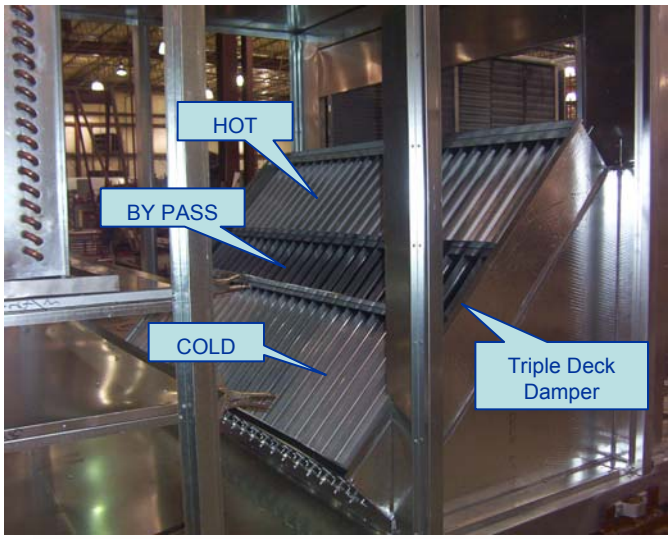
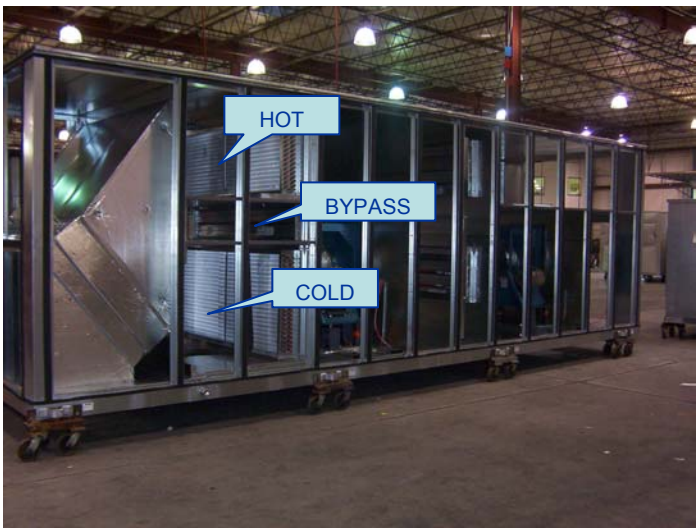
Seasons-4 Multi-zone Triple Deck Systems

The Seasons-4 triple deck multi-zone rooftop HVAC unit was developed in the mid 90's to meet the needs of two specific markets. One is the "replacement" market" with thousands of old high maintenance multi-zone units that are expensive to operate (EER of only 5 or 6). The other market is "new construction", requiring a single unit that can handle many different zone requirements simultaneously, operate efficiently, provide maintenance simplicity, and last 25-30 years or longer.

ASHRAE Standard 90.1, "Energy Efficient Design of New Buildings", dictates that an HVAC unit may NOT operate both heating and cooling to the same zone simultaneously. This is also as required by California's Title 24, and similar to many other state requirements for energy efficient HVAC designs.

The Seasons-4 triple deck multi-zone units comply with these energy codes and other applicable code requirements. The units are available in Constant volume (CAV) which will provide a constant CFM to the space regardless of a cooling or heating call, and Variable air volume (VAV) which will reduce the amount of CFM based on the space demand but will never deliver less than the minimum ventilation required.





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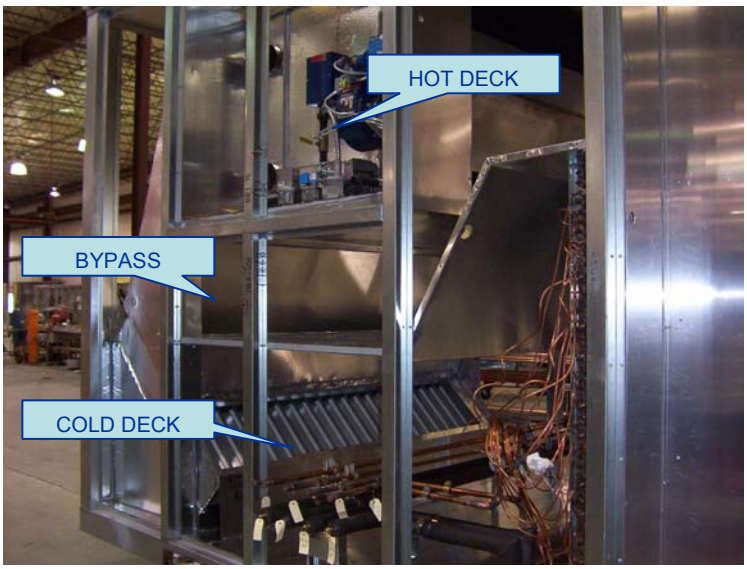
The Triple Deck Multi-zone (TDMZ) Unit consists of standard HVAC unit components like a supply fan, filters, a return fan (if required), and a DDC control system. The multi-zone portion of the unit consists of the cooling, bypass and heating decks, and the TDMZ damper. All connected to the zone ducts. The cooling medium can be either DX or ChW. The heating medium is gas-fired furnaces, electric heat, HW or steam.

Our triple deck multi-zone damper is connected to the end of the hot, cold, and bypass decks, and is mounted at an angle for ease of actuator access. The hot and cold deck blades are spring loaded onto a common shaft, and the bypass deck blades are fixed to the shaft. Each zone has one hot, cold, and bypass damper with corresponding blades, driven by a single actuator that is controlled by the space temperature sensor.



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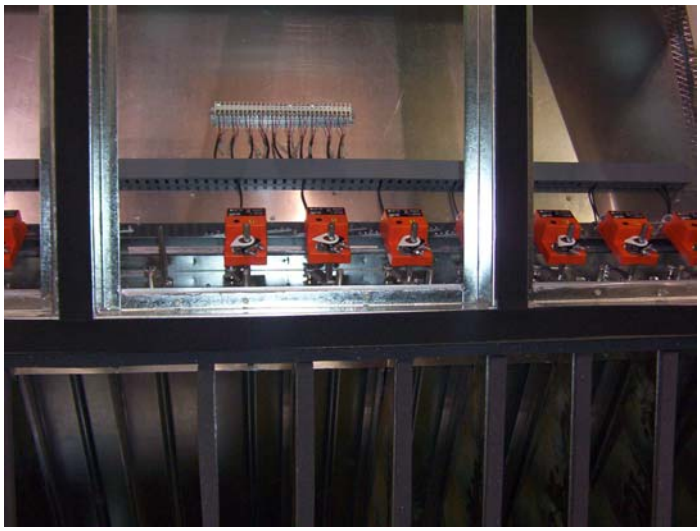
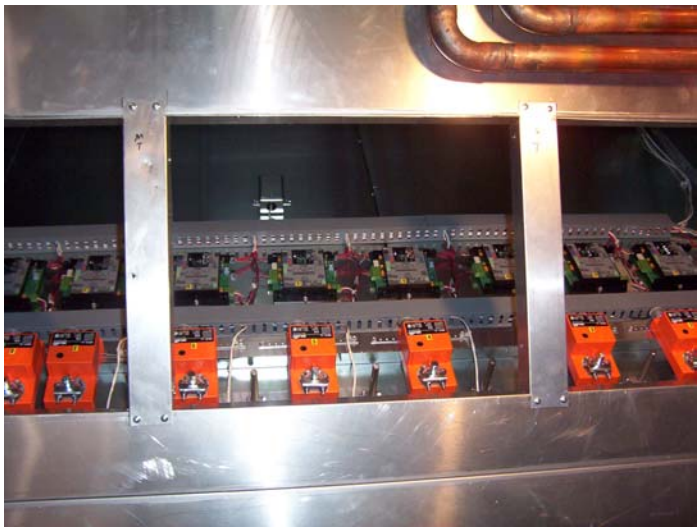
The actuator receives a signal from the space sensor, of 2 - 10 VDC or 4 - 20 mA for the full range of operation. Full heating is the at minimum signal and full cooling is at the maximum signal; the neutral damper position is always at mid range signal except in full heating or full cooling signal where the neutral damper is closed.

For example 2 volts DC is a full call for heat, with the hot deck fully open and the cold and neutral decks closed. 6 volts is neutral with the bypass deck fully open and both hot and cold decks are closed. 10 volts is a full call for cooling, with the cool deck fully open and the hot and neutral decks closed. The following sequences will show the dynamic damper modulation during calls for heating and cooling using one zone as an example.

Note the differences in the sequences of operation between TDMZ-CV and TDMZ-VAV.





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TRIPLE DECK MULTIZONE-CONSTANT VOLUME, (TDMX-CV).

NEUTRAL

The neutral position for this design is when the space sensor is satisfied and the actuator is at mid range. The hot and cold dampers are closed, and all the air (the minimum OA and the RA), are flowing through the neutral, (bypass) deck to the space.

COOLING

As cooling is being called for and the signal is increasing, the bypass deck starts to close and the cold deck starts to open. As the increasing signal approaches the 75% signal, the bypass deck is approximately halfway closed and the cold deck is approximately halfway open. As the signal approaches the maximum (or 100%), the bypass deck is closed and the cold deck is fully open.

As the call for cooling lessens from full cool, the cold deck starts to close and the bypass deck starts to open. As the signal reaches neutral (or 50%), the cold deck closes and the bypass deck is now bypassing the full CFM required. The hot deck is always closed during cooling.

HEATING

The cycle is identical to cooling except the space sensor signal decreases. From neutral as the decreasing signal approaches 25%, the bypass deck is approximately halfway closed and the hot deck is approximately halfway open. As the signal approaches the minimum (or 0%), the bypass deck is closed and the hot deck is full open.

As the call for heating reduces from full heat, the hot deck starts to close and the bypass deck starts to open. As the signal reaches neutral (or 50%), the hot deck closes and the bypass deck is now bypassing the full CFM required. The cold deck is always closed during heating.

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TYPICAL SEQUENCE OF OPERATION
FOR
SEASONS-4 CONSTANT VOLUME TRIPLE DECK MZ UNIT

EQUIPMENT DESCRIPTION

The unit is a packaged rooftop-mounted multizone type with cooling, heating, and economizer control. The unit includes a supply air fan, a return air fan, and a tubular gas burner. The control system can be a solid state sequencer type or DDC with remote mounted zone temperature sensors.

SUPPLY AIR FAN

The supply air fan will run continuously. The supply air fan will be constant volume.

RETURN AIR FAN

The return air fan will run continuously. The return air fan will be constant volume.

ECONOMIZER

The economizer will have a dry-bulb changeover control which will enable the economizer anytime there is a call for cooling and the ambient dry-bulb temperature is below the changeover setpoint of 53°F (adjustable). The outdoor and return air dampers will modulate to maintain a mixed air temperature of 55°F (adjustable) . When the economizer is disabled and the unit is in occupied mode, the outdoor air damper will be set at minimum position. When the economizer is disabled and the unit is in unoccupied mode, the outdoor air damper will be closed. The exhaust air damper is gravity relief type. The outdoor and return air damper actuators are electric.

COOLING MODE

The compressors will be enabled based on a call for cooling (any zone at 100% cooling), and cooling stages will stage on/off in sequence to maintain a cold deck temperature setpoint of 55°F (adjustable). The unit will have a low ambient temperature lockout set at 50°F (adjustable).

HEATING MODE

The unit heat will be enabled based on a call for heating (any zone at 100% heating), and controlled to maintain a hot deck temperature setpoint of 90°F (adjustable). The unit will have a tubular burner with power vented exhaust. The burner control will be modulating. The unit will have a high ambient temperature lockout set at 70°F (adjustable).

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ZONE DAMPER

The zone damper will be a triple deck damper.
The center (bypass) blade is attached to the full-length 0.5" diameter shaft. The hot deck and cold deck blades (at either side of the bypass) are secured to larger hollow shafts that ride on bearings supported by the 0.5" shaft. They are spring-loaded to the closed position and are opened by a lever attached to the 0.5" shaft.
A full sequence of control occurs during 90 degrees of rotation by the 0.5" shaft. The sequence given below is the clockwise (facing the shaft end) rotation. The description applies when actuated from either side of the damper.

POINT OF ROTATION	ACTION
0 DEGREES	The nearest deck is open. The bypass deck is closed. The farthest deck is closed
0-45 DEGREES	The nearest deck closes and the bypass deck opens
45 DEGREES	The nearest deck is closed. The bypass deck is open. The farthest deck is closed. This is the normal position for all shafts when no rotational or resistance forces are applied. It is the position of the blades when the temperature of the zone is at set-point
45-90 DEGREES	The bypass deck closes as the farthest deck opens
90 DEGREES	The nearest deck is closed. The bypass deck is closed. The farthest deck is open

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TRIPLE DECK MULTIZONE-VARIABLE AIR VOLUME, (TDMZ-VAV)

The TDMZ-VAV unit is identical to the TDMZ-CAV unit with two exceptions: (1) the VAV unit uses VFD's for fan control, and (2) a manual volume damper is installed at the entrance to the neutral or bypass deck. This damper is set and locked at the unit minimum ventilation
CFM, allowing minimum ventilation required for the space when the space temperature is satisfied and fan is operating at its reduced speed.

NEUTRAL

The neutral position for this design is when the space sensor is satisfied and the actuator is at mid range. The hot and cold dampers are closed but only the minimum airflow is supplied through the bypass deck due to the manual quadrant damper causing the fan to be at minimum speed.

COOLING

As cooling is called for with an increasing signal, the bypass deck starts to close, and the cold deck starts to open causing the fan to ramp up to maintain pressure in the unit. As the increasing signal approaches 75%, the fan continues to ramp up, the bypass deck is approximately halfway closed and the cold deck is approx halfway open. As the signal reaches the maximum of 100%, the fan is now at full speed, the bypass deck is closed, and the cold deck is full open. The hot deck is always closed during cooling.

As the call for cooling decreases, the fan slows down and the cold deck starts to close while the bypass deck starts to open.

When the signal reaches neutral (or 50%), the cold deck closes and the bypass deck is now bypassing the pre-set minimum CFM, as set by the manual damper. The fan slows to the minimum CFM.

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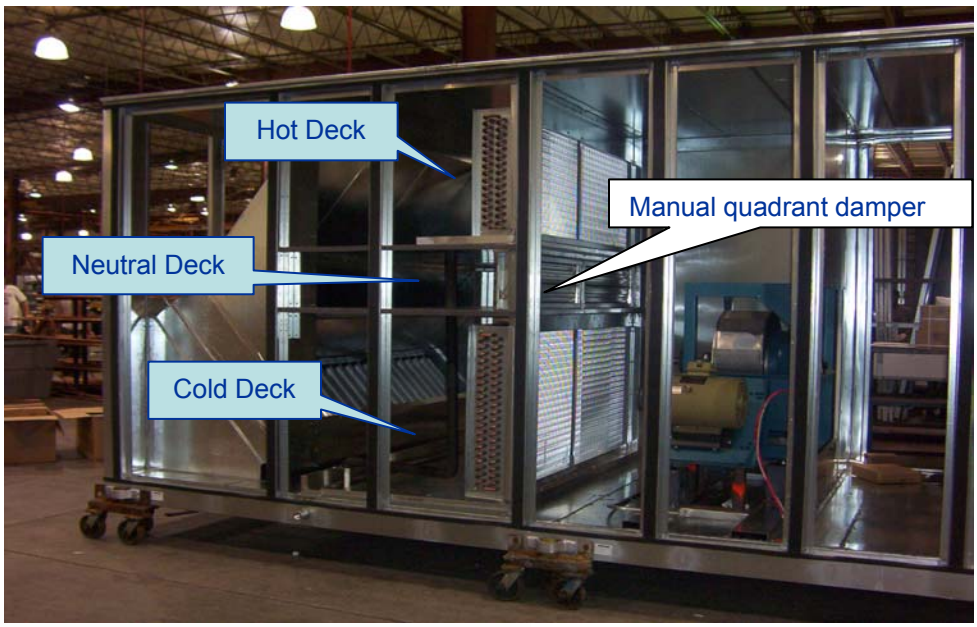
HEATING

The cycle is the same for heating as for cooling, except that the signal from the space sensor is now decreasing from the neutral or midway position of 50%. When the decreasing signal approaches 25%, the bypass deck is halfway closed, the hot deck is halfway open, and the fan ramps up to maintain pressure in the unit. As the signal approaches 0%, the bypass deck is closed, the hot deck is fully open, and the fan is at full speed. The cold deck is always closed during heating.

As the call for heating reduces from full heat, the hot deck starts to close, the bypass deck starts to open, and the fan speed drops.

As the signal reaches neutral, (or 50%), the hot deck closes and the bypass deck is now bypassing the pre-set minimum CFM, as set by the manual damper, and the fan is at minimum speed.



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TYPICAL SEQUENCE OF OPERATION
For
SEASONS-4 TRIPLE DECK MULTI-ZONE VAV UNITS

This sequence example is applicable for a VAV multi-zone unit with following components:
DX Cooling with Hot Gas Bypass
Modulating or Multi Stage Heat
Dry Bulb or Enthalpy Changeover Economizer
DDC Controls
Triple Deck Multi-zone Damper

The equipment is a Multi-Zone Variable Air Volume (VAV) unit which includes Variable Speed Drives (VSD) on both the supply and return air blowers.

Multi-Zone Damper

The multi-zone damper is a triple deck type only allowing modulated airflow to a given zone from the cold deck or the hot deck, at any one time. The multi-zone damper shall consist of hot deck, bypass, and cold deck sections. A manually adjustable damper is provided between the cooling coil and heating section of the unit to restrict the airflow to the bypass deck. This damper will create the pressure drop required for the VSD to slow the fan speed. As more zones operate in a partial cooling or heating mode, the bypass deck damper will increase the pressure in the unit, requiring the fan RPM to drop. The manual damper must be set (and locked in) to minimum airflow requirements by the air balancing contractor.
The triple deck damper operates as follows: when a zone requires full cooling the cold deck damper for that zone will modulate to 100% open. As cooling load for that zone decreases the cold deck damper modulates to closed position and the bypass damper modulates to open position. When there is no cooling requirement for that zone the cold deck damper is fully closed and the bypass damper is fully open. The same damper operating sequence takes place in the heating mode.

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Supply Air Blower

The supply blower operation shall be continuous during the building occupied mode. It will be controlled by a VSD. The input to the VSD shall be a pressure transducer located in the supply air fan discharge plenum of the unit. This transducer will send a control signal (mA) to the controller that will in turn send a voltage signal to the drive. The drive will ramp the speed of the fan to maintain a constant supply air plenum pressure, initially set at 2.0" W.C. There shall be a manual reset high pressure safety switch, located in the supply fan plenum to de-energize the supply air blower in case the supply air blower plenum pressure becomes excessive.

Cooling

Mechanical cooling shall be available when the outdoor air temperature is above 50° Fdb, as determined by an outdoor air temperature sensor. When there is a call for cooling, the cold deck shall be maintained at 55° Fdb as determined by an averaging sensor located on the leaving air side of the evaporator coil. A call for cooling shall be initiated when any zone blade(s) is opened to 100% cooling. The cold deck set-point shall be constant, and is adjustable through the controller software. The compressors will sequence as necessary to maintain the cold deck set-point. Hot gas bypass is available on the lead compressor to assure safe operation during low-load conditions. A call for cooling must exist for 5 minutes before the first stage of cooling is energized.

Economizer

When outside air, as determined by a dry bulb or enthalpy outside air changeover sensor, is available for cooling it will be used as the first stage of cooling and the compressors shall be locked out. During economizer operation when the unit is in the occupied mode, the outdoor air and return air damper actuators shall modulate to maintain a mixed air temperature of 58°F (adj.). When the unit is not in economizer operation, the outdoor air damper shall be set at its minimum position.

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Heating

Heating shall be available anytime the outdoor air temperature is 70° or less, as determined by an outdoor air temperature sensor. When there is a call for heating, the hot deck shall be maintained at 90° Fdb as determined by a sensor located downstream of the heat exchanger. A call for heating shall be initiated when any zone's blade(s) is opened 100% to heating. The hot deck set-point shall be constant, and is adjustable through the controller software. A modulating gas valve or a multi stage arrangement will allow the heating capacity to maintain the hot deck set-point. A call for heating must exist for 5 minutes before the first stage of heating is energized.

Return Air Blower

The return air blower shall be enabled when the unit is in operation and modulated by the return air blower VSD. The return air blower speed shall track the supply air blower speed.

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TYPICAL TRIPLE DECK MULTI-ZONE VAV ARRANGMENT

FIG. 1– COOLING

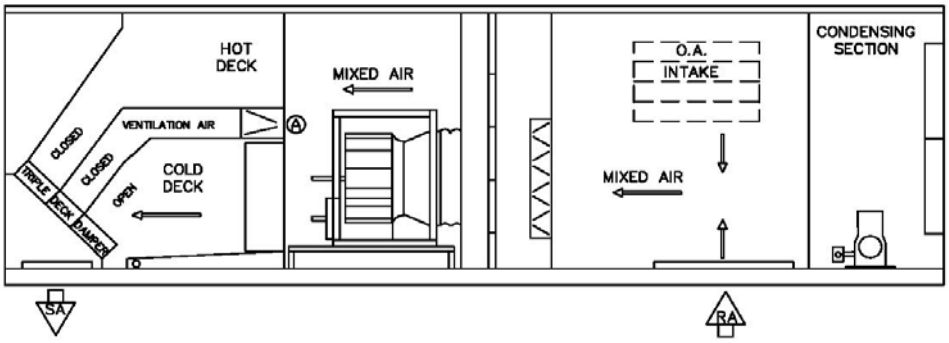


FIG. 2– HEATING

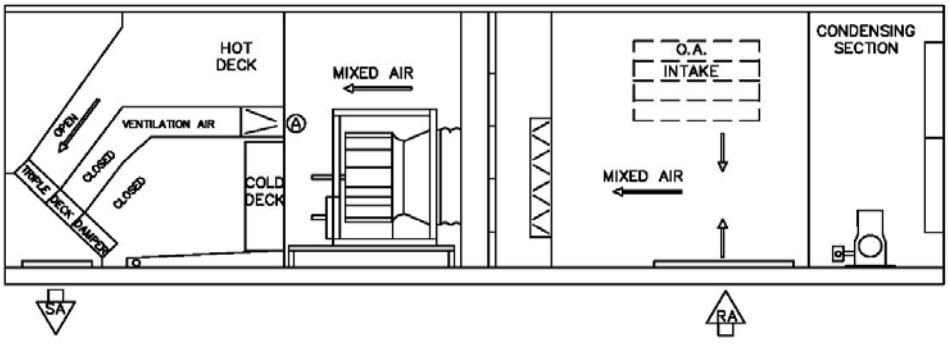
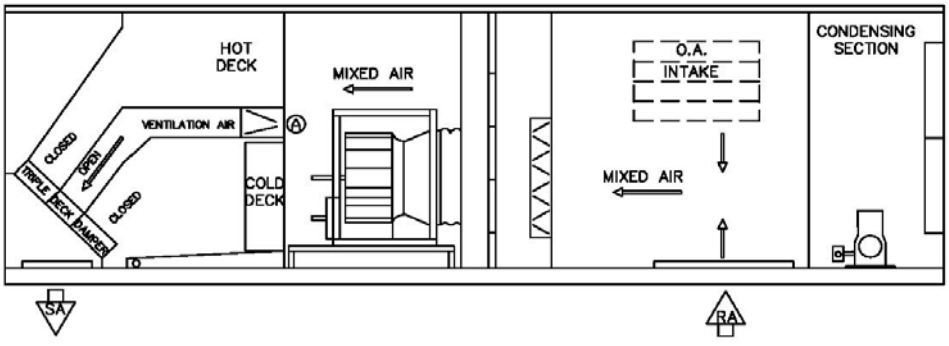


FIG. 3– UNOCCUPIED



Ⓐ MINIMUM VENTILATION DAMPER

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VAV Multi-zone Manual Bypass Damper Adjustment

With cold deck fully open (hot & bypass deck fully closed) and supply fan running at rated maximum frequency, balance the system to produce required maximum CFM. Record the static pressure in the supply fan plenum. Input this pressure in the DDC system for VAV control of the supply fan.
Slowly close the cold deck dampers completely. Make sure that the manual bypass damper is fully open. When the cold deck is completely closed the bypass deck should be fully open.
Slowly start to close the manual bypass damper to achieve minimum ventilation CFM, while allowing the DDC to keep the supply fan plenum pressure constant. Record the frequency of the supply fan motor displayed by the VSD once the minimum ventilation CFM is achieved.

An example:
Total CFM required = 10,000 CFM
Minimum ventilation CFM required = 2,000 CFM
With the fan running at 60 HZ balance the system to achieve total airflow of 10,000 CFM. Read the static pressure in the supply fan compartment and let's say this static pressure is 3.0" of W.C.
Input this 3.0" static pressure in the DDC controller. DDC controller will send signal to VSD to ramp up or down the supply fan speed to maintain supply fan plenum static pressure of 3.0" W.C.
Close the cold deck damper; bypass deck should be fully open. The supply fan should start to ramp down. Slowly (keeping in mind that the VSD ramps at a speed of 1 HZ/5 seconds) close the manual bypass damper to achieve total CFM of 2,000 CFM. Record the frequency of the supply fan motor. The frequency should be approximately 12 HZ.

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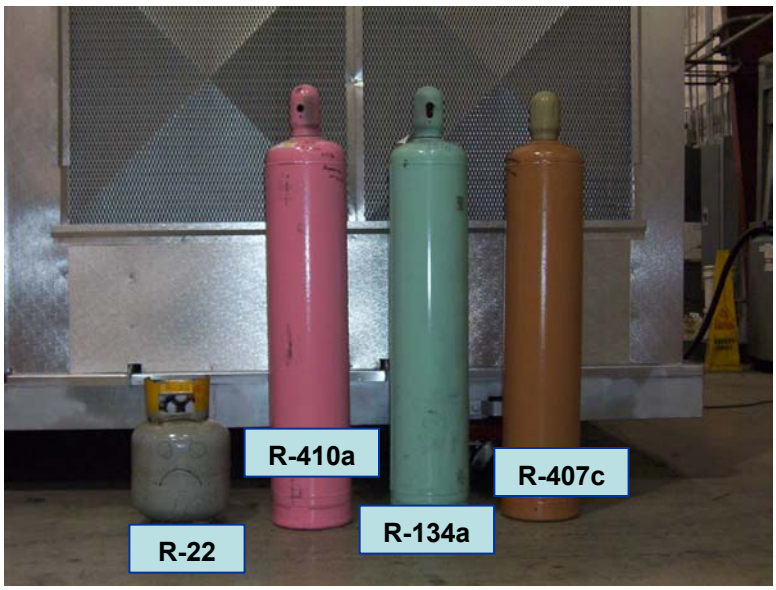
SMOKE ALARM SYSTEM (OPTIONAL)

The unit will have a supply air smoke detector. Upon detection of smoke, alarm contacts will close in the unit and the supply and return air fans will de-energize. The outdoor and return air dampers shall drive to a fully closed position. A terminal block is provided for field wiring connections to a remote location if desired.

Multi-Zone Triple Deck Systems are available with:

Energy Recovery Wheels,
Heat pipes,
Air to Air plate type heat exchangers and Hot gas reheat coils.

Alternative Refrigerants:
R-410a
R-134a
R-407c
R-22



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