

SODIUM HYPOCHLORITE BUILDING HVAC CONTROL SEQUENCES

1. GENERAL

- .1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 All setpoints and times of operation given in the control sequences are indicative. Final setpoints shall be dictated by site conditions.
- .3 The relationships between the points, systems and building are described in the control sequences.
- .4 Review with the Contract Administrator during the Shop Drawing stage to finalize the control sequences for each system.
- .5 Supply and install all controls, wiring, and ancillaries required to provide the functionality described within this section.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 General

- .1 Occupied mode shall be between the hours of 0600 and 1800 hrs Mon-Fri inclusive. Times out with this range and Holidays are designated as unoccupied.
- .2 Several alarm points generated by the BAS are to be reported to the on Site SCADA system. These alarm points take the form of common alarms and are identified in this sequence and on the schematic drawings.
- .3 A hardwire interlock shall initiate the shutdown of all ventilation systems (MAUs, AHUs and exhaust fans) and boilers in the event of a fire alarm activation. The Contractor shall Supply and Install keyed override switches to allow for each area to be ventilated individually by the attending Fire Officer. Upon an override signal from the keyed switch, the system that is energized shall operate in maximum capacity and with maximum outside air unless otherwise specified. Switches shall be installed adjacent to the fire alarm annunciation panel and identified as to function with engraved lamacoids. The ventilation equipment Manufacturers shall coordinate the override function with the fire alarm system Manufacturer.
- .4 Upon activation of the unit in hand mode the unit will start following the sequences indicated herein and run with the VFD's at 100% on the supply and extract. The DCS shall maintain control of the heating valve.

3.2 Make Up Air Unit MAU-H850 - Sequence of Operation

- .1 Description of Operation:

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- .1 Outside air enters the unit through the outside air damper and passes through a summer filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a winter filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.
- .2 Exhaust air enters the unit and passes through a filter, the air-to-air heat exchanger, the exhaust fan and is discharged through the exhaust air damper to outside.
- .2 Prior to Start Up:
 - .1 During heating season, 2-port motorized valve will modulate to maintain setpoint temperature of 15°C at TT-H850E.
- .3 Start Up Normal Operation:
 - .1 With the system in auto, the BAS shall energize MAU-H850, the outside air damper, MD-H850A, the exhaust air damper MD-H880 and the discharge air damper MD-H850B shall motor fully open, the room air damper MD-H881 shall motor fully closed. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open, fully closed for MD-H881. Failure to open the outside air or the exhaust air damper or to close room air damper shall result in the shut down of the unit.
 - .2 With confirmation of the dampers being in the required position, the BAS shall start the supply fan SF-H850A. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the system design flow rate. There will be two distinct output values which are determined during the air balancing work. One output value reflects the condition when system MAU-H851 is off (unoccupied mode). The other value reflects the condition when both MAU-H850 and MAU-H851 are operational (occupied mode). The BAS will determine the appropriate VFD output value based on the status of the system MAU-H851.
 - .3 One minute after the starting of the supply fan, the exhaust fan EF-H850A, will start. The BAS shall energize the exhaust fan starter.
 - .4 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.
 - .5 When the external temperature is less than 13°C and the air temperature at TT-H850C is less than 15°C, then the BAS shall modulate the 2-port valve on the heating coil, CV-H875 to maintain a minimum temperature of 15°C in the duct at TT-H850E. Additionally the BAS shall modulate the 2-port valve on the heating coil CV-H875 to maintain a minimum temperature of 15°C at the dictate of the room temperature sensor TT-H850D.
- .4 Summer / Winter Filters:
 - .1 Differential pressure sensors PT-H850A and PT-H850B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either

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filter an alarm only shall be signaled to the BAS to indicate filter change is required. Upon detection of pressure drop above (80 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate double-filter condition. Upon detection of pressure drop below (60 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate filter-missing condition.

.5 Exhaust Air Filter:

- .1 Differential pressure switch PS-H850B shall monitor the pressure drop across the exhaust filter. Upon detection of an excessive pressure drop (250 Pa) across the filter an alarm only shall be signaled to the BAS.

.6 Temperature Monitoring:

- .1 The BAS shall monitor the following temperatures: space TT-H850D, supply air downstream of heating coil TT-H850E, outside air TT-H850A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H850A, TT-H850C, TT-H850D and TT-H850B.

.7 System Shut Down:

- .1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans, open the room-air damper MD-H881 and outside air damper MD-H882. After 30 seconds, the BAS shall close the outside air damper MD-H850A, the discharge air damper MD-H850B and the exhaust air damper MD-H880.

.8 Common Fault/Alarm:

- .1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.3 Make Up Air Unit MAU-H851 - Sequence of Operation

.1 Description of Operation:

- .1 Outside air enters the unit through the outside air damper and passes through a summer filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a winter filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.

- .2 Exhaust air enters the unit and passes through a filter, the air-to-air heat exchanger, the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up

- .1 During heating season, 3-port motorized valve will modulate to maintain setpoint temperature of 15°C at TT-H851E.

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.3 Start Up Occupied mode:

- .1 With the system in auto, the BAS shall energize MAU-H851, the outside air damper, MD-H851A, the exhaust air damper MD-H851B and discharge air damper MD-H851C shall motor fully open. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit.
- .2 With the outside air, exhaust air and discharge air dampers open, the BAS shall energize both the supply fan SF-H851A and exhaust fan EF-H851A.
- .3 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.
- .4 When the external temperature is less than 13°C and the air temperature at TT-H851C is less than 15°C, then the BAS shall modulate the 3-port valve on the heating coil, CV-H876 to maintain a minimum temperature of 15°C in the duct at TT-H851E. Additionally the BAS shall modulate the 3-port valve on the heating coil CV-H876 to maintain a minimum temperature of 15°C at the dictate of the room temperature sensor TT-H850D.

.4 Summer / Winter Filters:

- .1 Differential pressure sensors PT-H851A and PT-H851B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS to indicate filter change is required. Upon detection of pressure drop above (80 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate double-filter condition. Upon detection of pressure drop below (60 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate filter-missing condition.

.5 Exhaust Air Filter

- .1 Differential pressure switch PS-H851C shall monitor the pressure drop across the exhaust filter. Upon detection of an excessive pressure drop (250 Pa) across the filter an alarm only shall be signaled to the BAS.

.6 Temperature Monitoring:

- .1 The BAS shall monitor the following temperatures: space TT-H851D, supply air downstream of heating coil TT-H851E, outside air TT-H851A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H851A, TT-H851C, TT-H851D and TT-H851B.

.7 System Shut Down:

- .1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans. After 30 seconds, the BAS shall close the

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outside air damper MD-H851A, the exhaust air damper MD-H851B and the discharge damper MD-H851C.

.8 Common Fault/Alarm:

- .1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.4 Make Up Air Unit MAU-H852 - Sequence of Operation

.1 Description of Operation:

- .1 Outside air enters the unit through the outside air damper and passes through a summer filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a winter filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.
- .2 Exhaust air enters the unit and passes through a filter, the air-to-air heat exchanger, passes through the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up:

- .1 During heating season, 3-port motorized valve will modulate to maintain setpoint temperature of 15°C at TT-H852E.

.3 Start Up/Unoccupied mode/Occupied Mode/Emergency Mode:

- .1 With the system in auto, the BAS shall energize MAU-H852, the outside air damper, MD-H852A, and the exhaust air damper MD-H852B shall motor fully open. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit.
- .2 With the outside air damper and exhaust air damper open, the BAS shall start the supply fan SF-H852A and exhaust fan EF-H852A. The BAS shall output a 4-20 mA proportional signal to ramp up the VFD output of each fan to maintain the design flow rates according to the operation mode. During unoccupied periods, the BAS shall output a value equivalent 25% of system design airflow capacity. During occupied periods, the BAS shall output a value equivalent to 100% design airflow capacity. These output values will be determined during the system air balancing period.
- .3 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.
- .4 When the external temperature is less than 10°C and the air temperature at TT-H852C is less than 15°C, then the BAS shall modulate the 3-port valve on the heating coil, CV-H877 to maintain a minimum temperature of 15°C in the duct at TT-H852E.

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Additionally the BAS shall modulate the 3-port valve on the heating coil CV-H877 to maintain a minimum temperature of 15°C and a maximum temperature of 35°C at the dictate of the room temperature sensor TT-H852D.

- .5 When the BAS detects temperature at TT-H852C above 20°C, the BAS shall output a discrete signal to the defrost system of the air-to-air heat exchanger to have supply air bypass the heat exchanger.
- .4 Summer / Winter Filters:
 - .1 Differential pressure sensors PT-H852A and PT-H852B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS to indicate filter change is required. Upon detection of pressure drop above (80 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate double-filter condition. Upon detection of pressure drop below (60 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate filter-missing condition.
- .5 Exhaust Air Filter:
 - .1 Differential pressure switch PS-H852C shall monitor the pressure drop across the exhaust filter. Upon detection of an excessive pressure drop (250 Pa) across the filter an alarm only shall be signaled to the BAS.
- .6 Temperature Monitoring:
 - .1 The BAS shall monitor the following temperatures: space TT-H852D, supply air downstream of heating coil TT-H852E, outside air TT-H852A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H852A, TT-H852C, TT-H852D and TT-H852B.
- .7 System Shut Down:
 - .1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans. After 30 seconds, the BAS shall close the outside air damper MD-H852A and the exhaust air damper MD-H852B.
- .8 Common Fault/Alarm:
 - .1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.5 Hypochlorite Generator Room Heat Relief Exhaust Fan EF-H853

- .1 Description of Operation:
 - .1 This exhaust system provides heat relief ventilation for the purpose of cooling the Hypochlorite Generator Room.

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.2 Startup/Normal Operation:

- .1 The BAS shall control the operation of this system at the dictate of the Room Temperature Transducer, TT-H853A.
- .2 Upon a rise of room temperature above 25°C, the BAS shall energize the outside air intake damper MD-H884 and exhaust air damper MD-H883. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit
- .3 With the damper fully open, the BAS shall output a 4-20mA proportional signal to ramp up the VFD-H853A output based on the following adjustable linear schedule:
 - .1 Room Temperature = 25°C, VFD output = 20%
 - .2 Room Temperature = 35°C, VFD output = 100%.

.3 Shut Down Sequence:

- .1 On a system shut down command, through manual or room temperature, the BAS shall de-energize the VFD-H853A, outside air intake damper MD-H884 and exhaust damper MD-H883.

.4 Common Fault/Alarm:

- .1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.6 Air Handling Unit AHU-H854 - Sequence of Operation

.1 Description of Operation:

- .1 The unit is in continuous operation.
- .2 Outside air is mixed with return air at the mixing box of the air handling unit. The mixed air then passes through a set of pre-filter and a final-filter and the DX cooling coil. Conditioned supply air is then discharged into the supply air ductwork by the supply fan.
- .3 The outside air and the return air motorized dampers are controlled by the BAS to at the dictate of the outside air dry bulb temperature to achieve free-cooling (economizer). When the system is not operating in economizer mode, return air damper shall open to a maximum position and outside air damper shall close to a minimum position allowing 10% of outside air entering the system.

.2 Start Up Normal Operation:

- .1 With the system in auto, the BAS shall initially modulate the inlet damper to the preset minimum position and the return air damper shall close to the preset maximum.

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- .2 After 2 minutes the BAS shall confirm that the outside air damper is in at the defined position. A failure to open the damper shall result in the BAS initiating the shut down sequence and an alarm being generated. The BAS shall energize the AHU supply fan and maintain the design flow rate. A failure to start the fan shall result in the BAS initiating the shut down sequence and an alarm being generated.
 - .3 The BAS shall monitor outside air temperature at TT-H854A and determines if economizer mode is applicable. When outside air temperature is below 15°C, the BAS shall enable the economizer mode by modulating the outside air damper MD-H854A and the return air damper MD-H854B to maintain mixed air temperature TT-H854C at minimum 15°C
 - .4 When outside air temperature is above 15°C, the BAS shall disable the economizer mode by closing the outside air damper to the preset minimum position and open the return air damper to the preset maximum position.
 - .5 The BAS shall also energize the air-cooled condenser CU-H854 as required to maintain room temperature below the maximum of 25°C. When energized, this DX cooling system shall maintain an induct temperature of 12°C, at the dictate of the duct temperature transmitter TT-H854D, until the room temperature sensor TT-H854E indicates that the room temperature is 5°C below the upper limit of the room temperature range.
 - .6 Should the space temperature sensor TT-H854E indicates a room temperature of 28°C or greater an alarm only shall be generated
- .3 Filters:
- .1 Differential pressure switches PS-H854B and PS-H854C shall monitor the pressure drop across the pre-filter and Final Filter. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS. This alarm shall have no effect on the run status of the unit.
- .4 System Shut Down:
- .1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the AHU supply fan. After 30 seconds, the BAS shall close the outside air damper and open the return air damper.
- .5 Common Fault/Alarm:
- .1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

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3.7 Fan Coil Unit FC-H890 - Sequence of Operation

- .1 Description of Operation:
 - .1 Outside air enters the unit through the outside air damper and passes through a set of filter prior to entry into the fan section. The supply fan then discharges the air through a Hydronic heating coil and into the supply air ductwork.
- .2 Prior to Start Up:
 - .1 During heating season, 3-port motorized valve will modulate to maintain setpoint temperature of 15°C at TT-H890B.
- .3 Start Up Occupied Mode:
 - .1 With the system in auto, the BAS shall energize FC-H890, the outside air damper, MD-H892, shall motor fully open. Limit switch on the damper shall confirm, after 2 minutes, that the damper is fully open. Failure to open the outside air damper shall result in the shut down of the unit.
 - .2 With the outside air damper open, the BAS shall energize the supply fan SF-H890A.
 - .3 A failure to start by the fan shall result in a shut down of the unit and an alarm indicated at the BAS.
 - .4 When the external temperature is less than 13°C and the air temperature at TT-H890A is less than 15°C, then the BAS shall modulate the 3-port valve on the heating coil, CV-H891 to maintain a minimum temperature of 15°C in the duct at TT-H890B. Additionally the BAS shall modulate the 3-port valve on the heating coil CV-H891 to maintain a minimum temperature of 15°C at the dictate of the room temperature sensor TT-H890C.
- .4 Air Filter:
 - .1 Differential pressure switch PS-H890A shall monitor the pressure drop across the exhaust filter. Upon detection of an excessive pressure drop (250 Pa) across the filter an alarm only shall be signaled to the BAS.
- .5 Temperature Monitoring:
 - .1 The BAS shall monitor the following temperatures: space TT-H890C, supply air downstream of heating coil TT-H890B and outside air TT-H890A.
- .6 System Shut Down:
 - .1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply fan. After 30 seconds, the BAS shall close the outside air damper MD-H892.

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.7 Common Fault/Alarm:

- .1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.8 Hydronic Heating System (50% ethylene glycol solution) Pressure Differential Control Valve CV-H878, Pressure Differential Sensor PT-H878B – Sequence of Operation

.1 Description of Operation:

- .1 The heat source for this hydronic heating subsystem is supplied by the central hydronic heating system, completing system circulating pumps, located in the Bulk Chemical Building.
- .2 The purpose of this system is to minimize the differential pressure fluctuation in the system due to the operation of 2-port control valves within the system.

.2 Normal Operation:

- .1 The BAS shall monitor the differential pressure sensed by PT-H878 and modulates the control valve CV-H878 to maintain a constant pressure differential between the supply and return headers.

3.9 Unit Heaters – UH-H860, UH-H861, UH-H862, UH-H863, UH-H864 and UH-H865 - Sequence of Operation

.1 Description of Operation:

- .1 Unit heaters provide warm air to maintain localized heating to various parts of the building. The unit heats the air by means of a hydronic coil fed from the hydronic heating loop.

.2 Normal Operation:

- .1 Unit heaters UH-860, HU-H861, UH-H862 and UH-H864 are designated as normal operating unit heaters. Each unit is permanently energized by an independent power supply. The BAS modulates the 3-port valve on each unit, to provide low temperature hot water to the heating coil. The BAS modulates the control valve at the dictate of the associated room temperature transducer.

.3 Emergency Operation:

- .1 Unit heater UH-H865 is designated as emergency Unit Heater and it is operational only when the BAS has recognized that the system MAU-H850 has been de-energized due to a system fault.
- .2 If the external temperature is 5°C or less, then during emergency conditions, the BAS shall energize the blower of UH-H865 and modulate its 2-port valve at the dictate of its associated room temperature transducer to maintain the space temperature at 5°C.

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3.10 Electric Radian Bird Screen Defrost Systems – Sequence of Operation.

- .1 Description of Operation:
 - .1 The objective of this system is to prevent the build-up of hoar frost on the bird screens at the air intake louvers.
 - .2 This system consists of an electric radiant heater shining onto the bird screen and a pressure differential sensor that monitors the pressure drop across the exterior louver.
 - .3 This sequence of operation is applicable for the following systems:
 - .1 ERH-H850 with pressure differential switch PS-H850A and outside air temperature transducer TT-H850A
 - .2 ERH-H851A, ERH-H851B and ERH-H851C with pressure differential switch PS-H851A and outside air temperature transducer TT-H851A
 - .3 ERH-H852 with pressure differential switch PS-H852A and outside air temperature transducer TT-H852A
 - .4 ERH-H854 with pressure differential switch PS-H854A and outside air temperature transducer TT-H854A
- .2 Startup/Normal Operation:
 - .1 The BAS shall control the operation of each system at the dictate of its associated outside air temperature transducer and the pressure differential switch.
 - .2 The BAS shall energize a discrete contact to turn on the radiant heater(s) when the outside air temperature transducer detects a temperature below 0°C and the pressure differential switch detects a pressure drop of above 62 Pa simultaneously.

3.11 Heat Tracing - Sequence of Operation

- .1 Description of Operation:
 - .1 Heat tracing system is incorporated behind the small intake louver for the system FC-H890. This system operates automatically dependant of the external weather conditions.
- .2 Normal Operation:
 - .1 The BAS shall energize the heat tracing system on the louver at the dictate of the external temperature sensor TT-H890A. The system shall operate when the external temperature ranges between -5°C and 5°C.
 - .2 The BAS shall monitor the status of the heat tracing controller. Any fault in the heat tracing system shall generate an alarm only at the BAS.

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3.12 Water Pressure Booster Package P-H885A, P-H885B and P-H885C - Sequence of Operation

- .1 Description of Operation:
 - .1 This is a packaged system that comes complete with its own controls. The BAS shall receive and monitor operating status and failure alarm for each of the three pumps from packaged control system.
- .2 Common Fault:
 - .1 Any alarm received by the BAS pertaining to this system, a common alarm shall be generated by the BAS to the site SCADA system.

3.13 Standby Power Mode

- .1 Description of Operation
 - .1 Upon receiving a digital signal identified as YY-H080A “Water Treatment Plant in Standby Power Mode – HVAC Shutdown Command” from Plant PLC, the BAS shall initiate the Standby Power Mode and initiate a system shutdown for all systems within its domain.
 - .2 Within 30 seconds (adjustable) immediately after YY-H080A has been received, the BAS shall resume normal operation for the first group of systems. These are:
 - .1 Process water Pressure Booster System.
 - .3 Within 60 seconds (adjustable) immediately after YY-H080A has been received, the BAS shall resume normal operation for the first group of systems. These are:
 - .1 Electrical Room Ventilation, and all associated dampers, fans and condenser unit.
 - .2 Hypochlorite Generation Room Ventilation and all associated dampers and fans
 - .3 Bridge and Link Way Ventilation, and all associated dampers.
 - .2 The programming of this sequence shall include functionalities that provide a means of adding and/or removing any system to and/or from the group above through the HMI. These functionalities shall apply user-friendly operations such as drag-and-drop for the purpose of adding or removing systems.
 - .3 The programming of this sequence shall also take into consideration the components within each system, such that if a system is to be added or removed from a group, all components within the system must be included

END OF SECTION