HVAC SYSTEMS

ALL OF THE EQUIPMENT NECESSARY TO PROVIDE THE DESIRED ENVIRONMENTAL CONDITIONS IN A BUILDING OR ITS PARTS

FACTORS TO BE CONSIDERED WHEN SELECTING A SYSTEM

1. PERFORMANCE
2. FIT INTO AVAILABLE SPACE
3. GIVE THE OWNER THE BEST COMBINATION OF:
   A. FIRST COST
   B. OPERATING COST
   C. RELIABILITY

HVAC SYSTEMS

PRIMARY SYSTEMS: TO CONVERT THE ENERGY IN A FUEL OR ELECTRICITY TO THERMAL ENERGY FOR HEATING OR COOLING (BOILERS, CHILLERS, ETC.)

SECONDARY SYSTEMS: TO DISTRIBUTE FRESH AIR, HEATING AND COOLING TO THE SPACES IN A BUILDING (DUCTS, FANS, PIPES, PUMS, DAMPERS, ETC.)

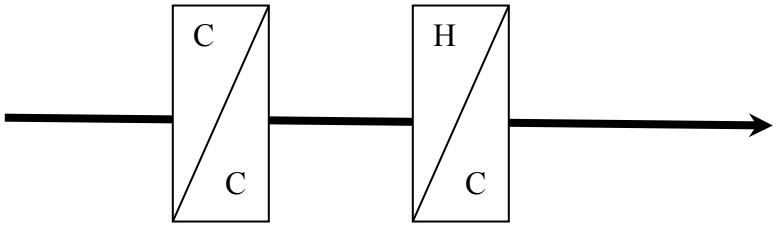
PRIMARY SYSTEMS

- CONVENTIONAL SYSTEMS (BOILERS, FURNACES, CHILLERS, COOLING TOWERS)
- HEAT PUMP SYSTEMS (AIR-SOURCE, GROUND SOURCE)
- CO-GENERATION SYSTEMS
- SOLAR THERMAL (AIR AND WATER BASED)
- PV, BUILDING INTEGRATED PV (BIPV)
- THERMAL STORAGE

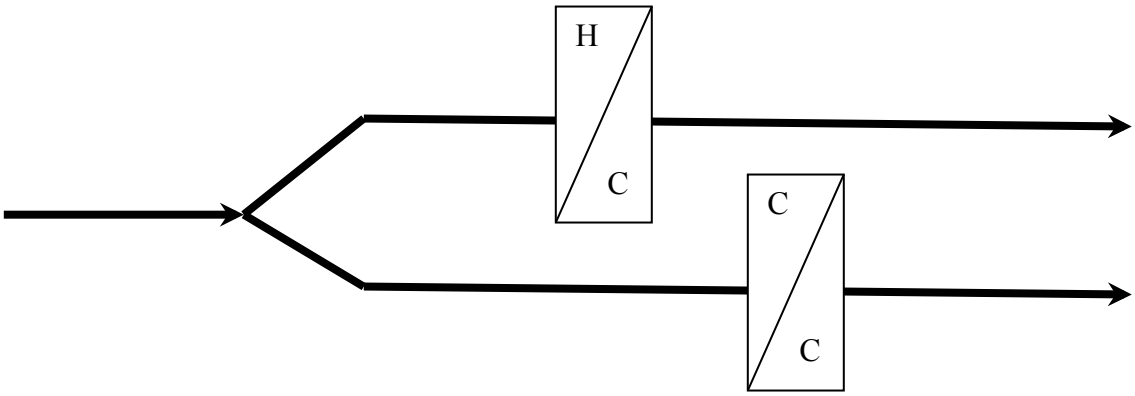
SECONDARY SYSTEMS:

1. ALL-AIR SYSTEMS

A. SINGLE PATH SYSTEMS (SZCV, CV REHEAT, VAV, VVVT)



B. DUAL PATH SYSTEMS (DUAL DUCT)



2. AIR-AND-WATER SYSTEMS

2, 3 OR 4-PIPE SYSTEMS, FAN-COIL SYSTEMS

3. ALL-WATER SYSTEMS

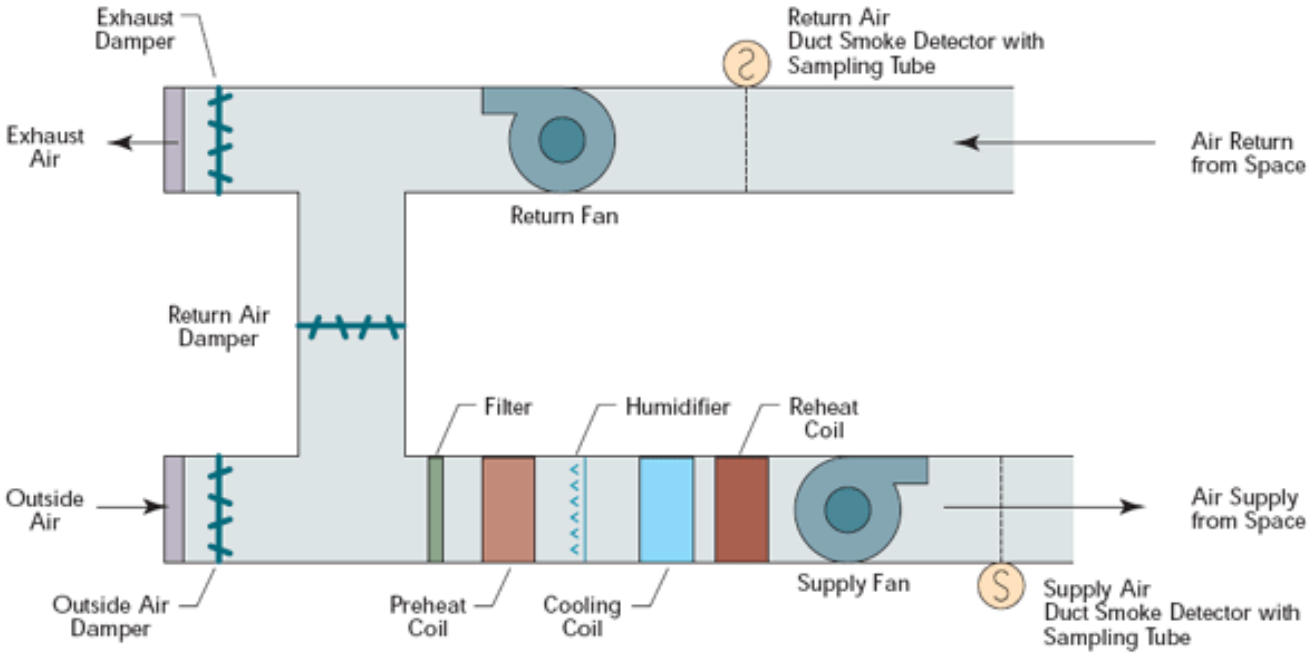
UNIT VENTILATORS, FAN-COILS, BASEBOARD CONVECTION

4. PACKAGED (UNITARY) SYSTEMS

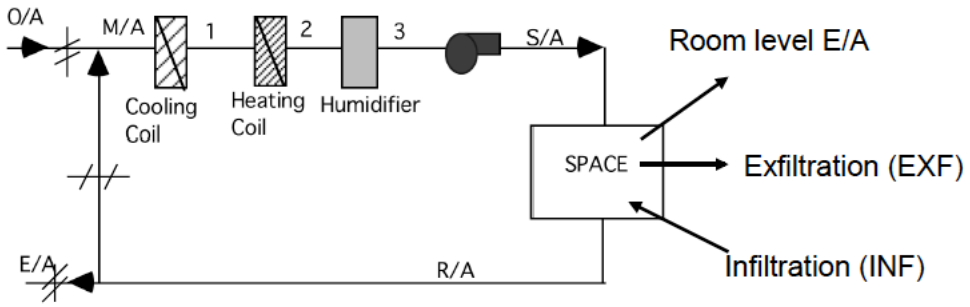
WINDOW AIR CONDITIONERS, ROOF-TOP SYSTEMS

ALL-AIR SYSTEMS

1. SINGLE-ZONE CONSTANT VOLUME (SZCV)



MASS FLOW RATE BALANCES



R/A - E/A + O/A = M/A = S/A

S/A + INF = RL(E/A) + EXF + R/A

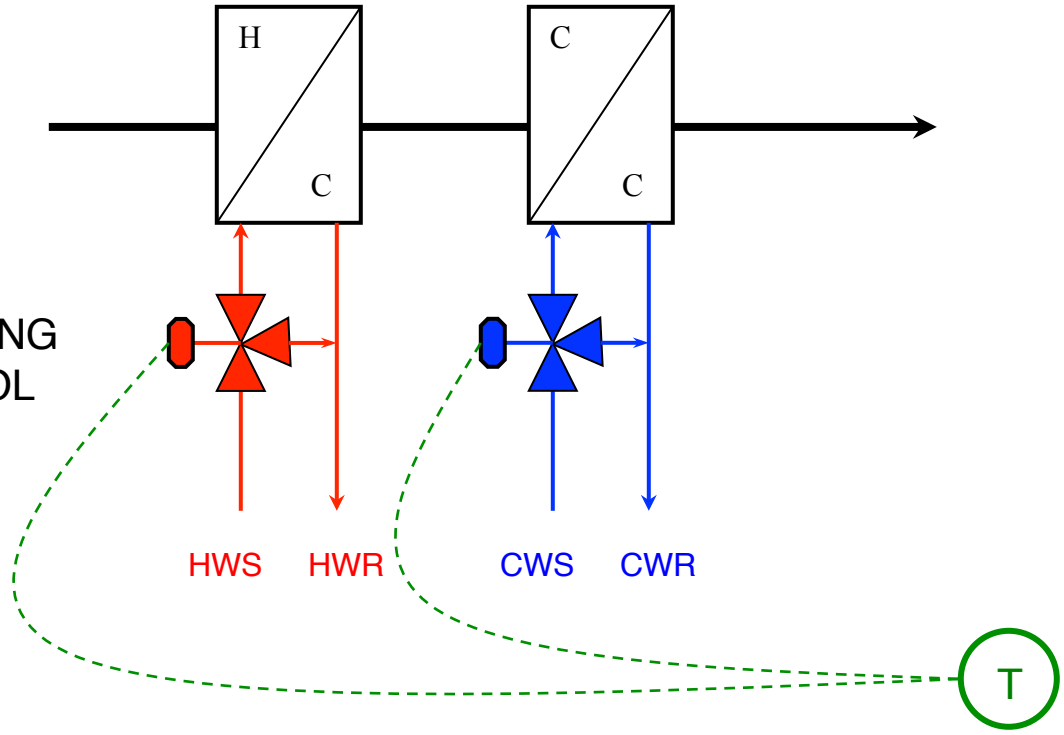
If S/A = R/A, then:

INF = RL(E/A) + EXF

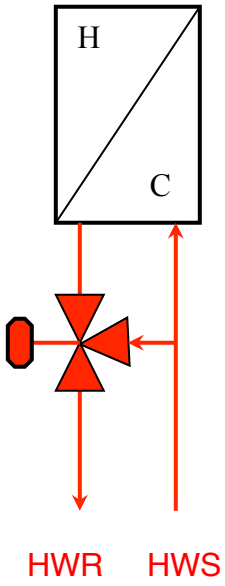
and if RL(E/A) = 0, then

INF = EXF

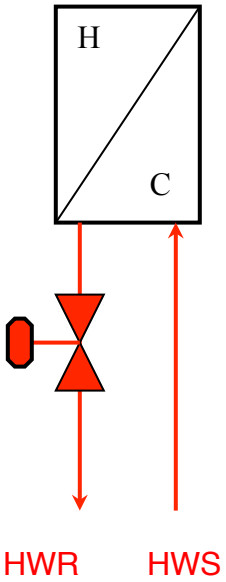
3-WAY
DIVERTING
CONTROL
VALVES



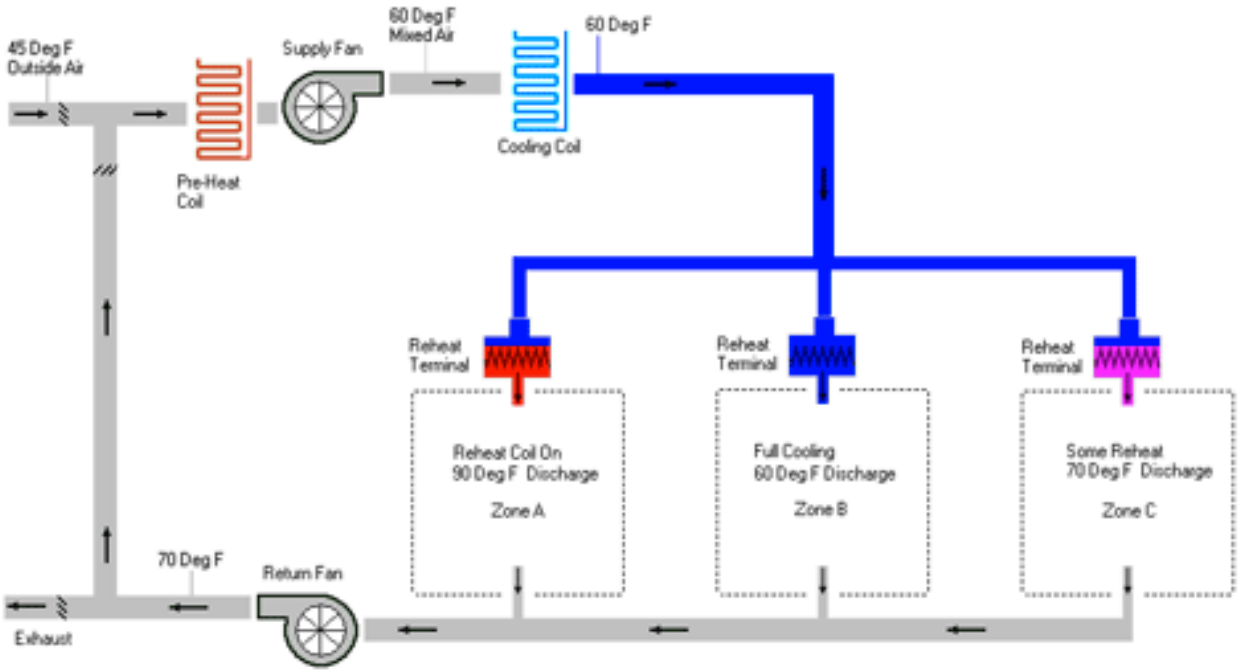
3-WAY MIXING CONTROL VALVE



2-WAY CONTROL VALVE (could be on the supply or return side)

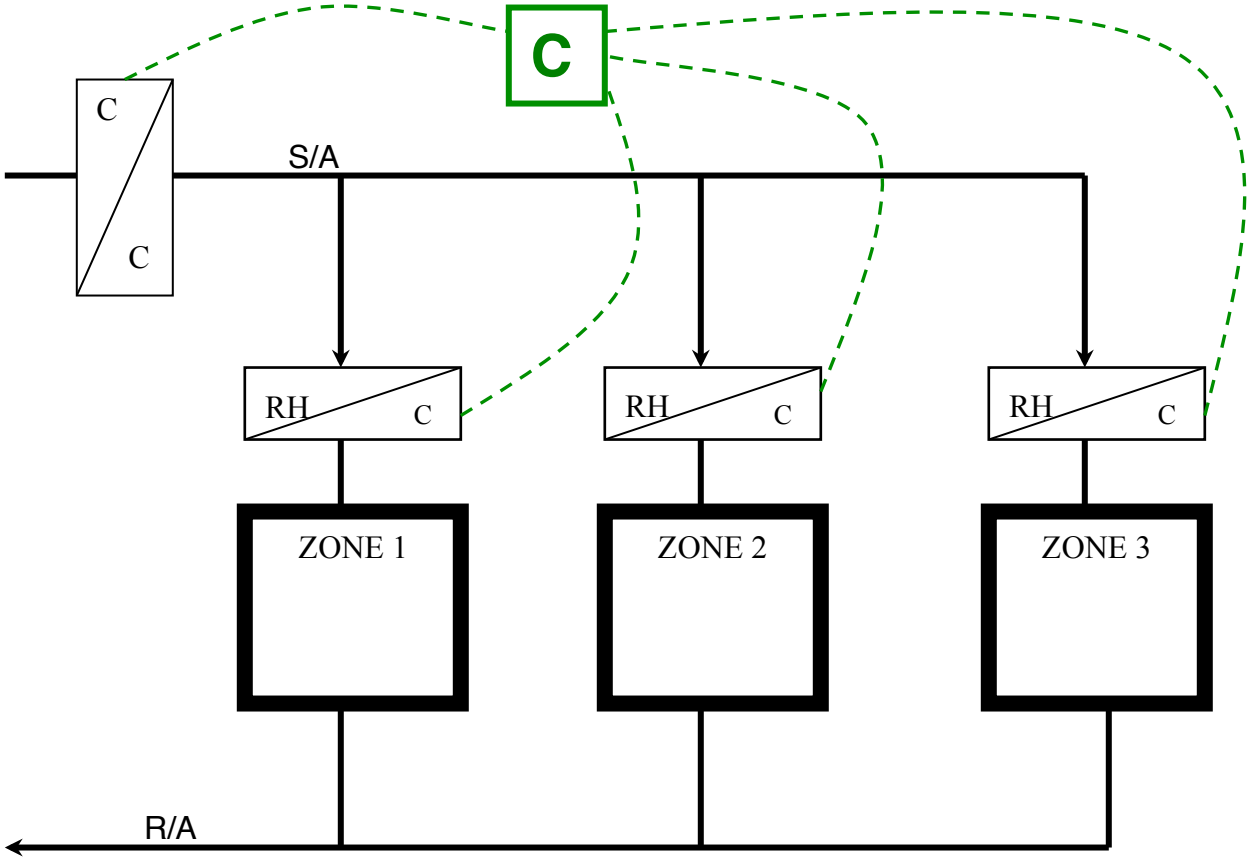


2. CONSTANT VOLUME - TERMINAL REHEAT



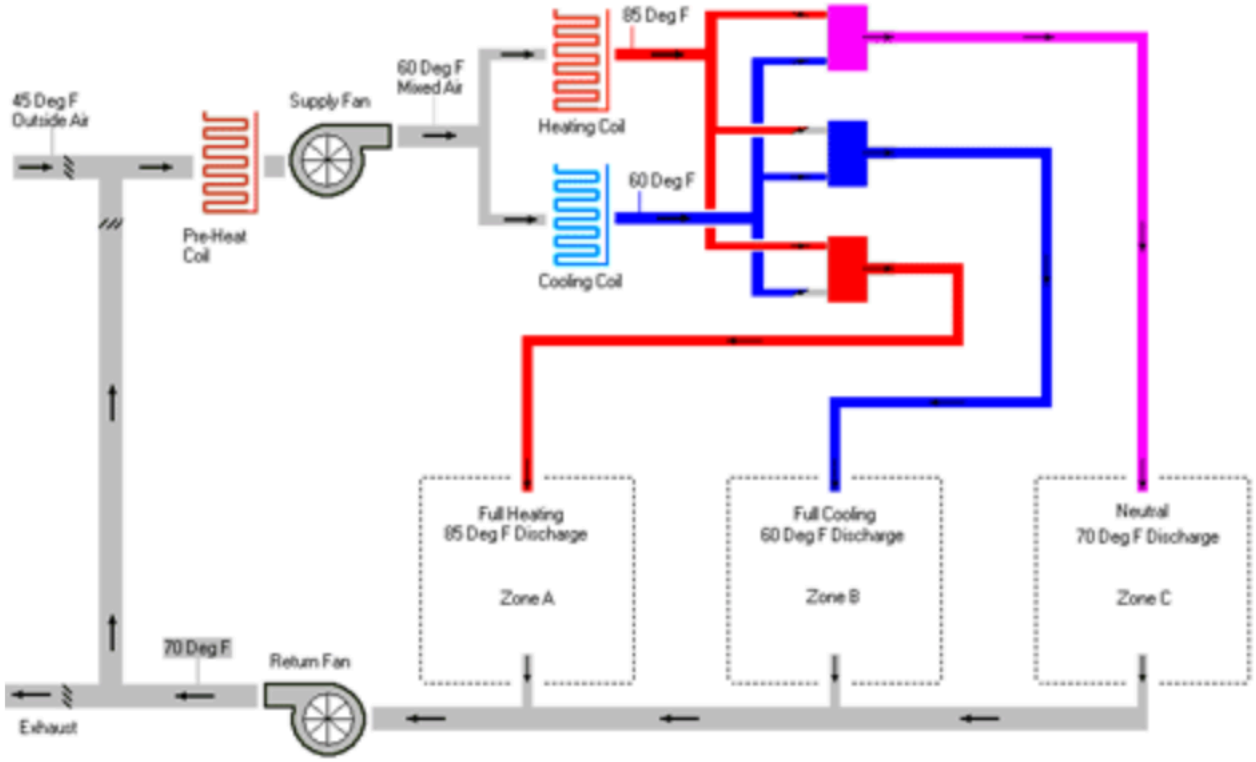
DISCRIMINATOR CONTROL:

TO MINIMIZE REHEAT



THE S/A TEMP IN THE MAIN DUCT IS INCREASED UNTIL THE VALVE ON THE REHEAT BOX OF ONE ZONE IS FULLY CLOSED.

3. CONSTANT VOLUME MULTI-ZONE



DISCRIMINATOR CONTROL:

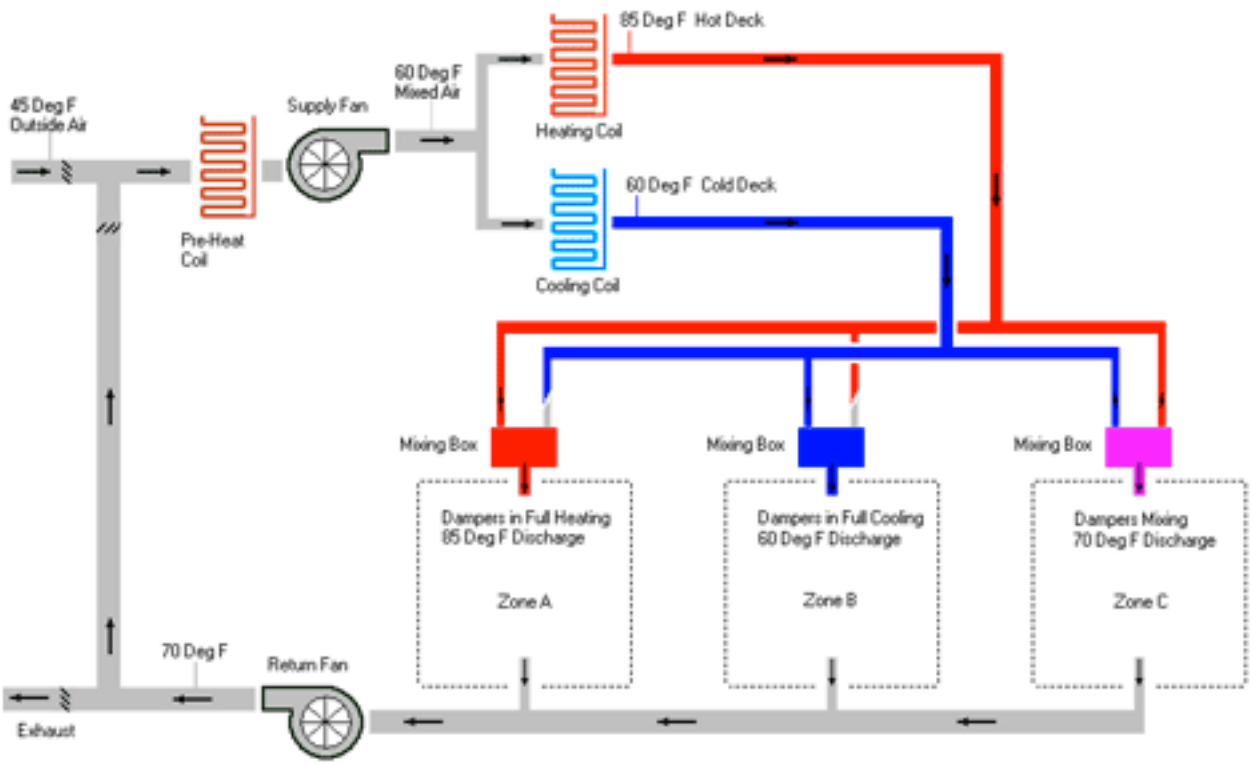
1. INCREASES THE COLD DUCT TEMP UNTIL THE HOT DUCT DAMPER OF ONE ZONE IS FULLY CLOSED
2. DECREASES THE HOT DUCT TEMP UNTIL THE COLD DUCT DAMPER OF ONE ZONE IS FULLY CLOSED

OBJECTIVE: TO MINIMIZE MIXING

4. CONSTANT VOLUME BY-PASS MULTI-ZONE

NO NEED FOR DISCRIMINATOR CONTROL!

5. CONSTANT VOLUME DUAL DUCT

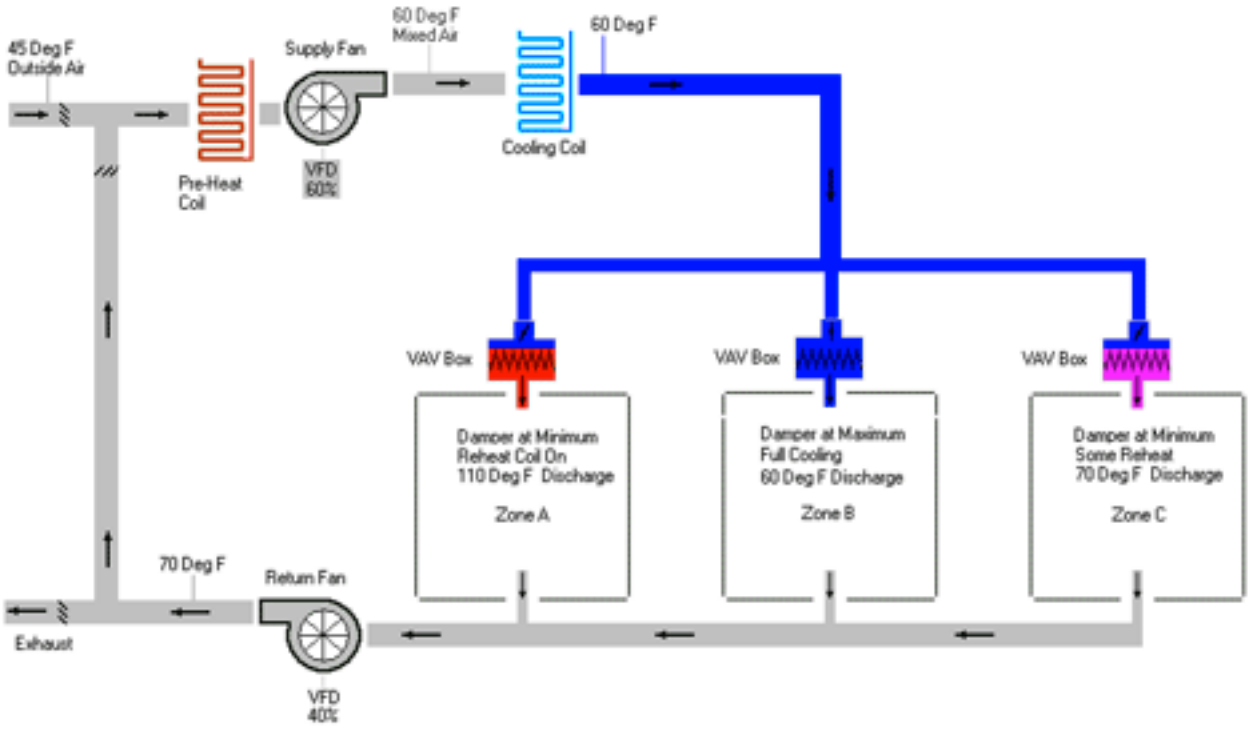


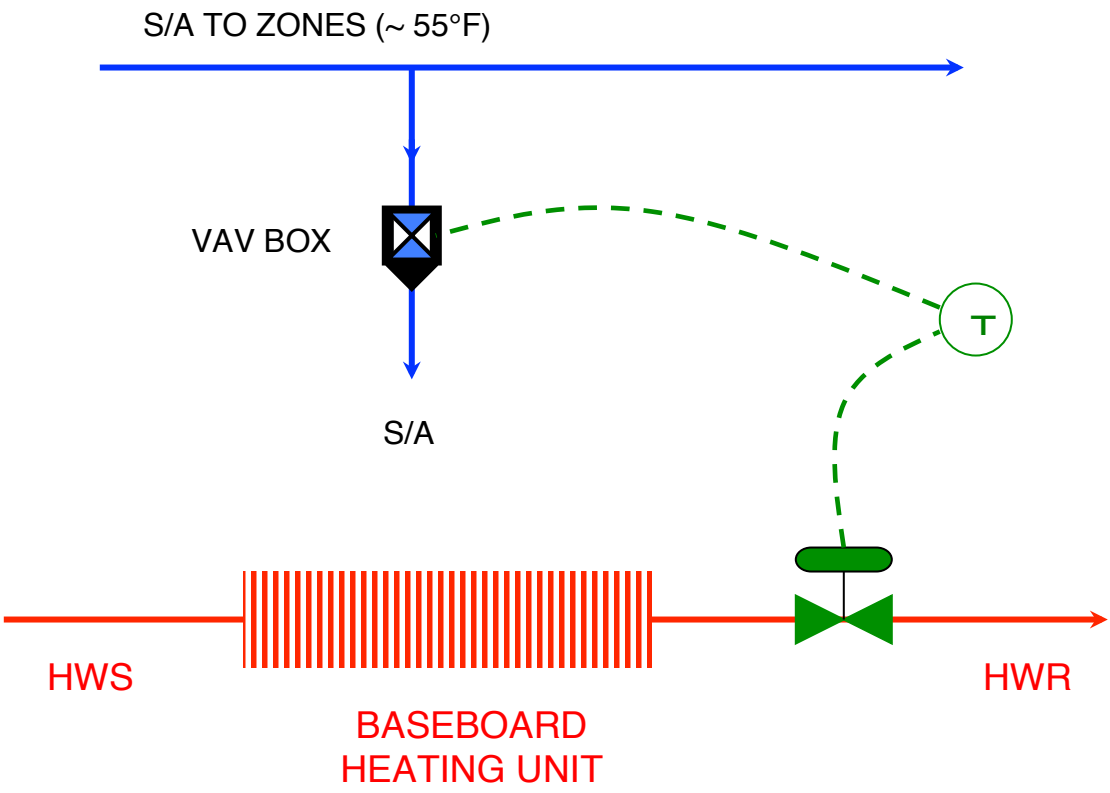
DISCRIMINATOR CONTROL:

1. INCREASES THE COLD DUCT TEMP UNTIL THE HOT DUCT DAMPER OF ONE ZONE IS FULLY CLOSED
2. DECREASES THE HOT DUCT TEMP UNTIL THE COLD DUCT DAMPER OF ONE ZONE IS FULLY CLOSED

OBJECTIVE: TO MINIMIZE MIXING

6. VARIABLE AIR VOLUME (VAV)





OPERATING SEQUENCE:

- AT FULL CLNG LOAD: VAV BOX FULL OPEN
  HTNG VALVE CLOSED
- AS CLNG LOAD DECREASES:
  VAV BOX MODULATES CLOSE
  HTNG VALVE REMAINS CLOSED
- AS CLNG LOAD FURTHER DECREASES:
  VAV BOX WILL REACH ITS MIN POSITION
  AND WILL NOT CLOSE ANY FURTHER
- ONSET OF HTNG LOAD:
  HTNG VALVE MODULATES OPEN
  VAV BOX REMAINS AT MIN POSITION

SUPPLY FAN TRACKING (VAV SYSTEMS)
(TO REDUCE FAN POWER CONSUMPTION)

- S/A AND R/A FANS ARE VARIABLE VOLUME FANS (VARIABLE SPEED OR VARIABLE INLET VANES)
- R/A FAN MUST TRACK THE S/A FAN (MEASURE THE S/A FLOW RATE AND MATCH THE R/A FAN OPERATION TO MATCH THE S/A FLOW RATE
- S/A FAN IS CONTROLLED BY A STATIC PRESSURE SENSOR AT THE FAR END OF THE DUCT SYSTEM

AIR-AND-WATER SYSTEMS

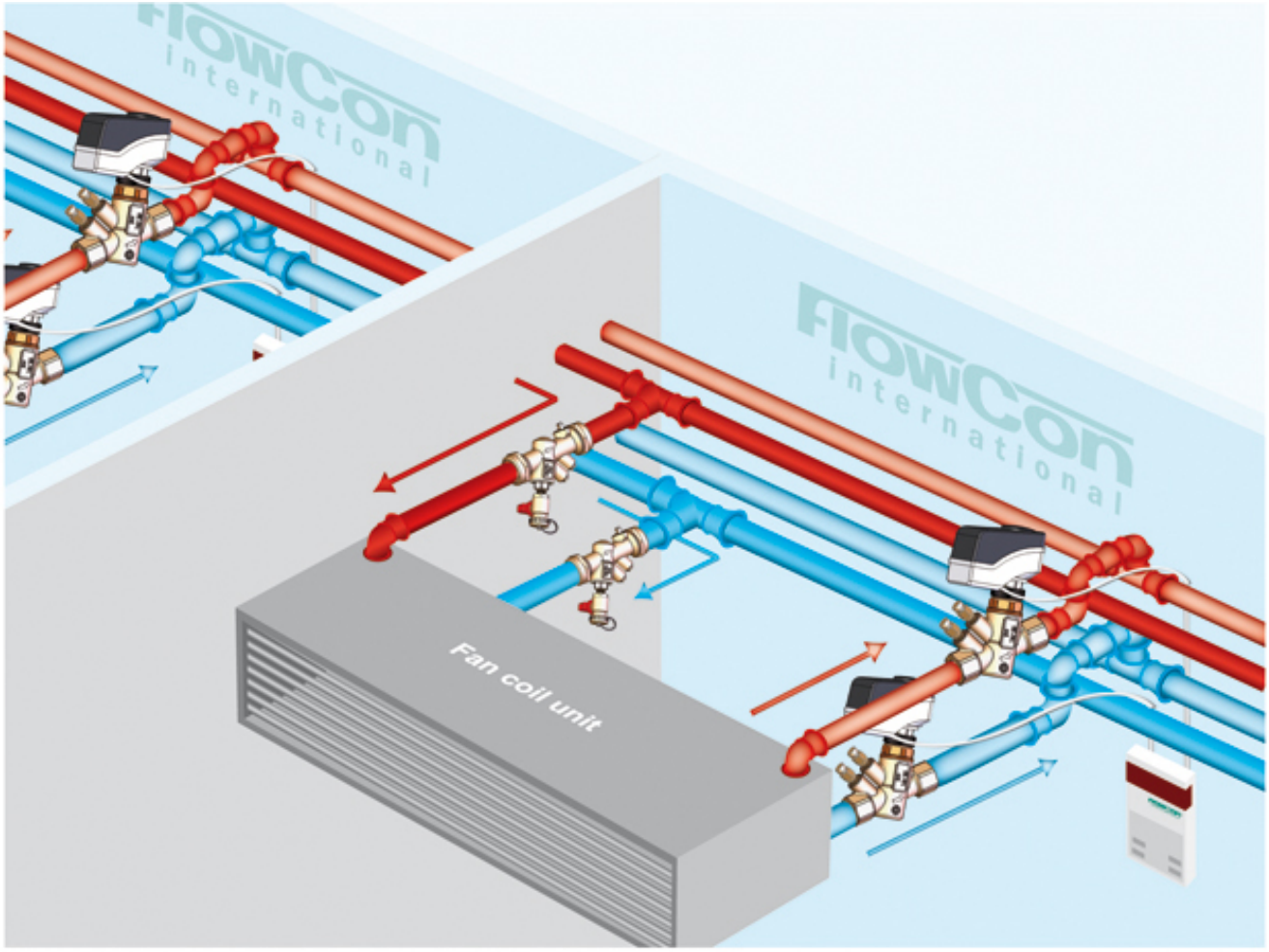
- HEATING AND COOLING PERFORMED BY BOTH AIR AND WATER SUPPLIED TO THE SPACE

- ADVANTAGES:
  LESS SPACE REQ'S SINCE
  $c_{p,water} >> c_{p,air}$
  PUMPING POWER << FAN POWER

- QUANTITY OF AIR SUPPLIED = VENTILATION REQMNT

- IF THIS AIR IS EXHAUSTED DIRECTLY AT THE ZONE LEVEL => NO R/A SYSTEM NEEDED

FAN COIL SYSTEM
(VENTILATION DUCT NOT SHOWN)



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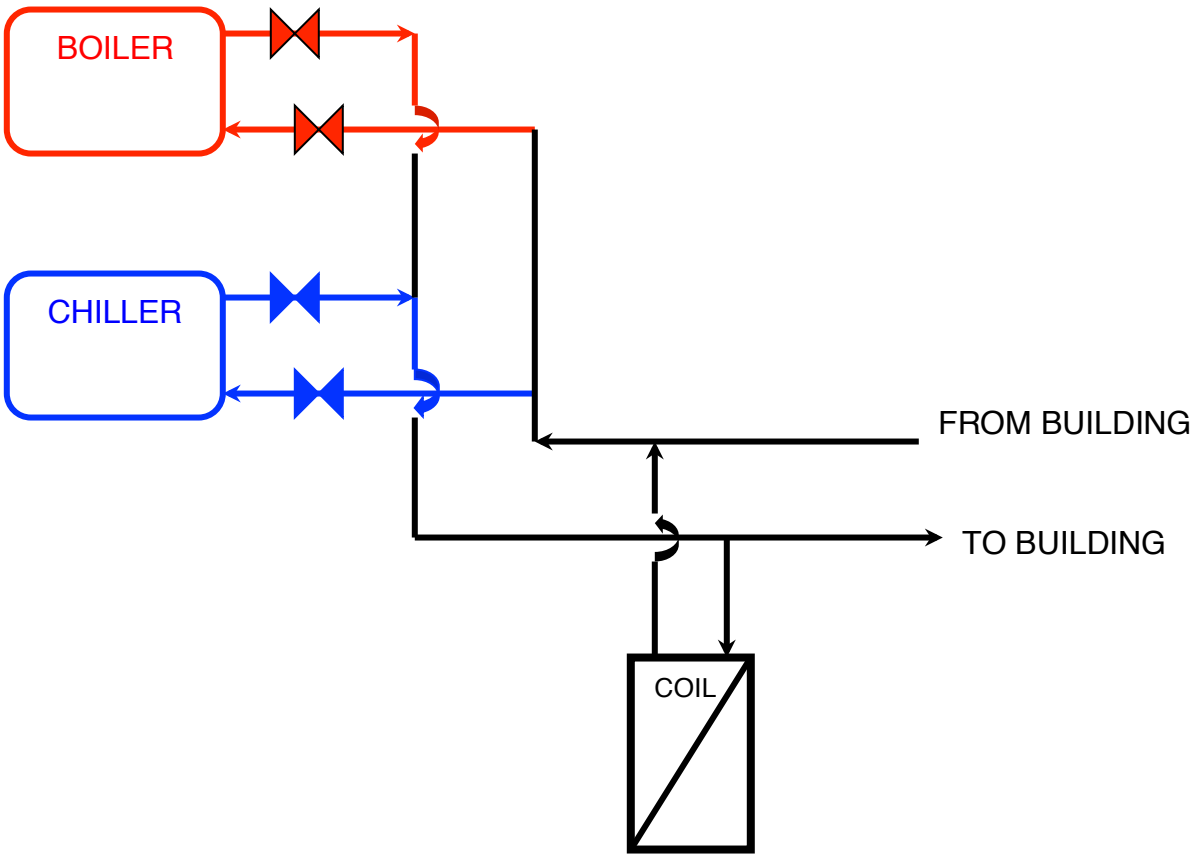
1. 2-PIPE SYSTEMS (CHANGEOVER)

- ONLY TWO PIPES IN THE WATER DISTRIBUTION CIRCUIT: ONE FOR SUPPLY, ONE FOR RETURN
- THE COIL IS USED SEASONALLY FOR HEATING OR COOLING
- ALL COILS IN THE BUILDING OPERATE EITHER AS HEATING OR AS COOLING COILS

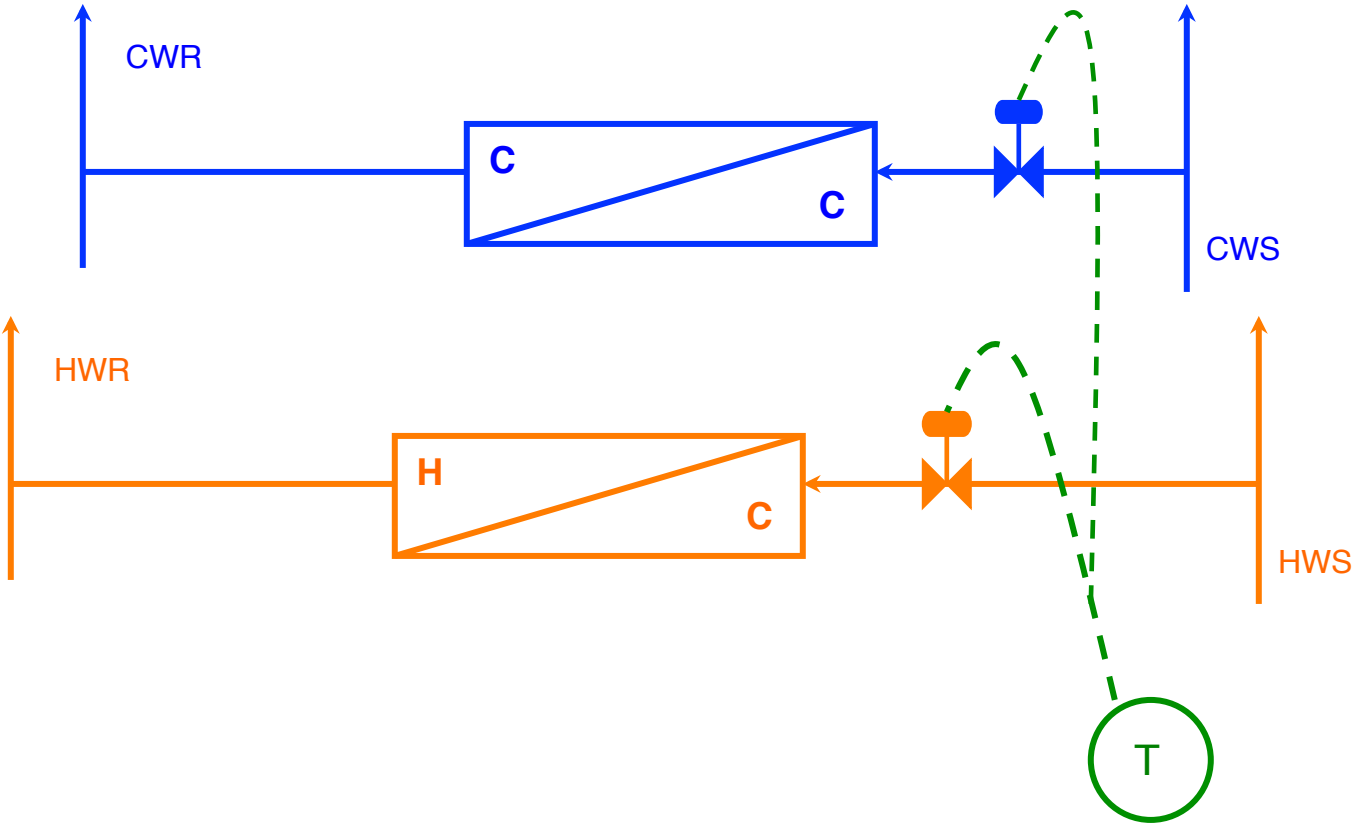
  => THEREFORE, THIS SYSTEM IS NOT FLEXIBLE FOR MIXED DUTY

  (SOME SIMULTANEOUS HTNG AND CLNG POSSIBLE USING PRIMARY AIR)

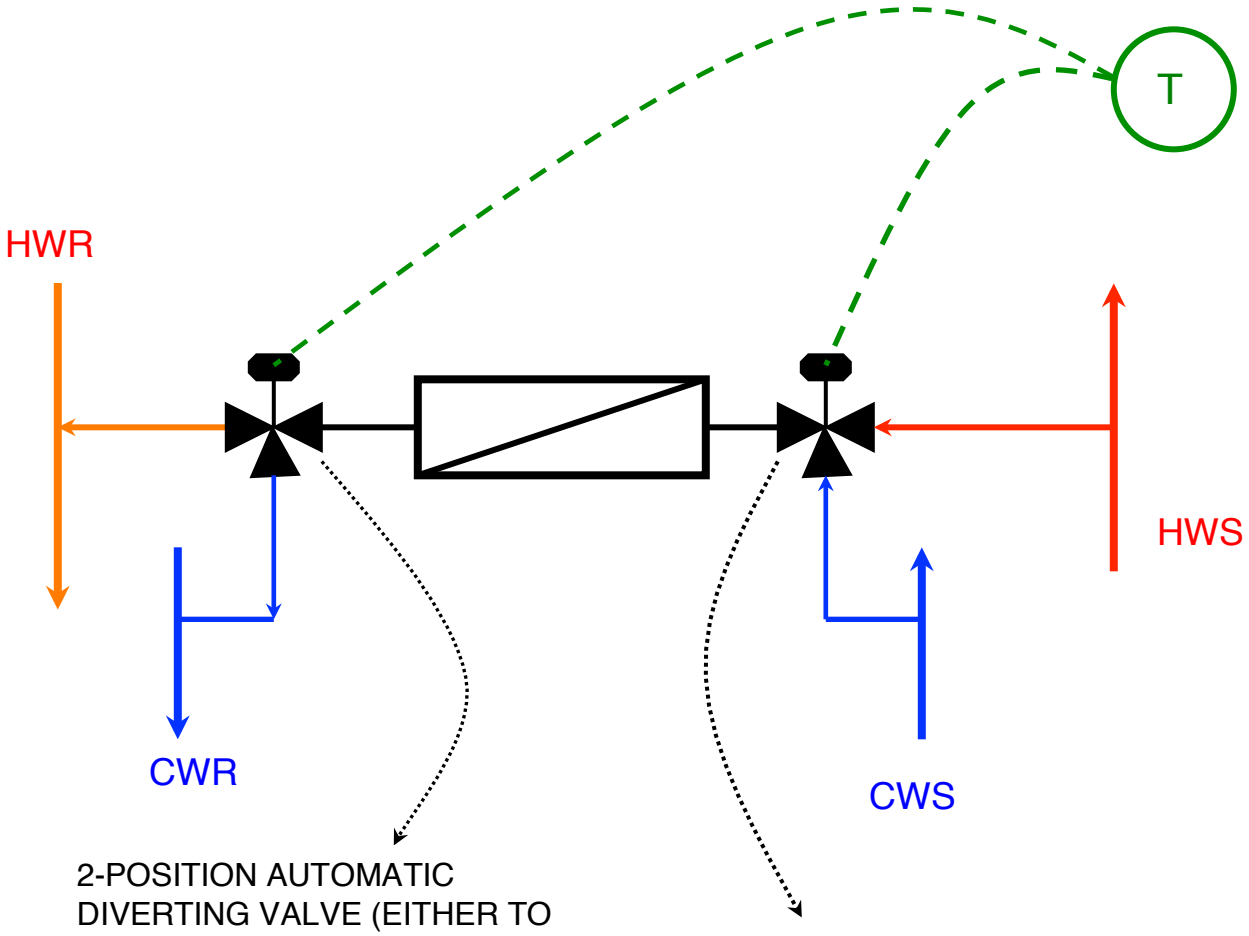


2. 4-PIPE SYSTEMS

A) SEPARATE COILS AT EACH ZONE TERMINAL BOX



B) COMMON COIL



2-POSITION AUTOMATIC DIVERTING VALVE (EITHER TO CHILLER OR HOT WATER RETURN LINE)

SEQUENCE VALVE => CONTROLS HOT AND CHILLED WATER SUPPLY SELECTIVELY AND PROPORTIONALLY, BUT DOES NOT MIX THEM

TERMINAL UNITS: - FAN COIL
- INDUCTION

3) 3-PIPE SYSTEMS

- HOT WATER SUPPLY
- CHILLED WATER SUPPLY
- COMMON RETURN

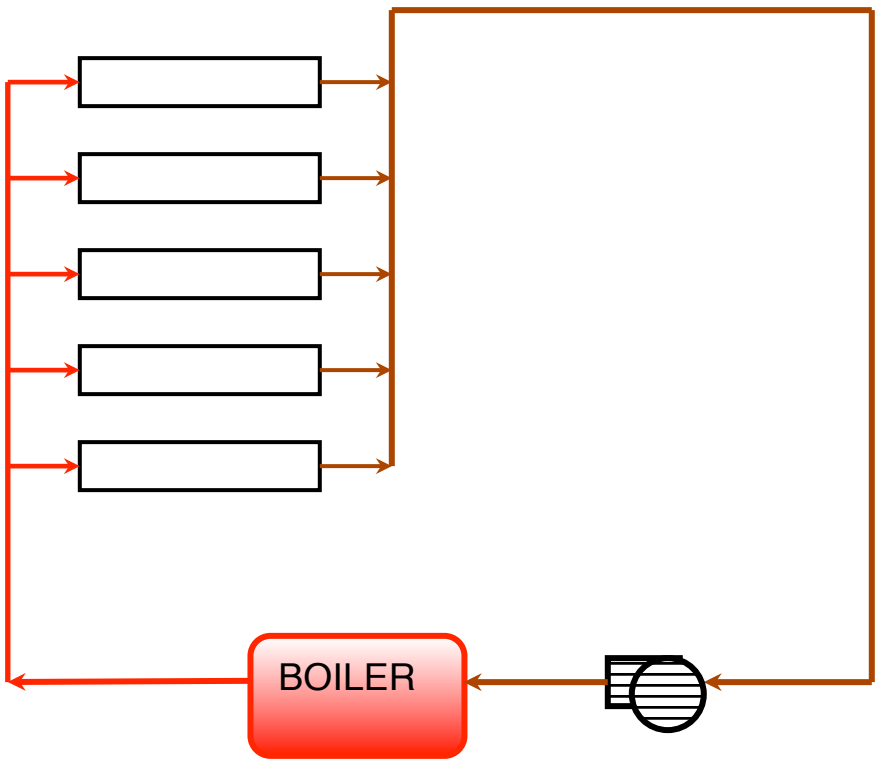
- WASTEFUL AND SENSELESS => UNCOMMON

ALL WATER SYSTEMS

- FAN COIL
- UNIT HEATER
- BASEBOARD CONVECTION

NO POSSIBILITY TO PROVIDE VENTILATION, THEREFORE NOT USED ANY MORE

REVERSE-RETURN PIPING SYSTEM

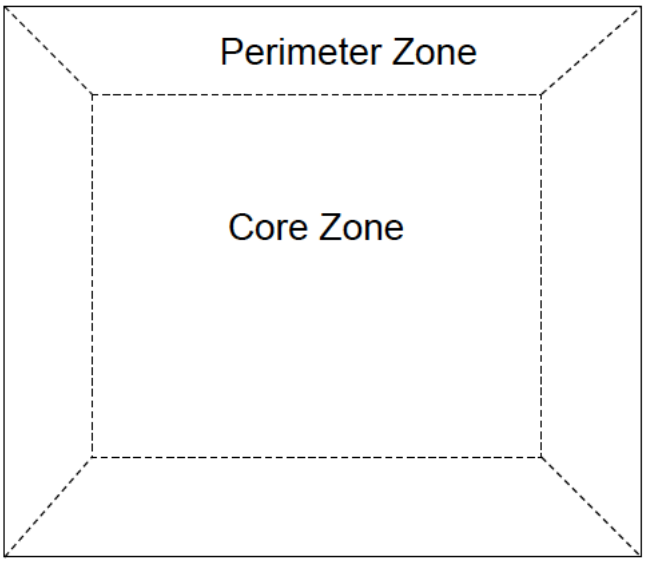


REVERSIBLE WATER SOURCE HEAT PUMP SYSTEM

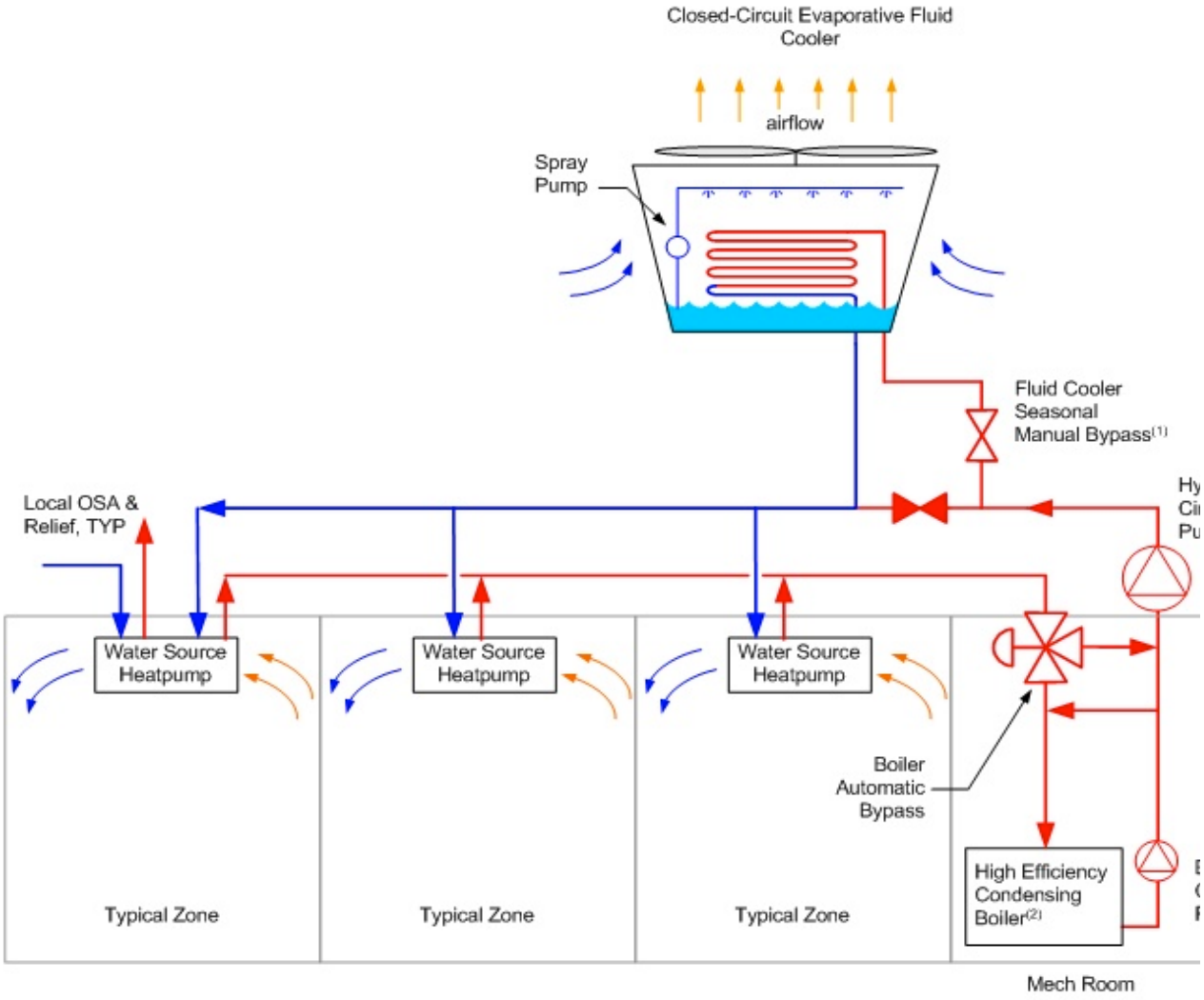
CONSIDER A BUILDING WITH AN INNER CORE OPERATING IN WINTER:

- THE PERIMETER ZONES WILL BE IN HEATING MODE
- THE CORE ZONE WILL BE IN COOLING MODE (NO HEAT LOSS)

THIS PROVIDES AN OPPORTUNITY FOR HEAT RECOVERY USING "REVERSIBLE WATER SOURCE HEAT PUMPS".



REVERSIBLE WATER SOURCE HEAT PUMP SYSTEM



HEAT RECOVERY POTENTIAL

- EXHAUST AIR HEAT RECOVERY TO PREHEAT/PRECOOL VENTILATION AIR
  - AIR-TO-AIR HEAT EXCHANGER
  - HEAT RECOVERY VENTILATOR
  - HEAT WHEEL (SENSIBLE AND SENSIBLE+LATENT)
  - RUN-AROUND GLYCOL LOOP
  - HEAT PIPE
  - GREY WATER HEAT RECOVERY
- HEAT RECOVERY FROM REFRIGERATION EQUIPMENT

PASSIVE SOLAR DESIGN

- ORIENTATION OF LONG AXIS (E-W)
- WINDOW PLACEMENT, SIZE AND TYPE
- EXTERNAL SHADING
- TROMBE WALL
- THERMAL STORAGE
- NATURAL VENTILATION/SOLAR CHIMNEY
- SOLARWALL
- VENTILATION AIR PRE-HEATING
- BUILDING INTEGRATED PHOTOVOLTAICS/THERMAL (BIPVT)