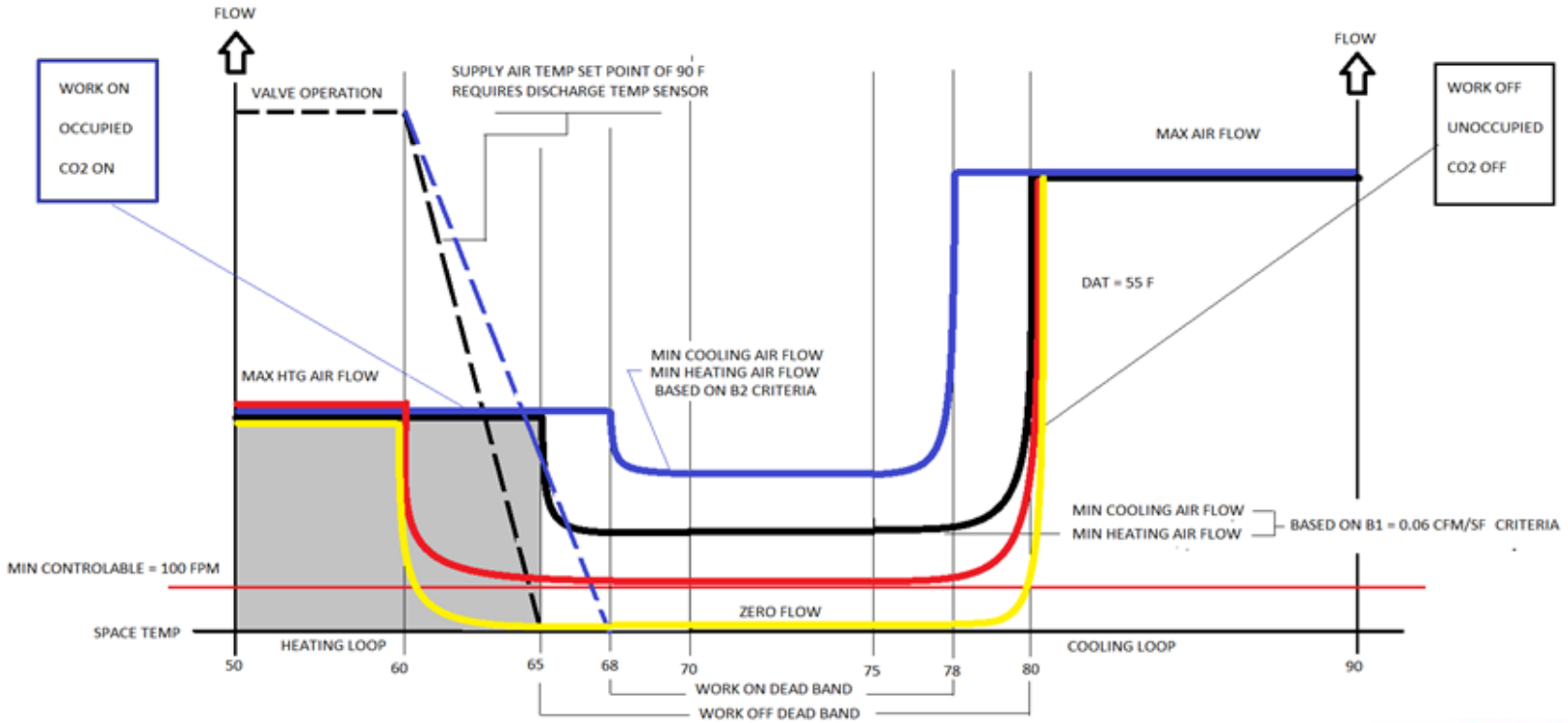
VAVs with Zero Min Airflow? – YES!!!



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Engineer's Concerns

- Minimum air movement and stuffiness
- Diffuser dumping and poor distribution problems
- Air change effectiveness

Engineer's Concerns - Addressed

- Do not use this strategy when air terminal serves many different zones.
- Do not use this strategy when perfect air distribution is needed all the time.
- Carefully select the diffusers to accommodate low flow distributions.

More VAV Advanced Settings

Additional VAV advanced settings for air terminals can be found with:

- Use space temperature reset controls to maximize benefit of unoccupied spaces as per owner's desire
- Use supply air temperature reset control from 55F to 60F at any time building humidity allows it

Advanced VAV Controls Re-cap

- By setting back temperature and airflow setpoints when the space served is unoccupied, central fan airflow is reduced and zone reheat is minimized, and it is all possible with thermal dispersion air flow probes.

- By stretching the dead-band minimum airflow rate, spaces are not over-cooled when there is no cooling load and “pushed” into the heating mode

- By controlling the reheat valve to maintain discharge supply temperature rather than space temperature, supply air temperature can be limited so that stratification and short circuiting of supply to return does not occur. This improves heating performance and ventilation effectiveness.

Questions??