



## DOAS Control Specifications

### Description

All controls shall be pre-wired and housed in an insulated electrical cabinet within the unit(s). The electrical cabinet shall be illuminated by a door-activated LED strip. All sensors shall be wired back to the main control board that continuously monitors all critical components and makes decisions based on pre-determined logic to accurately control all heating modulation, compressor and outdoor fan modulation, Electronic Expansion Valve (EEV) position and modulating reheat valve position (if applicable). All set points are configured on a proprietary, LED backlit, LCD Human-Machine Interface (HMI) mounted within the unit's control cabinet (up to 4 optional space mounted HMIs are available). All HMIs shall be wired using standard CAT5 cables.

### Network Capabilities

All unit controls shall be compatible with BACnet and LonWorks based building management systems. Controls shall be capable of communicating using CASLink; a proprietary, cloud based monitoring system developed to aid in the future development and troubleshooting of equipment.

### Intake/Return Damper Control

- **Building Automation System (BAS) Control**  
BAS sends a 0V (100% return air) to 10V (100% outdoor air) signal to damper actuator to modulate damper position.
- **Field Wired Switch Control (Two Position)**  
Unit(s) communicates with a field wired switch to determine whether 100% outdoor air or 100% return air is desired.
- **Manual Control**  
Unit(s) shall modulate damper position based upon a set voltage determined by the user. A 0 to 10V signal can be adjusted via any one of the HMIs connected to the unit.
- **Outdoor Air Percentage Control**  
Unit(s) shall automatically modulate the intake damper actuator to maintain a desired percent of outdoor air based upon calculations using temperature sensors within the unit.
- **Schedule Control**  
Unit(s) shall maintain a desired outdoor air percentage when in occupied mode, and another desired outdoor air percentage while in unoccupied mode.
- **Static Pressure Control**  
Unit(s) shall adjust outdoor air percentage to maintain a specific internal static pressure. Building static pressure differential shall be adjusted using a pressure differential photohelic.
- **Analog Control**  
A 0-10V signal shall be supplied to the main control board that will modulate the damper linearly between minimum and maximum outdoor air voltage set points.
- **100% OA Control**  
Unit(s) shall maintain a 100% outdoor air damper position while the supply fan is active and a fully closed position when the supply fan is inactive to prevent back drafts into the space.

### Activation Controls

- **Activate Based on Intake (Heating)**  
Unit will activate heating when the intake temperature drops below the desired set point.
- **Activate Based on Intake (Cooling)**  
Unit will activate cooling when the intake temperature rises above the desired set point.
- **Activate Based on Intake (Dehumidification)**  
Unit will activate dehumidification when the intake dew point rises above the desired intake set point's dew point, or when the intake relative humidity rises above the desired intake relative humidity set point.
- **Activate Based on Space (Heating)**  
Unit will activate heating when the space temperature drops below the desired set point.
- **Activate Based on Space (Cooling)**  
Unit will activate cooling when the space temperature rises above the desired set point.
- **Activate Based on Space (Dehumidification)**  
Unit will activate dehumidification when the space dew point rises above the desired space set point's dew point, or when the space relative humidity rises above the desired space relative humidity set point.
- **Activate Based on Both (Heating)**  
Unit will activate heating when the space AND intake temperature drop below the desired set point.
- **Activate Based on Both (Cooling)**  
Unit will activate cooling when the space AND intake temperature rise above the desired set point.
- **Activate Based on Both (Dehumidification)**  
Unit will activate dehumidification when the space and intake dew point rise above the desired space and intake set points' dew point, or when the space and intake relative humidity rise above the desired space and intake relative humidity set points.
- **Activate Based on Either (Heating)**  
Unit will activate heating when the space OR intake temperature drops below the desired set point.



### **Activation Controls continued**

- **Activate Based on Either (Cooling)**  
Unit will activate cooling when the space OR intake temperature rises above the desired set point.
- **Activate Based on Either (Dehumidification)**  
Unit will activate dehumidification when the space or intake dew point rises above the desired space or intake set point's dew point, or when the space or intake relative humidity rises above the desired space or intake relative humidity set point, respectively.
- **Activate Based on Stat (Heating)**  
Unit will activate heating when the space thermostat sends a 24V signal to W and G on the main control board. Unit will modulate to maintain a constant discharge heat set point.
- **Activate Based on Stat (Cooling)**  
Unit will activate cooling when the space thermostat sends a 24V signal to Y and G on the main control board. Unit will modulate to maintain a constant discharge cool set point.

### **Temperature Controls**

- **Discharge Temp Control (Heating)**  
Unit modulates the burner flame (current supply in the case of electric heating) to accurately maintain the desired discharge temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using proprietary heating PID controls designed specifically for the DOAS.
- **Discharge Temp Control (Cooling & Optional Heat Pump)**  
Unit modulates the compressor frequency to accurately maintain the desired discharge temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using proprietary cooling (heating when in heat pump mode) PID controls designed specifically for the DOAS.
- **Space Temp Control (Heating)**  
Unit modulates the burner flame (current supply in the case of electric heating) to accurately maintain the desired space temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using proprietary heating PID controls designed specifically for the DOAS. Minimum and maximum discharge set points can be set to limit the temperature entering the space. An optional additional HMI or room thermostat can be used to determine the space temperature. In the case that no temperature sensor is available in the space, the unit will use an internal return temperature sensor.
- **Space Temp Control (Cooling & Optional Heat Pump)**  
Unit modulates the compressor frequency to accurately maintain the desired space temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using proprietary cooling (heating when in heat pump mode) PID controls designed specifically for the DOAS. Minimum and maximum discharge set points can be set to limit the temperature entering the space. An optional additional HMI or room thermostat can be used to determine the space temperature. In the case that no temperature sensor is available in the space, the unit will use an internal return temperature sensor.

### **Gas Heating Controls**

#### **Sequence of Ignition**

In order to ensure proper combustion, each burner ignition unit shall be pre-programmed with an ignition sequence comprised of a 1 minute pre-purge, 1 minute inter-purge, 2 minute post-purge, 15 second ignition, 3 trials for ignition, and 60 minute lockout. When ignition has been proven, burner will light and modulate using specially configured PID controls to accurately maintain the desired temperature set point.

#### **Safety Controls**

The following safety controls shall be installed on gas heating units:

- Non-fused disconnect.
- Supply airflow safety pressure switch that disables heating and displays a warning on the HMI until supply airflow has proven.
- Combustion airflow safety pressure switch that disables heating and displays a warning on the HMI until combustion airflow has proven.
- Two manual reset, high temperature flame roll out switches with a non-adjustable set point of 325F designed to display a fault on the HMI, and shut heating down when activated.
- A high temperature, auto-recycling limit with a maximum non-adjustable set point of 250F. When triggered, a fault will display on the HMI indicating a high temperature limit has been reached within the unit. Unit shall disable gas heating until the temperature has fallen below the 250F limit.
- Optional high and low gas pressure switches that disable heating and display a warning on HMI when gas pressure is out of the acceptable range of the unit.
- Optional freezestat with adjustable set points for time and temperature to detect failures in heating. If unit discharge temperature drops too low, freezestat shall activate and force the supply fan to shut down. The integrated control board logic shall allow for one attempt to heat. If discharge air is too low after second attempt, unit shall shut supply air and display a fault on HMI.

### **Electric Heating Controls**

Electric coils shall be controlled using Silicon Controlled Rectifier (SCR) controls. SCR is a time proportioning type controller that modulates the heater and supplies the exact amount of power to match the heat demand. Proprietary electric heating controls shall be used to modulate the discharge temperature of the unit.

### **Electric Heating Controls continued**

#### **Safety Controls**

The following safety controls shall be installed on electric heating units:

- Non-fused disconnect.
- Main supply airflow safety pressure switch that disables heating and displays a warning on the HMI until supply airflow has proven.
- Redundant supply airflow safety pressure switch that disables heating and displays a warning on the HMI until supply airflow has proven.
- High temperature limit switch designed to shut down heating and display a fault on the HMI when activated.
- Optional freezestat with adjustable set points for time and temperature to detect failures in heating. If unit discharge temperature drops too low, freezestat shall activate and force the supply fan to shut down. The integrated control board logic shall allow for one attempt to heat. If discharge air is too low after second attempt, unit shall shut supply air and display a fault on HMI.

### **Cooling Controls**

When in cooling mode, unit(s) shall automatically modulate compressor frequency via a variable frequency drive, outdoor fan speed, and EEV position in conjunction with each other to accurately achieve the desired temperature set point. When reheat is applicable, additional logic is utilized to adjust modulating valves to achieve a desired leaving temperature and relative humidity. All real-time line temperatures and pressures shall be accessible remotely by a certified technician without the use of a gauge set through any of the installed HMIs.

- **Compressor Modulation**  
Compressor shall be capable of automatically modulating from a minimum speed of 50Hz (30Hz on smaller units) to a maximum speed of 200Hz while maintaining a safe operating envelope to efficiently cool to the desired temperature set points. Compressor shall have a timed oil boost cycle to ensure proper oil return to the compressor's crankcase.
- **Outdoor Fan Modulation**  
Outdoor fans shall be capable of automatically modulating from 10 to 100% of their total capacity to minimize energy usage while still displacing the necessary heat to achieve desired temperature set points. Outdoor fans shall be capable of maintaining a desired outdoor coil temperature relative to ambient with the use of pressure transducers and temperature sensors, allowing the system to run as efficiently as possible independent of ambient conditions. Outdoor fans shall also have the capability to be run at a constant, user defined speed.
- **EEV Modulation**  
EEV shall automatically modulate between 0 and 100% open to maintain a specific superheat value by utilizing pressure transducers and temperature sensors. EEV shall automatically close when unit is inoperable to prevent liquid from migrating to the compressor crankcase.
- **Dehumidification/Reheat Mode (Optional)**  
When dehumidification mode is active, the compressor shall modulate to maintain an adjustable supply air dew point temperature. Reheat valve(s) shall be capable of automatically modulating between 0 and 100% open to reheat the supply air to the desired leaving air temperature and relative humidity percentage set points.

#### **Safety Controls**

The following safety controls shall be installed on cooling units:

- Continuous operating envelope monitoring that utilizes line temperature and pressure sensors to keep coil conditions within the acceptable range of the compressor. Detailed faults shall be displayed on HMI indicating what went wrong.
- Indoor condensate float switch that disables cooling and displays a fault on the HMI in the case of a drain blockage.
- High refrigerant pressure switch that disables cooling and displays a fault on the HMI until re-activated.
- Low refrigerant pressure switch that disables cooling and displays a fault on the HMI until re-activated. Software reset required via HMI to re-activate cooling.
- Integrated minimum on and off timer to prevent the compressor from cycling on and off too quickly.
- Oil level sensor that passively monitors the compressor oil level and initiates an oil boost to increase oil return back to the compressor's crankcase (availability dependent on hardware selection).
- Pumpdown mode reduces liquid refrigerant migration to the compressor's crankcase during an off cycle by isolating the system's refrigerant to the outdoor coil.

### **Heat Pump Controls (Optional)**

When in heat pump mode, unit(s) shall automatically modulate compressor frequency via a variable frequency drive, outdoor fan speed, and EEV position in conjunction with each other to accurately achieve the desired leaving air temperature set point. Unit(s) shall have a defrost cycle activated based on line temperature and pressure to ensure outdoor coil does not freeze, optimizing system efficiency. All real-time line temperatures and pressures shall be accessible remotely by a certified technician without the use of a gauge set through any of the installed HMIs.

### **Heat Pump Controls (Optional) continued**

- **Compressor Modulation**  
Compressor shall be capable of automatically modulating from a minimum speed of 50Hz (30Hz on smaller units) to a maximum speed of 200Hz while maintaining a safe operating envelope to efficiently heat to the desired temperature set points. Compressor shall have a timed oil boost cycle to ensure proper oil return to the compressor's crankcase.
- **Outdoor Fan Modulation**  
Outdoor fans shall be capable of automatically modulating from 10 to 100% of their total capacity to minimize energy usage while still displacing the necessary heat to achieve desired temperature set points. Outdoor fans shall be capable of maintaining a desired outdoor coil temperature relative to ambient with the use of pressure transducers and temperature sensors, allowing the system to run as efficiently as possible independent of ambient conditions. Outdoor fans shall also have the capability to be run at a constant, user defined speed.
- **EEV Modulation**  
EEV shall automatically modulate between 0 and 100% open to maintain a specific superheat value by utilizing specially placed pressure transducers and temperature sensors. EEV shall automatically close when unit is inoperable to prevent liquid from migrating to the compressor crankcase.
- **Defrost Cycle**  
Heat pump units shall be pre-programmed to automatically activate a defrost cycle when ambient conditions allow for the outdoor coil to freeze. Defrost cycles shall activate when either the line temperature AND pressure decline below user defined set points, or after a user defined period of time. When a defrost cycle is active, backup heat shall activate to ensure the supply air is tempered to desired conditions.
- **Backup Heat**  
A backup heat source shall be utilized when the unit is equipped with a heat pump. A heat pump shall only activate when outdoor temperature is above a configurable temperature, "X". Electric or indirect fired backup heat shall activate when outdoor temperature drops below "X". Backup heat shall activate when discharge temperatures fall below a configurable, minimum discharge temperature for an extended period of time. When minimum discharge temperature is capable of being maintained, heat pump shall re-activate. In the case of a critical fault related to the heat pump system, backup heat shall activate to ensure the supply air is tempered to desired conditions.

### **Safety Controls**

The following safety controls shall be installed on heat pump units:

- Continuous operating envelope monitoring that utilizes line temperature and pressure sensors to keep coil conditions within the acceptable range of the compressor. Detailed faults shall be displayed on the HMI indicating what went wrong.
- High refrigerant pressure switch that disables heating and displays a fault on the HMI until re-activated.
- Bi-metal, high refrigerant temperature switch that disables heating and displays a fault on the HMI until re-activated. Software reset required via HMI to re-activate heating.
- Low refrigerant pressure switch that disables heating and displays a fault on the HMI until re-activated. Software reset required via HMI to re-activate heating.
- Integrated minimum on and off timer to prevent the compressor from cycling on and off too quickly.
- Oil level sensor that passively monitors the compressor oil level and initiates an oil boost to increase oil return back to the compressor's crankcase (availability dependent on hardware selection).
- Pumpdown mode reduces liquid refrigerant migration to the compressor's crankcase during an off cycle by isolating the system's refrigerant to the outdoor coil.