Sequence of Operation for CAV Air Conditioning System

Constant Air volume Air Conditioning System Air Handling Units AHU's

The unit shall consist of:

Supply Side

1. Intake motorized damper
2. Panel (Pleated) Filter
3. Bag Filter
4. Cooling Coil
5. Supply Fan (with VFD)
6. Plate Heat Exchanger
7. Intake and discharge attenuators
8. Wrap Around heat Pipe
9. Sensors and controls (refer to BMS Schematic Diagram)

Exhaust Side

1. Exhaust motorized damper
2. Panel (Pleated Filter)
3. Exhaust fan (with VFD)
4. Intake and Discharge attenuators
5. Sensors and controls (refer to BMS Schematic Diagram)

The constant volume full fresh air type AHU shall start/stop controlled operate under the dictates of one of the DDC controllers inbuilt time schedules initially set to24 hours operation (adjustable) and control in the following manner.

On a command to start the supply fan will be enabled and positive indication of this given by means of a differential pressure switch fitted across motor.

The fan shall be enabled when the BMS signals for the air handling plant to operate and the outside air and exhaust air dampers (modulating) are proven open. The fan operation shall be proven when the differential air pressure switch signal is detected.

When the proven signal is not detected, following a 30second start-up period, a fan failure warning signal shall be sent to the BMS and the fan operation signal shall be removed. The fan operation signal shall be disabled when an overload relay in MCC has tripped.

The supply fan control signal shall be fixed control to obtain the required system flow rate defined during commissioning. The controller shall operate utilising a preset time clock (adjustable) to set back the unit flow rate during non-operational hours.

Fan speed will be varied by the use of inverter/VFD drives via hardwire contacts. Fan speed modulation is only to be utilised for commissioning purposes and at the change over from operational and non-operational time periods as defined by the time schedule.

Indication of fan running is provided by means of a differential air pressure switch fitted across the fan which will alarm in the event of failure. Individual indication of “fan trip” and “switch not in auto position” will be provided through the DDC controller.

A hand/off/auto selector switch shall be located on the extract fan control panel. The extract fan motor shall be interlocked to this selector switch, the supply fan fail and the damper proving end switches. The Exhaust will run at the same speed of supply fan.

The supply air temperature set point to swimming pool shall be scheduled to 18°C (adjustable) to maintain room temperature of 28°C.

If the supply air temperature rises above a set point of 18°C or below a set point of 12°C during normal operation the BMS shall give a supply air temperature high/low warning.

The supply air temperature set point is determined according to the strategy selected above.

The space conditions will be maintained by the DDC controller modulating in sequence the cooling valve based on PI control to the satisfaction of the supply air temperature sensors. Positive feedback of valve and damper position will be displayed on the BMS. During commissioning the contractor is to ensure that the PI loop time constants are set to ensure that hunting does not occur due to over cooling of the space.

If the relative humidity reported at the duct mounted supply air humidity sensor rises above its set point of 50-60% (adjustable) and the supply fan is proven by the differential pressure sensors cooling coil and heating coil are to operate in conjunction to dehumidify the supply air by cooling to 12°C (adjustable) with the heating modulating to maintain the space temperatures as defined above.

The above temperature control mode shall be set up and commissioned for the specific project and the set points adjusted and suitable time delays applied to ensure hunting does not occur.

During non-operational periods of the swimming pool as defined by the BMS time clock the AHU volumes are to be adjusted down to the set-back conditions with the control of the cooling coils as defined previously.

Room temperature and relative humidity will be monitored by sensors and displayed at the BMS System. Pre and bag filters in the supply duct will have differential pressure sensors fitted for indication and alarm purposes on the BMS. An alarm shall be generated to BMS in case the differential pressure across each filter bank exceeds the adjustable set-point decided during commissioning.

A graphical representation of the plant will be produced with all set points, alarms and time schedules displayed with simple mouse clicks. Access to the graphic will be through a system of site plans, plant rooms and systems.

All values are to be historically recorded at controller level so that locally any laptop or Portable operator's terminal may retrieve the data as well as the network BMS Supervisor.

A fire alarm interlock (thru VFC to DDC) shall be hardwired into the control circuit of the AHU to ensure that it shuts down in an alarm condition.

Multiple Zone Variable Volume Type Recirculating Air Handling Units AHU

The system shall be variable volume package Fresh Air Handling Unit.

The unit shall consist of:

Supply Side

1. Intake motorized damper
2. Panel (Pleated) Filter
3. Bag Filter
4. Cooling Coil
5. Supply Fan (with VFD)
6. Intake and discharge attenuators
7. Sensors and controls (refer to BMS Schematic Diagram)

Exhaust Side

1. Exhaust motorized damper
2. Panel (Pleated Filter)
3. Exhaust fan (with VFD)
4. Intake and Discharge attenuators
5. Sensors and controls (refer to BMS Schematic Diagram)

The Variable Volume AHUs shall operate under the dictates of one of the DDC controllers inbuilt time schedules (adjustable) to suit the operational requirement of the school and control in the following manner.

A hand/off/auto selector switch shall be located on the supply fan control panel. The supply fan motor shall be interlocked to this selector switch, the extract fan fail and the outside air damper proving end switch.

On a command to start the supply fan (thru a VFC from DDC to control Panel) will be enabled and positive indication of this given by means of a differential pressure switch fitted across motor.

The fan shall be enabled when the BMS signals for the air handling plant to operate and the outside air and exhaust air dampers (modulating) are proven open. The fan operation shall be proven when the differential air pressure switch signal is detected.

When the proven signal is not detected, following a 30second start-up period, a fan failure warning signal shall be sent to the BMS and the fan operation signal shall be removed. The fan operation signal shall be disabled when an overload relay in MCC has tripped.

The supply fan control signal shall be modulated under PI control to obtain the minimum static pressure set points defined during commissioning. The index run VAV box shall be satisfied to have an inlet pressure of 150 Pa (adjustable). The controller shall modulate the supply fan speed utilizing the measured sensor value versus its set point.

The supply fan shall be disabled and a warning sent to the BMS if the supply air pressure rises above a limit of 1500Pa (adjustable).

Once air flow is established the system will allow its temperature control algorithm to operate. The system will maintain the minimum fresh air requirement (pre-set to ensure that negative pressure is not the encountered) and the fresh air and recirculating dampers will be modulated according to the average space air quality (measured by duct mount C02 sensors to maintain 500 ppm (adjustable) and an alarm shall be generated if the CO2 level remains at 750 ppm continously for a period of 5 minutes) to reduce the load on the plant. This will ensure that high volumes of outdoor air are not unnecessarily cooled.

The actual fresh air volume delivered to the space will be measured by a multi-point velocity detector in the intake ductwork.

The chilled water coil shall be provided with a 2-portpressure independent control valve for supply air dehumidification and sensible cooling. The CHW valve shall be positioned closed when the air handling plant is not operating.

No action is taken when the BMS signals a low outside temperature when the air plant is operational should this ever occur.

The valve shall be positioned to close when a fan failure signal is present. The valve shall fully open when the supply fan is proven and the BMS signals an optimum cooling start operation.

The CHW valve's position shall be modulated in response to a PI control signal in order to obtain the required set point (design set point of supply air is 12°C) the greatest demand of dehumidification or sensible cooling control shall have priority. The position of the mixing dampers shall be controlled to supply the air to meet indoor CO2levels.

If the supply air temperature rises above a set point of25°C and 26°C during summer and winter respectively or below a set point of 12°C during normal operation the BMS shall give a supply air temperature high/low warning.

These AHU's are distributing conditioned air via VAV units to the conditioned spaces. When the VAV modulating dampers start closing, the pressure in the supply duct rises. The supply air duct is provided with pressure sensor at 2/3rd distance, which gives 0-10vdc signal to DDC corresponding to increase in the duct pressure. On receiving the signal, the DDC gives a 0-10vdc to the fan motor VFD to reduce the speed. The supply pressure set point will be adjustable as per load requirement. The operator can adjust the supply pressure set point from BMS Workstation at any time.

A variable volume return fan shall be provided. The extract fan shall be disabled when the BMS signals a shutdown period.

The exhaust fan operation signal shall be disabled if a supply fan fail signal is received by the BMS. The fan shall be enabled when the BMS signals for the air handling plant to operate and the outside air and exhaust air dampers are proven open. The fan operation shall be proven when the differential air pressure switch signal is detected.

When the proven signal is not detected, following a 30second start-up period, a fan failure warning signal shall be sent to the BMS and the fan operation signal shall be removed. The fan operation signal shall be disabled when an overload relay in MCC has tripped.

The return fan control signal shall be modulated to produce a return air volume flow rate at a ratio of 90%(adjustable) of the supply fan speed or as per static pressure build up due to modulating VAV boxes in the system.

A hand/off/auto selector switch shall be located on the extract fan control panel. The extract fan motor shall be interlocked to this selector switch, the supply fan fail and the damper proving end switches.

A smoke detection device shall be provided in the return air ductwork. On sensing smoke the supply fan (and extract fan) shall be stopped and an alarm raised at the BMS central supervisor and at the fire alarm main panel. The detector shall be manually reset from Fire Alarm System.

A fire alarm interlock (thru VFC to DDC) shall be hardwired into the control circuit of the AHU to ensure that it shuts down in an alarm condition.

VAV Box Control without Heater

Pressure independent intelligent VAV terminal units (with reheat as defined on the schedules and drawings) shall be utilized.

The system shall be package variable air volume (VAV) box. The unit shall consist of:

1. Motorized damper complete with actuator
2. Discharge attenuators
3. Flow rate controller inbuilt in VAV controller

During normal operation the VAV's will operate based on Zone Temperature Set point which is user adjustable.

When the zone temperature is between of the bias, the primary air damper shall be at the minimum CFM. On arise in zone temperature above the effective set point, the primary air damper shall increase the Air Flow.

OCCUPIED MODE:

When the zone temperature (ZN-T) is below the cooling set point (EFFCLG-SP), the primary air damper (DPR-O) will be at the minimum CFM (SA-F). On a rise in zone temperature (ZN-T) above the cooling set point (EFFCLG-SP), the primary air damper (DPR-O) will increase the CFM (SA-F).

UNOCCUPIED MODE:

When in this mode, while the zone temperature (ZN-T) is between the unoccupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) set points (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F). On arise in zone temperature (ZN-T) above the unoccupied cooling set point (EFFCLG-SP), the primary air damper (DPR-O) will increase the CFM (SA-F) (if available). On a drop in zone temperature (ZN-T) below the unoccupied heating set point (EFFHTG-

SP), the primary air damper (DPR-O) will be at the minimum CFM (SA-F).

UNIT ENABLE:

A network unit enable (UNITEN-MODE) signal will control the mode of the box.

VAV Box Control with Heater

Pressure independent intelligent VAV terminal units (with reheat as defined on the schedules and drawings) shall be utilized.

The system shall be package variable air volume (VAV) box. The unit shall consist of:

1. Motorized damper complete with actuator
2. Discharge attenuators
3. Flow rate controller inbuilt in VAV controller

During normal operation the VAV's with Heater will operate based on Zone Temperature Set point which is user adjustable. Effective Heating & Effective Cooling Set point will be automatically calculated by the controller as per below.

Effective Cooling set point will be automatically calculated by controller & will be $1^{o}C$ higher than the Zone Set point.

Effective Heating set point will be automatically calculated by controller & will be $1^{o}C$ lower than the Zone Set point. Heater command will be modulated to maintain effective Heating set point.

When the zone temperature is between the effective heating and cooling set points (inside of the bias), the primary air damper shall be at the minimum CFM and the electric heater shall remain off. On a rise in zone temperature above the effective set point, the primary air damper shall increase the Air Flow and the electric heat shall remain off. On a drop in zone temperature below the effective heating set point, the electric heat shall modulate to cycle the heat on and the damper is controlled to provide a minimum Air Flow.

OCCUPIED MODE:

When the zone temperature (ZN-T) is between the occupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) set points (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F) and there will be no mechanical heating. On a rise in zone temperature (ZN-T) above the cooling set point (EFFCLG-SP), the primary air damper (DPR-O) will increase the CFM (SA-F) and there will be no mechanical heating.

On a drop in zone temperature (ZN-T) below the heating set point (EFFHTG-SP), the reheat coil will be used to maintain the zone temperature (ZN-T) and the damper (DPR-O) is controlled to provide a minimum CFM (SA-F).

UNOCCUPIED MODE:

When in this mode, while the zone temperature (ZN-T) is between the unoccupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) set points (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F) and there will be no mechanical heating. On a rise in zone temperature (ZN-T) above the unoccupied cooling set point (EFFCLG-SP), the primary air damper (DPR-O) will increase the CFM (SA-F) (if available) and there will be no mechanical heating. On a drop in zone temperature (ZN-T) below the unoccupied heating set point (EFFHTG-SP), there heat coil will be used to maintain the zone temperature (ZN-T) and the primary air damper (DPR-O) will be at the minimum CFM (SA-F).

UNIT ENABLE:

A network unit enable (UNITEN-MODE) signal will control the mode of the box.