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**Partie 1      General**

**1.1            SUMMARY**

.1      Section Contents

- .1      Detailed narrative description of the control sequences of each system including ramping periods and reset schedules.

**1.2            SEQUENCING**

.1      Control Modes

- .1      Start commands are switched weekly for lead/lag equipment such as pumps, fans, etc. Upon a lost of status of the lead equipment, the lag equipment is started.
- .2      The Local Control Unit (CNP) ensures minimum runtime to prevent short cycling when equipment is automatically started.
- .3      Upon start-up of ventilation systems, allow recirculation mode to operate for a minimum of 5 minutes.
- .4      Enthalpy control must include a band within which the minimum amount of fresh air can be adjusted.

.2      Analog Alarms

- .1      Program high and low alarm limits for all analog points.
- .2      Provide 4 levels of alarms: two high limits and two low limits. Some alarm levels are already indicated in the control sequences.
- .3      Alarms from transmitters located in ventilation duct or piping, unless otherwise stated, are locked out by the fan of the pump status to prevent alarms when the system is stopped.

.3      Critical Alarms

- .1      When the status is available, program critical alarms for the following points:
  - .1      unwanted start/stop of fans and pumps;
  - .2      freeze protection;
  - .3      high or low pressure;
  - .4      faults (equipment);
  - .5      control variable outside limits (level, pressure, temperature).
- .2      When an unwanted stop alarm persists for more than 2 minutes, the start command is cancelled.
- .3      Unless otherwise stated, system stop alarms are interlocked with the fire alarm system to eliminate redundant alarms on the fire alarm system.
- .4      Some critical alarms are sent to the guard's station.

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- .4 Maintenance Alarms
    - .1 When the status is available, program maintenance alarms for the following points:
      - .1 stopped system;
      - .2 dirty filter;
      - .3 runtime.
  - .5 The setpoints specified in the current Section are provided as working assumptions. They must be fully editable from the BAS according to actual building operation and experience.
  - .6 Setpoint Ramps
    - .1 Provide control algorithms which will gradually bring setpoint from its start value to desired value upon system start-up or setpoint changes.
    - .2 Ramping progression speeds must be adjustable.
  - .7 Start-up following power failure
    - .1 Upon the return of power supply, electromechanical equipment (such as fans, pumps, etc) are restarted according to a pre-established sequence in order to protect against overload. Provide programmable start delays for each equipment controlled. When a power failure occurs, open start contacts of all equipment controlled to allow sequential restart.
  - .8 Control Sequences of Systems
    - .1 System 100: Fresh Air / Exhaust (General and East)
      - .1 System Shutdown:
        - .1 Supply (VA1, VA2, and VA3) and exhaust (VE1 and VE2) fans are stopped.
        - .2 Outside air and exhaust dampers are closed.
        - .3 When the outdoor temperature is above 5 °C (41 °F), the dual-mode coil's control valve is closed. Below 5 °C outside, the dual-mode coil's control valve is modulated by the CNP to maintain the setpoint at 13 °C (55 °F) between the heat recovery wheel and the filters inside the ventilation unit.
        - .4 The heat recovery wheel is stopped.
        - .5 The humidifier is stopped.
      - .2 System Start-Up:
        - .1 A command from the CNP opens the outside air damper according to an occupancy schedule.
        - .2 Upon full-open confirmation of the outside air damper, the supply fans start at low speed.
        - .3 The exhaust damper opens by electrical interlock with the supply fans.

- .4 Upon full-open confirmation of the exhaust damper, the exhaust fans starts at low speed.
- .3 Normal Operation:
  - .1 The speed of supply fans is simultaneously modulated by the CNP to maintain supply duct static pressure at setpoint.
  - .2 The speed of supply fans is limited by the CNP to prevent excessive pressure at the supply end of ventilation unit. If the measured pressure exceeds the critical setpoint, the system is shutdown.
  - .3 The speed of exhaust fans is simultaneously modulated by the CNP to maintain exhaust air flow at setpoint. This setpoint is the difference between supply air flow and a constant value representing the amount of air exhausted by other systems.
  - .4 The speed of exhaust fans is limited by the CNP to prevent excessive negative pressure in the exhaust duct. If the measured pressure exceeds the critical setpoint, the system is shutdown.
  - .5 The humidifier is modulated by the CNP to maintain the relative humidity in the exhaust at setpoint. The CNP limits the relative humidity in the supply at a maximum of 80% R.H.
- .4 Heating Mode: Outdoor Temperature Below 12 °C
  - .1 The speed of the heat recovery wheel is modulated by the CNP in sequence with the dual-mode coil's control valve to maintain the supply air temperature at setpoint.
  - .2 The CNP limits the speed of the heat recovery wheel to maintain the exhaust temperature above 1 °C.
- .5 Cooling Mode: Outdoor Temperature Above 14 °C
  - .1 The heat recovery wheel stops when the outdoor temperature is both above 10 °C and below room temperature plus 3 °C. When the outdoor temperature is above room temperature plus 3 °C the CNP starts the heat recovery wheel at full speed.
  - .2 The dual-mode coil's control valve is modulated by the CNP to maintain supply temperature at setpoint.
- .6 Local Protection:
  - .1 The humidifier stops when either the low flow switch (IDA) or the high humidity limit switch (IH) is triggered.
  - .2 The supply fan is stopped when the freezestat switch (IG) is triggered. The freezestat is set to 5 °C (41 °F).
  - .3 A fire alarm contact stops the system.
- .7 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.
  - .3 Humidifier fault is sent to the CNP.
  - .4 Status of filters is sent to the CNP.

- .5 Freezestat switch (IG) status is sent to the CNP.
- .6 Alarms are generated when the following variables exceed their limits:
  - .1 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;
  - .2 exhaust relative humidity:  $< 15 \text{ } \% \text{ R. H.}$ ;
  - .3 supply relative humidity:  $> 90 \text{ } \% \text{ R.H.}$  (when humidifying);
  - .4 supply static pressure:  $SP \pm 60 \text{ Pa.}$
- .2 System 101: Multipurpose Room – Interior Zone (East)  
System 103: Multipurpose Room – Interior Zone (West)
  - .1 System Shutdown:
    - .1 The supply fan is stopped.
    - .2 Cooling coil's control valve is closed.
    - .3 The fresh air variable volume box is closed.
  - .2 System Start-Up:
    - .1 The CNP starts the supply fan at low speed according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
    - .2 The CNP opens the fresh air variable volume box to its minimum position according to the occupancy schedule.
  - .3 Normal Operation:
    - .1 The supply fan speed is modulated by the CNP to maintain duct static pressure at setpoint 2/3 downstream of supply fan.
    - .2 The cooling coil's control valve is modulated by the CNP to maintain supply temperature at setpoint ( $13 \text{ }^\circ\text{C}$ ).
    - .3 The fresh air variable volume box is modulated by the CNP to maintain the carbon dioxide ( $\text{CO}_2$ ) level of the least favored sector at its setpoint.
    - .4 For each zone, as read by suspended temperature sensors from systems 102 and 104, the damper is modulated by the CNP to maintain zone temperature at setpoint.
  - .4 Local Protection:
    - .1 A fire alarm contact stops the system.
  - .5 Alarm:
    - .1 Fan operating status is sent to the CNP.
    - .2 Variable frequency drive fault is sent to the CNP.
    - .3 Status of filter is sent to the CNP.
    - .4 Alarms are generated when the following variables exceed their limits:
      - .1 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;

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- .2 carbon dioxide levels: > 1200 ppm;
  - .3 supply static pressure:  $SP \pm 60$  Pa.
- .3 System 102: Multipurpose Scenography Room (East)  
System 104: Multipurpose Scenography Room (West)
- .1 System Shutdown:
    - .1 Supply fan is stopped.
    - .2 Cooling coil's control valve is closed.
    - .3 System isolation damper is closed.
    - .4 Zone dampers are closed.
  - .2 System Start-Up:
    - .1 The CNP opens the isolation damper of a supply fan (the one with the least running time) according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
    - .2 Upon full-open confirmation of the isolation damper, the supply fan starts at low speed by electrical interlock with the limit switch of the damper's actuator.
  - .3 Normal Operation:
    - .1 The supply fan speed is modulated by the CNP to maintain the average of the two supply duct static pressure sensors at setpoint.
    - .2 If static pressure cannot be maintained with a single system, the second system is started and its isolation damper is opened by the CNP. The speed of the supply fans of both systems is then simultaneously modulated. Inversely, when the systems operate below 40% (adjustable) of their capacity, the system with the most running time is stopped.
    - .3 The control valve of the cooling coil is modulated by the CNP to maintain supply temperature at setpoint (13 °C).
    - .4 For each zone, the two zone dampers are modulated by the CNP to maintain zone temperature (suspended temperature sensors) at setpoint.
  - .4 Local Protection:
    - .1 A fire alarm contact stops the system.
  - .5 Alarm:
    - .1 Fan operating status is sent to the CNP.
    - .2 Variable frequency drive fault is sent to the CNP.
    - .3 Status of filter is sent to the CNP.
    - .4 Alarms are generated when the following variables exceed their limits:
      - .1 supply temperature:  $SP \pm 2$  °C;
      - .2 supply static pressure:  $SP \pm 60$  Pa.

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- .4 System 105: Lobby (East)  
System 106: Lobby (West)
    - .1 System Shutdown:
      - .1 Supply fan is stopped.
      - .2 Cooling coil's control valve is closed.
      - .3 The fresh air variable volume box is closed.
    - .2 System Start-Up:
      - .1 The CNP starts the supply fan at low speed according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
      - .2 According to the occupancy schedule, the CNP opens the fresh air variable volume box to its minimum position.
    - .3 Normal Operation:
      - .1 The supply temperature setpoint is readjusted from a high of 20 °C to a low of 13 °C in sequence with the supply fan speed to maintain room temperature setpoint at 22 °C.
      - .2 The cooling coil's control valve is modulated by the CNP to maintain supply temperature at calculated setpoint.
      - .3 The speed of supply fans is limited by the CNP to prevent excessive pressure at the supply end of ventilation unit. If the measured pressure exceeds the critical setpoint, the system is shutdown.
      - .4 The CNP modulates the fresh air variable volume box to maintain the room's carbon dioxide level (CO<sub>2</sub>) at setpoint.
      - .5 Allow a minimum of 60 minutes (adjustable) before switching from one mode to another.
    - .4 Normal Operation of Heating Mode:
      - .1 When the perimeter zone switches from cooling to heating, the modulating valve is closed and the isolation valves on the secondary cold water network are closed. The isolation valves on the low temperature hot water network are then opened and the baseboard's control valve is then allowed to modulate.
      - .2 The baseboard's control valve is modulated in sequence with the baseboard's fan by the Specific Application Controller (CNA) to maintain room temperature at setpoint. Setpoint is according to occupation mode (occupied, unoccupied, summer and winter).
      - .3 When room temperature is below setpoint, the sequence is as follows:
        - .1 Gradual opening of baseboard's control valve;
        - .2 When control valve is 50% open the fan starts at medium speed (on room temperature rise, stop fan when valve is 10% open);

- .3 When the control valve is 100% open, the fan is set to high speed (on room temperature rise, reduce fan speed to medium when valve is 60% open).
- .5 Normal Operation of Cooling Mode:
  - .1 Upon a cooling demand of the interior zone, the perimeter zone setpoint is reduced.
  - .2 When the perimeter zone switches from heating to cooling, the modulating valve is closed and the isolation valves on the low temperature hot water network are closed. The isolation valves on the secondary cold water network are then opened and the baseboard's control valve is then allowed to modulate.
  - .3 The baseboard's control valve is modulated in sequence with the baseboard's fan by the CNA to maintain temperature setpoint. Setpoint is according to occupation mode (occupied, unoccupied, summer and winter).
  - .4 When room temperature is above setpoint, the sequence is as follows:
    - .1 The fan starts at medium speed;
    - .2 Gradual opening of baseboard's control valve;
    - .3 When control valve is 50% open the fan is set to high speed (on room temperature decrease, reduce fan speed to medium when valve is 10% open);
- .6 Local Protection:
  - .1 A fire alarm contact stops the system.
- .7 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.
  - .3 Status of filter is sent to the CNP.
  - .4 Alarms are generated when the following variables exceed their limits:
    - .1 room temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;
    - .2 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;
    - .3 carbon dioxide level:  $> 1200 \text{ ppm}$ ;
    - .4 supply static pressure:  $SP \pm 60 \text{ Pa}$ .
- .5 System 107: East Building – North Part
  - .1 System Shutdown:
    - .1 The supply fan is stopped.
    - .2 Cooling coil's control valve is closed.
    - .3 The fresh air variable volume box is closed.

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- .2 System Start-Up:
    - .1 The CNP starts the supply fan at low speed according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
    - .2 The CNP opens the fresh air variable volume box to its minimum position according to the occupancy schedule.
  - .3 Normal Operation:
    - .1 The supply fan speed is modulated by the CNP to maintain duct static pressure at setpoint 2/3 downstream of supply fan.
    - .2 The cooling coil's control valve is modulated by the CNP to maintain supply temperature at setpoint (13 °C).
    - .3 The fresh air variable volume box is modulated by the CNP to maintain the carbon dioxide (CO<sub>2</sub>) level of the least favored zone at its setpoint.
    - .4 The air flow through the terminal variable volume box is modulated by the CNA in sequence with the baseboard's control valve to maintain the room temperature at setpoint. The terminal unit is authorized to open for a minimum period of 30 minutes (adjustable) if permitted by the occupancy schedule and if a person is detected inside the room (by the presence detector, if applicable).
  - .4 Local Protection:
    - .1 A fire alarm contact stops the system.
  - .5 Alarm:
    - .1 Fan operating status is sent to the CNP.
    - .2 Variable frequency drive fault is sent to the CNP.
    - .3 Status of filter is sent to the CNP.
    - .4 Alarms are generated when the following variables exceed their limits:
      - .1 supply temperature:  $SP \pm 2$  °C;
      - .2 carbon dioxide level: > 1200 ppm;
      - .3 supply static pressure:  $SP \pm 60$  Pa.
  - .6 System 108: East Building – South Part
    - .1 System Shutdown:
      - .1 The supply fan is stopped.
      - .2 Cooling coil's control valve is closed.
      - .3 The fresh air variable volume box is closed.

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- .2 System Start-Up:
    - .1 The CNP starts the supply fan at low speed according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
    - .2 The CNP opens the fresh air variable volume box to its minimum position according to the occupancy schedule.
  - .3 Normal Operation:
    - .1 The supply fan speed is modulated by the CNP to maintain duct static pressure at setpoint 2/3 downstream of supply fan.
    - .2 The cooling coil's control valve is modulated by the CNP to maintain supply temperature at setpoint (13 °C).
    - .3 The fresh air variable volume box is modulated by the CNP to maintain the carbon dioxide (CO<sub>2</sub>) level of the least favored zone or in the return duct at its setpoint.
    - .4 The air flow through the terminal variable volume box is modulated by the CNA in sequence with the baseboard's control valve to maintain the room temperature at setpoint. The terminal unit is authorized to open for a minimum period of 30 minutes (adjustable) if permitted by the occupancy schedule and if a person is detected inside the room (by the presence detector, if applicable).
  - .4 Local Protection:
    - .1 A fire alarm contact stops the system.
  - .5 Alarm:
    - .1 Fan operating status is sent to the CNP.
    - .2 Variable frequency drive fault is sent to the CNP.
    - .3 Status of filters is sent to the CNP.
    - .4 Alarms are generated when the following variables exceed their limits:
      - .1 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;
      - .2 carbon dioxide level:  $> 1200 \text{ ppm}$ ;
      - .3 supply static pressure:  $SP \pm 60 \text{ Pa}$ .
  - .7 System 109: East Building – Mess
    - .1 System Shutdown:
      - .1 The supply fan is stopped.
      - .2 Cooling coil's control valve is closed.
      - .3 The fresh air variable volume box is closed.

- .2 System Start-Up:
  - .1 The CNP starts the supply fan at low speed according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
  - .2 The CNP opens the fresh air variable volume box to its minimum position according to the occupancy schedule.
- .3 Normal Operation:
  - .1 The supply temperature setpoint is readjusted from a high of 20 °C to a low of 13 °C in sequence with the supply fan speed to maintain the zone (east or west) with the maximum cooling demand at setpoint.
  - .2 The cooling coil's control valve is modulated by the CNP to maintain supply temperature at calculated setpoint.
  - .3 The fresh air variable volume box is modulated by the CNP to maintain the carbon dioxide (CO<sub>2</sub>) level of the zone at its setpoint.
- .4 Local Protection:
  - .1 A fire alarm contact stops the system.
- .5 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.
  - .3 Status of filters is sent to the CNP.
  - .4 Alarms are generated when the following variables exceed their limits:
    - .1 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;
    - .2 carbon dioxide level:  $> 1200 \text{ ppm}$ .
- .8 System 110: Commemorative Space
  - .1 System Shutdown:
    - .1 The supply fan is stopped.
    - .2 Cooling coil's control valve is closed.
    - .3 The ground floor terminal heating coil's control valve is closed.
    - .4 The fresh air variable volume box is closed.
  - .2 System Start-Up:
    - .1 The CNP starts the supply fan at low speed according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
    - .2 The CNP opens the fresh air variable volume box to its minimum position according to the occupancy schedule.

- .3 Normal Operation:
  - .1 The supply fan speed is modulated by the CNP to maintain duct static pressure at setpoint 2/3 downstream of supply fan.
  - .2 The cooling coil's control valve is modulated by the CNP to maintain supply temperature at setpoint (13 °C).
  - .3 The fresh air variable volume box is modulated by the CNP to maintain the carbon dioxide (CO<sub>2</sub>) level of the least favored zone at its setpoint.
  - .4 The air flow through the terminal unit is modulated by the CNA in sequence with the baseboard's control valve and the ground floor terminal heating coil's control valve (SC1-110-A01) to maintain the room temperature at setpoint.
- .4 Local Protection:
  - .1 A fire alarm contact stops the system.
- .5 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.
  - .3 Status of filter is sent to the CNP.
  - .4 Alarms are generated when the following variables exceed their limits:
    - .1 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;
    - .2 carbon dioxide level:  $> 1200 \text{ ppm}$ ;
    - .3 supply static pressure:  $SP \pm 60 \text{ Pa}$ .
- .9 System 200: Fresh Air / Exhaust (West)
  - .1 System Shutdown:
    - .1 Supply (VA1) and exhaust (VE1) fans are stopped.
    - .2 Outside air, exhaust and general exhaust dampers are closed.
    - .3 When the outdoor temperature is above 5 °C (41 °F), the dual-mode coil's control valve is closed. Below 5 °C outside, the dual-mode coil's control valve is modulated by the CNP to maintain the setpoint at 13 °C (55 °F) between the heat recovery wheel and the filters inside the ventilation unit.
    - .4 The heat recovery wheel is stopped.
    - .5 The humidifier is stopped.
  - .2 System Start-Up:
    - .1 A command from the CNP opens the outside air damper according to an occupancy schedule.
    - .2 Upon full-open confirmation of the outside air damper, the supply fan starts at low speed.
    - .3 The exhaust damper opens by electrical interlock with the supply fan.

- .4 Upon full-open confirmation of the exhaust damper, the exhaust fan starts at low speed.
- .3 Normal Operation:
  - .1 Supply fan speed is modulated by the CNP to maintain supply duct static pressure at setpoint.
  - .2 Supply fan speed is limited by the CNP to prevent excessive pressure at the supply end of ventilation unit. If the measured pressure exceeds the critical setpoint, the system is shutdown.
  - .3 Exhaust fan speed is modulated by the CNP to maintain exhaust air flow at setpoint. This setpoint is the difference between supply air flow and a constant value representing the amount of air exhausted by other systems.
  - .4 Exhaust fan speed is limited by the CNP to prevent excessive negative pressure in the exhaust duct. If the measured pressure exceeds the critical setpoint, the system is shutdown.
  - .5 The general exhaust damper is modulated by the CNP to maintain the sanitary exhaust air flow at setpoint (see balancing report for air flow value).
  - .6 The humidifier is modulated by the CNP to maintain the relative humidity in the exhaust at setpoint. The CNP limits the relative humidity in the supply at a maximum of 80% R.H.
- .4 Heating Mode: Outdoor Temperature Below 12 °C
  - .1 The speed of the heat recovery wheel is modulated by the CNP in sequence with the dual-mode coil's control valve to maintain the supply temperature at setpoint.
  - .2 The CNP limits the speed of the heat recovery wheel to maintain the exhaust temperature above 1 °C.
- .5 Cooling Mode: Outdoor Temperature Above 14 °C
  - .1 The heat recovery wheel stops when the outdoor temperature is both above 10 °C and below room temperature plus 3 °C. When the outdoor temperature is above room temperature plus 3 °C the CNP starts the heat recovery wheel at full speed.
  - .2 The dual-mode coil's control valve is modulated by the CNP to maintain supply temperature at setpoint.
- .6 Local Protection:
  - .1 The humidifier stops when either the low flow switch (IDA) or the high humidity limit switch (IH) is triggered.
  - .2 The supply fan is stopped when the freezestat switch (IG) is triggered. The freezestat is set to 5 °C (41 °F).
  - .3 A fire alarm contact stops the system.
- .7 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.

- .3 Humidifier fault is sent to the CNP.
- .4 Status of filters is sent to the CNP.
- .5 Freezestat switch (IG) status is sent to the CNP.
- .6 Alarms are generated when the following variables exceed their limits:
  - .1 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;
  - .2 exhaust relative humidity:  $< 15 \text{ } \% \text{ R. H.}$ ;
  - .3 supply relative humidity:  $> 90 \text{ } \% \text{ R.H.}$  (when humidifying);
  - .4 supply static pressure:  $SP \pm 60 \text{ Pa}$ .
- .10 System 201: West Building (interior zone)
  - .1 System Shutdown:
    - .1 The supply fan is stopped.
    - .2 Cooling coil's control valve is closed.
    - .3 The fresh air variable volume box is closed.
  - .2 System Start-Up:
    - .1 The CNP starts the supply fan at low speed according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
    - .2 The CNP opens the fresh air variable volume box to its minimum position according to the occupancy schedule.
  - .3 Normal Operation:
    - .1 The supply fan speed is modulated by the CNP to maintain duct static pressure at setpoint 2/3 downstream of supply fan.
    - .2 The cooling coil's control valve is modulated by the CNP to maintain supply temperature at setpoint ( $13 \text{ }^\circ\text{C}$ ).
    - .3 The fresh air variable volume box is modulated by the CNP to maintain the carbon dioxide ( $\text{CO}_2$ ) level of the least favored zone or return duct at its setpoint.
    - .4 The air flow through the terminal variable volume box is modulated by the CNA in sequence with the baseboard's control valve and fan to maintain the room temperature at setpoint. The terminal unit is authorized to open for a minimum period of 30 minutes (adjustable) if permitted by the occupancy schedule and if a person is detected inside the room (by the presence detector, if applicable).
    - .5 Allow a minimum of 60 minutes (adjustable) before switching from one mode to another.

- .4 Normal Operation of Heating Mode:
  - .1 When the perimeter zone switches from cooling to heating, the modulating valve is closed and the isolation valves on the secondary cold water network are closed. The isolation valves on the low temperature hot water network are then opened and the baseboard's control valve is then allowed to modulate.
  - .2 The baseboard's control valve is modulated in sequence with the baseboard's fan by the CNA to maintain temperature at setpoint. Setpoint is according to occupation mode (occupied, unoccupied, summer and winter).
  - .3 When room temperature is below setpoint, the sequence is as follows:
    - .1 Gradual opening of baseboard's control valve;
    - .2 When control valve is 50% open the fan starts at medium speed (on room temperature rise, stop fan when valve is 10% open);
    - .3 When the control valve is 100% open, the fan is set to high speed (on room temperature rise, reduce fan speed to medium when valve is 60% open).
- .5 Normal Operation of Cooling Mode:
  - .1 When the perimeter zone switches from heating to cooling, the modulating valve is closed and the isolation valves on the low temperature hot water network are closed. The isolation valves on the secondary cold water network are then opened and the baseboard's control valve is then allowed to modulate.
  - .2 The baseboard's control valve is modulated in sequence with the baseboard's fan by the CNA to maintain temperature at setpoint. Setpoint is according to occupation mode (occupied, unoccupied, summer and winter).
  - .3 When room temperature is above setpoint, the sequence is as follows:
    - .1 The fan starts at medium speed;
    - .2 Gradual opening of baseboard's control valve;
    - .3 When control valve is 50% open the fan is set to high speed (on room temperature decrease, reduce fan speed to medium when valve is 10% open);
- .6 Local Protection:
  - .1 A fire alarm contact stops the system.
- .7 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.
  - .3 Status of filter is sent to the CNP.

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- .4 Alarms are generated when the following variables exceed their limits:
    - .1 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;
    - .2 carbon dioxide level:  $> 1200 \text{ ppm}$ ;
    - .3 supply static pressure:  $SP \pm 60 \text{ Pa}$ .
  - .11 System 202: West Building (East Perimeter Zone)  
System 203: West Building (West Perimeter Zone)
    - .1 System Shutdown:
      - .1 The supply fan is stopped.
      - .2 Heating coil's control valve is closed.
      - .3 Cooling coil's control valve is closed.
      - .4 The fresh air variable volume box is closed.
    - .2 System Start-Up:
      - .1 The CNP starts the supply fan at low speed according to either an occupancy schedule or to limit the room temperature to a maximum value outside of regular operation times. The system can also start by special request.
      - .2 The CNP opens the fresh air variable volume box to its minimum position according to the occupancy schedule.
    - .3 Normal Operation:
      - .1 The supply fan speed is modulated by the CNP to maintain duct static pressure at setpoint 2/3 downstream of supply fan.
      - .2 The heating coil's control valve is modulated in sequence with the cooling coil's control valve by the CNP to maintain the supply temperature at setpoint. This setpoint is readjusted from  $12 \text{ }^\circ\text{C}$  to  $30 \text{ }^\circ\text{C}$  according to outdoor temperature.
      - .3 The CNA modulates the terminal unit air flow to maintain façade temperature at setpoint. The façade temperature is the average of the temperature sensors in the façade zone.
      - .4 The fresh air variable volume box is modulated by the CNP to maintain the carbon dioxide ( $\text{CO}_2$ ) level in the return duct at setpoint.
    - .4 Local Protection:
      - .1 A fire alarm contact stops the system.
    - .5 Alarm:
      - .1 Fan operating status is sent to the CNP.
      - .2 Variable frequency drive fault is sent to the CNP.
      - .3 Status of filter is sent to the CNP.
      - .4 Alarms are generated when the following variables exceed their limits:
        - .1 supply temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ ;

- .2 carbon dioxide level: > 1200 ppm;
- .3 supply static pressure:  $SP \pm 60$  Pa.
- .12 System 301: West Kitchen  
System 302: East Kitchen
  - .1 System Shutdown:
    - .1 Transfer and exhaust fans are stopped.
    - .2 The transfer and exhaust damper is closed.
  - .2 System Start-Up:
    - .1 The CNP starts the east kitchen office's (100-13) exhaust fan according to the occupancy schedule of the east kitchen. The system can also start by special request. The exhaust damper opens by electrical interlock with the exhaust fan.
    - .2 The CNP starts the transfer fan at low speed and commands the kitchen hood exhaust fan according to an occupancy schedule or from a request of the hood control panel. The system can also start by special request.
    - .3 The CNP also commands hood control panel according to the same occupancy schedule.
    - .4 Upon full-open confirmation of the exhaust damper, the exhaust fan starts at low speed by electrical interlock with the limit switch of the damper's actuator.
  - .3 Normal Operation:
    - .1 The transfer fan speed is modulated by the CNP to maintain the kitchen to a slightly negative pressure and doing so compensate for the air evacuated by the kitchen hoods.
    - .2 Upon a sudden lost of kitchen pressurisation, opening of the door, the transfer fan speed remains constant at the last controlled value. The control starts when the door is shut (pressurisation is re-establish inside the kitchen).
    - .3 The hood control panel commands the exhaust fan at its maximum speed.
  - .4 Local Protection:
    - .1 Upon a safety switch opening, its auxiliary contact stops the fan.
  - .5 Alarm:
    - .1 Fan operating status is sent to the CNP.
    - .2 Variable frequency drive fault is sent to the CNP.
    - .3 Hood control panel fault is sent to the CNP.
    - .4 Status of filter is sent to the CNP.
- .13 System 401: Loading Dock
  - .1 System Shutdown:
    - .1 Gas heating unit is stopped.
    - .2 Exhaust fan is stopped.

- .3 Outdoor air and exhaust dampers are closed.
- .4 On a call for heating the unit heaters are controlled by the CNP to maintain room temperature at setpoint.
- .2 System Start-Up:
  - .1 The exhaust fan is started by the CNP to maintain the CO (<25 ppm) and NO<sub>2</sub> (< 0.7 ppm) levels at setpoint.
  - .2 The exhaust damper opens by electrical interlock with the exhaust fan.
  - .3 Upon confirmation of the operating status of the exhaust fan, the CNP starts the gas heating unit.
  - .4 The outdoor air damper opens by electrical interlock with the gas heating unit.
  - .5 On a call for heating the unit heaters are controlled by the CNP to maintain room temperature at setpoint.
- .3 Normal Operation:
  - .1 The supply temperature setpoint is readjusted from a high of 30 °C to a low of 13 °C by the CNP to maintain the room temperature at setpoint.
  - .2 The gas heating unit is modulated by the CNP to maintain supply temperature at calculated setpoint.
- .4 Local Protection:
  - .1 A fire alarm contact stops the system.
- .5 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Gas heating unit fault is sent to the CNP.
  - .3 Status of filter is sent to the CNP.
  - .4 Alarms are generated when the following variables exceed their limits:
    - .1 room temperature: < 18 °C;
    - .2 CO level: > 200 ppm;
    - .3 NO<sub>2</sub> level: > 2 ppm
- .14 System 402: Chiller Room Ventilation
  - .1 System Shutdown:
    - .1 Supply (VA1-402-B00) and return (VR1-402-B00) fans are stopped.
    - .2 Outdoor air and exhaust dampers are closed.
    - .3 Recirculation dampers are open.
  - .2 System Start-Up:
    - .1 The system runs continuously in regular conditions. The supply and return fans are started by the CNP.

- .2 Mixing dampers remain in complete recirculation for five (5) minutes following system start-up.
- .3 Normal Operation:
  - .1 Outside air, exhaust and recirculation dampers are modulated by the CNP to maintain room temperature at setpoint. The CNP limits the supply temperature to a minimum of 12 °C.
- .4 Local Protection:
  - .1 When a first level refrigeration detection alarm is generated, a start command is sent by electrical interlock to start the supply and return fans, to fully open the outside air and exhaust dampers and to close the recirculation dampers.
- .5 Alarm:
  - .1 Fans operating status is sent to the CNP.
  - .2 Refrigerant detection panel fault, first and second level alarms are transmitted to the CNP.
  - .3 Alarms are generated when the following variables exceed their limits:
    - .1 room temperature: < 18 °C;
    - .2 supply temperature: < 10 °C.
- .15 System 403: Generator Room
  - .1 System Shutdown:
    - .1 The outdoor air, combustion air and exhaust dampers are closed.
    - .2 The recirculation damper is open.
  - .2 System Start-Up:
    - .1 The combustion air damper opens by electrical interlock with the start of the generator.
  - .3 Normal Operation:
    - .1 The outdoor air, exhaust and recirculation dampers are modulated by the CNP to maintain the room temperature at setpoint.
  - .4 Local Protection:
    - .1 Not applicable.
  - .5 Alarm:
    - .1 Alarms are generated when the following variable exceeds its limits:
      - .1 room temperature: < 18 °C.
- .16 System 5xx: Electrical Room
  - .1 System Shutdown:
    - .1 The fan coil is stopped.
    - .2 The cooling coil's control valve is closed.

- .2 System Start-Up:
  - .1 The CNP starts the fan coil on a call for cooling. The system can also start by special request.
- .3 Normal Operation:
  - .1 The cooling coil's control valve is modulated by the CNP to maintain room temperature at setpoint. When the control valve is less than 5% open for a 10-minute period the fan coil is stopped.
- .4 Local Protection:
  - .1 A fire alarm contact stops the system.
- .5 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Status of filter is sent to the CNP.
  - .3 Leak detection switch (IN) status in the draining pan is sent to the CNP.
  - .4 Alarms are generated when the following variable exceeds its limits:
    - .1 room temperature: > 30 °C.
- .17 System 601: West Square Tower
  - .1 System Shutdown:
    - .1 Fan coil is stopped.
    - .2 Exhaust fan is stopped.
    - .3 Outdoor air and evacuation dampers are closed.
    - .4 Cooling coil's control valve is closed.
    - .5 When the outdoor temperature is above 5 °C (41 °F), the heating coil's control valve is closed. Below 5 °C outside, the heating coil's control valve is modulated by the CNP to maintain the setpoint at 13 °C (55 °F) between the filter and the heating coil inside the ventilation unit.
  - .2 System Start-Up:
    - .1 Outdoor air and evacuation dampers are opened by the CNP according to an occupancy schedule. The system can also start by special request.
    - .2 Exhaust fan is started and supply fan is started at low speed by the CNP.
    - .3 To maintain a maximum temperature outside of regular operating hours, the supply fan is started at low speed by the CNP. Outdoor air and evacuation dampers remain closed.
  - .3 Normal Operation:
    - .1 The supply fan speed is modulated by the CNP to maintain duct static pressure at setpoint 2/3 downstream of supply fan.

- .2 The heating coil's control valve is modulated by the CNP in sequence with the cooling coil's control valve to maintain supply temperature at setpoint (13 °C).
- .3 The air flow through the terminal variable volume box is modulated by the CNA in sequence with the baseboard's control valve to maintain the room temperature at setpoint. The terminal unit is authorized to open for a minimum period of 30 minutes (adjustable) if permitted by the occupancy schedule and if a person is detected inside the room (by the presence detector, if applicable).
- .4 Local Protection:
  - .1 A fire alarm contact stops the system.
  - .2 The supply fan is stopped when the freezestat switch (IG) upstream of the cooling coil is triggered. The freezestat is set to 5 °C (41 °F).
- .5 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.
  - .3 Status of filter is sent to the CNP.
  - .4 Freezestat switch (IG) status is sent to the CNP.
  - .5 Alarms are generated when the following variables exceed their limits:
    - .1 supply temperature:  $SP \pm 2 \text{ °C}$ ;
    - .2 supply static pressure:  $SP \pm 60 \text{ Pa}$ .
- .18 System 602: West Square Tower
  - .1 System Shutdown:
    - .1 Fan coil is stopped.
    - .2 Exhaust fan is stopped.
    - .3 Outdoor air and evacuation dampers are closed.
    - .4 Cooling coil's control valve is closed.
    - .5 When the outdoor temperature is above 5 °C (41 °F), the heating coil's control valve is closed. Below 5 °C outside, the heating coil's control valve is modulated by the CNP to maintain the setpoint at 13 °C (55 °F) between the filter and the heating coil inside the ventilation unit.
  - .2 System Start-Up:
    - .1 Outdoor air and evacuation dampers are opened by the CNP according to an occupancy schedule. The system can also start by special request.
    - .2 Exhaust fan is started and supply fan is started at low speed by the CNP.

- .3 To maintain a maximum temperature outside of regular operating hours, the supply fan is started at low speed by the CNP. Outdoor air and evacuation dampers remain closed.
- .3 Normal Operation:
  - .1 The supply fan speed is modulated by the CNP to maintain duct static pressure at setpoint 2/3 downstream of supply fan.
  - .2 The heating coil's control valve is modulated by the CNP in sequence with the cooling coil's control valve to maintain supply temperature at setpoint (13 °C).
  - .3 The air flow through the terminal variable volume box is modulated by the CNA in sequence with the baseboard's control valve to maintain the room temperature at setpoint. The terminal unit is authorized to open for a minimum period of 30 minutes (adjustable) if permitted by the occupancy schedule and if a person is detected inside the room (by the presence detector, if applicable).
- .4 Local Protection:
  - .1 A fire alarm contact stops the system.
  - .2 The supply fan is stopped when the freezestat switch (IG) upstream of the cooling coil is triggered. The freezestat is set to 5 °C (41 °F).
- .5 Alarm:
  - .1 Fan operating status is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.
  - .3 Status of filter is sent to the CNP.
  - .4 Freezestat switch (IG) status is sent to the CNP.
  - .5 Alarms are generated when the following variables exceed their limits:
    - .1 supply temperature:  $SP \pm 2 \text{ °C}$ ;
    - .2 supply static pressure:  $SP \pm 60 \text{ Pa}$ .
- .19 System 7xx: Sanitary Exhaust
  - .1 System Shutdown:
    - .1 The fan is stopped.
  - .2 System Start-Up:
    - .1 The CNP starts the fan according to the occupancy schedule of the associated supply system:
      - .1 VE1-700-A04 with system 107;
      - .2 VE1-701-A02 with system 110;
      - .3 VE1-702-A02 with systems 105 and 106.
  - .3 Normal Operation:
    - .1 Not applicable.

- .4 Local Protection:
  - .1 Not applicable.
- .5 Alarm:
  - .1 Fan operating status is sent to the CNP.
- .20 Mechanical Room
  - .1 System Shutdown:
    - .1 The unit heater is stopped.
  - .2 System Start-Up:
    - .1 Not applicable.
  - .3 Normal Operation:
    - .1 The unit heater is controlled by the CNP to maintain mechanical room temperature at setpoint.
  - .4 Local Protection:
    - .1 Not applicable.
  - .5 Alarm:
    - .1 Alarms are generated when the following variable exceeds its limits:
      - .1 room temperature: < 18 °C.
- .21 Type A and F Baseboards
  - .1 Temperature Control:
    - .1 The hot water baseboard's control valve is modulated by the CNP to maintain the room temperature at setpoint. Setpoint is according to operation mode (occupied, unoccupied, summer and winter).
  - .2 Alarm:
    - .1 Alarms are generated when the following variables exceed their limits:
      - .1 room temperature:  $SP \pm 2$  °C.
- .22 Type B, C and E Baseboards
  - .1 Temperature Control:
    - .1 The hot water baseboard's control valve is modulated in sequence with the baseboard's fan by the CNP to maintain room temperature at setpoint. Setpoint is according to operation mode (occupied, unoccupied, summer and winter).
    - .2 For a variable speed fan baseboard, the sequence is as follows on a room temperature decrease:
      - .1 Gradual opening of the hot water baseboard's control valve;
      - .2 When the control valve is 100% open, the fan starts (5 Vdc start signal to fan) and speed is gradually increased (3-10 Vdc signal to modulate).

- .3 For a two (2) speed fan baseboard, the sequence is as follows on a room temperature decrease:
  - .1 Gradual opening of the hot water baseboard's control valve;
  - .2 When the control valve is 50% open the fan starts at medium speed (on a room temperature rise, the fan stops when the valve is 10% open);
  - .3 When the control valve is 100% open, the fan is set to high speed (on a room temperature rise, the fan is set to medium speed when the valve is 60% open).
- .4 During events in the multipurpose room, a manual command from the operator will stop the baseboards' fan.
- .2 Alarm:
  - .1 Alarms are generated when the following variable exceeds its limits:
    - .1 room temperature:  $SP \pm 2 \text{ }^\circ\text{C}$ .
- .23 Heat pump Network
  - .1 Method of Operation:
    - .1 The building operates in two (2) different modes: heating and cooling.
    - .2 When switchover occurs from one mode to the other, the entire heat pump network is stopped, the pumps are stopped and the heat exchanger valves are closed.
    - .3 When in heating mode, the supply temperature setpoint on the condenser side of the heat pumps is adjusted to  $48.9 \text{ }^\circ\text{C}$  ( $120 \text{ }^\circ\text{F}$ ), the geothermal field's isolation valve opens and flow to the geothermal wells is permitted by the 3-way valve on the glycol loop.
    - .4 When in cooling mode, the supply temperature setpoint on the evaporator side of the heat pumps is adjusted to  $3.9 \text{ }^\circ\text{C}$  ( $39 \text{ }^\circ\text{F}$ ), the geothermal field's isolation valve is closed and the 3-way valve on the glycol loop is positioned to permit flow from heat exchanger EC1-GEO-B00 to the geothermal wells.
    - .5 Heat pump start priority is changed every week such that runtime is relatively equivalent for each heat pump. Priority is defined as follows:
      - .1 week one TP1-GEO-B00 is lead and TP2-GEO-B00, TP3-GEO-B00 and TP4-GEO-B00 start in sequence according to demand;
      - .2 week two TP2-GEO-B00 is lead TP3-GEO-B00, TP4-GEO-B00 and TP5-GEO-B00 start in sequence according to demand;

- .3 week three TP3-GEO-B00 is lead TP4-GEO-B00, TP5-GEO-B00 and TP1-GEO-B00 start in sequence according to demand;
- .4 and so on.
- .6 Supply pumps start by electrical interlock with the start of a new heat pump.
- .2 System Shutdown:
  - .1 The heat pumps (TP1-ERP-B00 to TP5-ERP-B00) are stopped.
  - .2 The heat pump supply pumps (PO1-TP1-B00 to PO2-TP5-B00) are stopped.
  - .3 The chillers (RF1-GLF-B00 and RF2-GLF-B00) are stopped.
  - .4 The chiller supply pumps (PO1-RF1-B00 and PO1-RF2-B00) are stopped.
  - .5 The cooling towers (TR1-ETR-C03 and TR2-ETR-C03) are stopped.
  - .6 The cooling tower supply pumps (PO1-TR1-B00 and PO1-TR2-B00) are stopped.
  - .7 The isolation valves on chiller RF1-GLF-B00 are closed to heat exchanger EC1-CBT-B00 and open to its cooling tower.
  - .8 The isolation valves on chiller RF2-GLF-B00 are closed to heat exchanger EC1-CBT-B00 and open to its cooling tower.
  - .9 The valve on the hot water return is open and bypasses heat exchanger EC1-CBT-B00.
  - .10 The condensing boilers (CH1-CBT-A00 and CH2-CBT-A00) are stopped.
  - .11 The supply pumps (PO1-CH1-A00 and PO1-CH2-A00) for the condensing boilers are stopped.
  - .12 The geothermal field's isolation valve is closed.
  - .13 The geothermal field's pumps (PO1-GEO-B00 and PO2-GEO-B00) are stopped.
  - .14 The geothermal exchanger's (EC1-GEO-B00) valve is closed.
  - .15 The pumps on the heating network (PO1-CBT-B00 and PO2-CBT-B00) are stopped.
  - .16 The bypass valve on the heating network pumps is open.
  - .17 The primary cooling network pumps (PO1-GLF-B00 and PO2-GLF-B00) are stopped.
  - .18 The bypass valve on the primary cooling network pumps is open.
  - .19 The valve between the cold glycol supply header and the return is closed.
  - .20 The secondary cooling network pumps (PO1-ERS-B00 and PO2-ERS-B00) are stopped.
  - .21 The cooling exchanger's (EC1-ERS-B00) valve is closed.

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- .22 The sand filters are stopped.
  - .3 System Start-Up:
    - .1 The heat pump network runs continuously.
    - .2 The lead heat pump is authorized to start and the corresponding pumps (evaporator and condenser) start by electrical interlock.
    - .3 One of the heating network pumps (PO1-CBT-B00 or PO2-CBT-B00) starts at low speed.
    - .4 One of the primary cooling network pumps (PO1-GLF-B00 or PO2-GLF-B00) starts at low speed
    - .5 One of the secondary cooling network pumps (PO1-ERS-B00 or PO2-ERS-B00) starts at low speed.
  - .4 Normal Operation of Heating Mode:
    - .1 The geothermal field's isolation valve opens and cold glycol flow to the geothermal wells is permitted by the 3-way valve on the glycol loop.
    - .2 The activation of the stages and the sequential start of the four (4) heat pumps and the start of the two (2) condensing boilers are command by the CNP to maintain hot water network supply temperature at a setpoint of 48.9 °C (120 °F).
    - .3 The bypass valve on the heating network pumps is modulated by the CNP in sequence with the speed of the heating network pump to maintain the heating distribution network's differential pressure at setpoint (determined during balancing).
    - .4 The valve on heat exchanger EC1-GEO-B00 (used as the heating network's bypass valve) is modulated by the CNP in sequence with the start of the first condensing boiler (the one with the least running time) and the modulation of the speed of its pump to maintain the differential pressure between the supply and the return headers at a slightly positive setpoint (determined during balancing). A negative differential pressure implies that the production of hot water by the heat pumps is insufficient to supply demand and that the condensing boilers must be started in sequence.
    - .5 When pump speed is over 60% for 15 minutes (the boiler is running at over 60% of its capacity), the second boiler is started and the speed of its pump is modulated by the CNP. The speed of both pumps is simultaneously modulated. When the speed of the pumps is below 25% for 15 minutes, the boiler with the most running time is stopped by the CNP. After an adjustable delay following a boiler shutdown, its supply pump is stopped.

- .6 The bypass valve on the primary cooling network pumps is modulated by the CNP in sequence with the primary cooling network pump speed to maintain the differential pressure between the network's supply header and the return at a slightly positive setpoint (determined during balancing).
  - .7 The geothermal pump is started (the one with the least running time) and its speed is modulated by the CNP to maintain the primary cooling network's differential pressure at setpoint (determined during balancing).
  - .8 The secondary cooling network's supply temperature setpoint is readjusted by the CNP in sequence with the modulation of the network's pump to maintain the network's differential pressure at setpoint (determined during balancing). The secondary cooling network's supply temperature setpoint is readjusted from 5.6 °C to 8.9 °C (42 °F to 48 °F).
  - .9 Heat exchanger's (EC1-ERS-B00) valve is modulated by the CNP to maintain the secondary cooling network's supply temperature at calculated setpoint.
  - .10 When the geothermal pump is stopped for more than 30 minutes and that no condensing boiler is running (cooling demand is too significant for heating mode), the heat pump network switches to cooling mode.
- .5 Normal Operation of Heating Mode With Strong Call for Cooling During Shows in The Multipurpose Room:
- .1 When the geothermal pump is stopped for more than 30 minutes and that a condensing boiler is running (cooling demand is too significant for heating mode), a chiller is required to satisfy the cooling demand (the one for the winter season).
  - .2 The geothermal field's isolation valve is closed and the 3-way valve is positioned to allow flow from heat exchanger EC1-GEO-B00 to the geothermal wells.
  - .3 The chiller's isolation valves open to heat exchanger EC1-CBT-B00 and close to its cooling tower.
  - .4 The valve on the hot water return closes thus forcing the return water through heat exchanger EC1-CBT-B00 and transferring the heat produced by the chiller to the low temperature hot water network.
  - .5 When the cold glycol return temperature reaches 12 °C (53.6 °F) the chiller is started and its cold glycol and cooling tower pumps are started by the CNP.
  - .6 The bypass valve on the primary cooling network pumps is modulated by the CNP in sequence with the cooling network pump speed to maintain the network's differential pressure at setpoint (determined during balancing).

- .7 The valve between the cold glycol supply header and the return is modulated by the CNP to maintain the differential pressure between the primary cooling network's supply and return headers at a slightly positive setpoint (determined during balancing).
- .8 The two (2) condensing boilers are modulated by the CNP in sequence with heat exchanger EC1-GEO-B00's valve to maintain the heating network's supply temperature at a setpoint of 48.9 °C (120 °F).
- .9 On a supply temperature rise, the sequence is as follows:
  - .1 The pump speeds of both condensing boilers are simultaneously and gradually diminished.
  - .2 When speed of both pumps is less than 25% for 15 minutes, the boiler with the most running time is stopped by the CNP. Following the boiler shutdown and an adjustable delay, its supply pump is stopped.
  - .3 The remaining pump's speed is gradually diminished. When its speed is less than 25% for 15 minutes, the CNP stops the boiler. Following the boiler shutdown and an adjustable delay, its supply pump is stopped.
  - .4 Gradual opening of heat exchanger EC1-GEO-B00's valve.
  - .5 When heat exchanger EC1-GEO-B00's valve is more than 10% open, the geothermal pump (the one with the least running time) starts and its speed is gradually increased in parallel with the opening of the valve.
- .10 When heat exchanger EC1-GEO-B00's valve is completely open (the geothermal pump is at full speed) and that the low temperature heating network's supply temperature is still too high, the speed of the heat recovery wheels from systems 100 and 200 is gradually reduced to favor the use of the low temperature heating network over energy recovery.
- .11 When the thermal wheels from systems 100 and 200 are completely stopped and that the low temperature heating network's supply temperature is still too high, the cooling tower associated with the chiller is used to evacuate the energy surplus.
- .12 On a supply temperature rise, the sequence is as follows:
  - .1 The outdoor air damper is opened and the cooling tower's fan is started at low speed;
  - .2 Complete opening of the 3-way bypass valve to the tower's sprinklers (no modulation);

- .3 When the 3-way valve is 100% open to the sprinklers, the fan's speed is gradually increased in parallel with the modulation of heat exchanger EC1-CBT-B00's 3-way valve toward the cooling tower.
- .13 The cooling tower's fan speed is limited by the CNP to always maintain the temperature at the condenser's inlet above 43.3 °C (110 °F).
- .14 At the end of a show when cooling demand is reduced the inverse sequence is followed and the heating mode is activated.
- .6 Normal Operation of Cooling Mode:
  - .1 The geothermal field's isolation valve is close and the 3-way valve is positioned to allow flow from heat exchanger EC1-GEO-B00 to the geothermal wells.
  - .2 The activation of the stages and the sequential start of the four (4) heat pumps are command by the CNP to maintain the primary cooling network's supply temperature at a setpoint of 3.9 °C (39 °F).
  - .3 Upon the start of all four (4) heat pumps and if the temperature setpoint is not maintained, a first chiller is started (the one with the least running time) and its cold glycol pumps and cooling tower are started by the CNP. When the chiller is running at 90% of its capacity for over 15 minutes, the second chiller is started and its cold glycol pumps and cooling tower are started by the CNP. When both chillers are running bellow 40% of their capacity for over 15 minutes, the chiller with the most running time is stopped by the CNP. Following the chiller shutdown, its pumps are stopped.
  - .4 Upon a confirmation that the cooling tower's pump is running, the CNP authorises the sand filter to function.
  - .5 The chemical treatment system is authorised to operate by electrical interlock with the cooling tower pump.
  - .6 At chiller and pump start-up the cooling tower's outdoor air damper opens, the fan starts at low speed and the 3-way valve is modulated by the CNP in sequence with the fan speed to maintain the condenser's water inlet temperature at a calculated setpoint. This setpoint is readjusted from 29.4 °C (85 °F) to 18.3 °C (65 °F) when the outdoor dew point temperature varies from 23.9 °C (75 °F) to 7.2 °C (45 °F).
  - .7 On a temperature rise at the condenser's water inlet, the sequence is as follows:
    - .1 The outdoor air damper is opened and the cooling tower's fan is started at low speed;
    - .2 Gradual opening of the 3-way bypass valve to the tower's sprinklers;

- .3 When the 3-way valve is 100% open to the sprinklers the fan speed is gradually increased.
- .8 The make-up water valve (supplied and installed by plumbing contractor) opens by electrical interlock upon low water detection inside the cooling tower (low level switch supplied with tower).
- .9 The bypass valve on the primary cooling network pumps is modulated by the CNP in sequence with the cooling network pump speed to maintain the network's differential pressure at setpoint (determined during balancing).
- .10 The valve between the cold glycol supply header and the return is modulated by the CNP to maintain the differential pressure between the supply and the return headers on the primary cooling network at a slightly positive setpoint (determined during balancing).
- .11 The secondary cooling network's supply temperature setpoint is readjusted by the CNP in sequence with the secondary network's pump speed to maintain the network's differential pressure at setpoint (determined during balancing). The secondary cooling network's supply temperature setpoint is readjusted from 5.6 °C to 8.9 °C (42 °F to 48 °F).
- .12 Heat exchanger EC1-ERS-B00's valve is modulated by the CNP to maintain the secondary cooling network's temperature at calculated setpoint.
- .13 The heating network pumps' bypass valve is modulated by the CNP in sequence with the speed of the pumps to maintain the differential pressure between the supply and the return headers on the heating network at a slightly positive setpoint (determined during balancing).
- .14 Heat exchanger EC1-GEO-B00's valve is modulated by the CNP to maintain the differential pressure of the heating network at setpoint (determined during balancing).
- .15 When heat exchanger EC1-GEO-B00's valve is 10% open, the geothermal pump (the one with the least running time) is started and its speed is modulated by the CNP to maintain the heating network's return temperature at a setpoint of 31.1 °C (88 °F).
- .16 When heat exchanger EC1-GEO-B00's valve is closed for more than 30 minutes and that no chiller is running (heating demand is too significant for cooling mode) the heat pump network switches to heating mode.
- .7 Local Protection:
  - .1 The chiller stops on a low flow indication from the differential pressure switches.

- .2 The cooling tower stops if excessive vibration is detected by the vibration switch (provided with the tower but electrical interlock by the current Section).
- .8 Alarm:
  - .1 Pump current intensity is sent to the CNP.
  - .2 Variable frequency drives fault is sent to the CNP.
  - .3 Glycol tank low level indication is sent to the CNP.
  - .4 Alarms are generated when the following variables exceed their limits:
    - .1 network differential pressure:  $SP \pm 10$  kPa;
    - .2 network supply temperature:  $SP \pm 2$  °C.
- .24 Dual-Mode Coils' Network
  - .1 System Shutdown:
    - .1 Glycol network pumps (PO1-GLY-B00 and PO2-GLY-B00) are stopped.
    - .2 The 3-way selection valve is open to the heating exchanger.
    - .3 The heating exchanger valve is closed.
    - .4 The cooling exchanger valve is closed.
  - .2 System Start-Up:
    - .1 In heating mode, one glycol network pump (PO1-GLY-B00 or PO2-GLY-B00) runs continuously.
    - .2 In cooling mode, one glycol network pump runs when system 100 or 200 is running.
    - .3 The glycol network pump is started at low speed by the CNP. Pump operation is alternated weekly.
  - .3 Normal Operation:
    - .1 Glycol network supply temperature setpoint is adjusted in sequence with the modulation of the network's pump speed by the CNP to maintain static pressure setpoint in the network. The network's supply temperature setpoint is readjusted from 30 °C to 15 °C in heating mode and 8 °C to 12 °C in cooling mode.
    - .2 The system must operate for a minimum of 4 hours before switching from one mode to the other.
  - .4 Heating Mode: Outdoor Temperature Below 6 °C
    - .1 Glycolated water is directed to heating exchanger (EC2-GLY-B00) by the 3-way selection valve.
    - .2 The heating exchanger's valve is modulated by the CNP to maintain the glycol network's supply temperature at setpoint. This setpoint is reduced by the pressure loop sequence on the glycol network.

- .5 Cooling mode: Outdoor Temperature Above 14 °C
  - .1 Glycolated water is directed to cooling exchanger (EC1-GLY-B00) by the 3-way selection valve.
  - .2 The cooling exchanger's valve is modulated by the CNP to maintain the glycol network's supply temperature at setpoint. This setpoint is augmented by the pressure loop sequence on the glycol network.
- .6 Local Protection:
  - .1 Not applicable.
- .7 Alarm:
  - .1 Pump current intensity is sent to the CNP.
  - .2 Variable frequency drive fault is sent to the CNP.
  - .3 Glycol tank low level indication is sent to the CNP.
  - .4 Alarms are generated when the following variables exceed their limits:
    - .1 network differential pressure:  $SP \pm 10$  kPa;
    - .2 network supply temperature:  $SP \pm 2$  °C.
- .25 Refrigeration System's Water Network
  - .1 System Shutdown:
    - .1 Water network's pump (PO1-ERC-B00) is stopped.
    - .2 The cooling exchanger valve is closed.
  - .2 System Start-Up:
    - .1 The pump runs continuously.
  - .3 Normal Operation:
    - .1 The exchanger valve is modulated by the CNP to maintain the water network's supply temperature at a setpoint of 21 °C (70 °F).
  - .4 Local Protection:
    - .1 Not applicable.
  - .5 Alarm:
    - .1 Pump current intensity is sent to the CNP.
    - .2 Alarms are generated when the following variable exceeds its limits:
      - .1 network supply temperature:  $SP \pm 2$  °C.

**Partie 2      Product**

**2.1            NOT APPLICABLE**

- .1 Not applicable.

**Partie 3      Execution**

**3.1            NOT APPLICABLE**

.1      Not applicable.

**END OF SECTION**