SECTION 23 0993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. NOTE: The basis of design supervisory controller for this project is a Johnson Controls FX80 to be located in a NEMA 1 enclosure with a 120/24V transformer and duplex maintenance receptacle. This panel shall be located in the first floor Office 115. Coordinate with owner for exact location.

1.02 SPECIFIC CONTROLS/MECHANICAL CONTRACT REQUIREMENTS

- A. Johnson Controls System: The building is designed as a basis Johnson Controls System with a series of self-contained controllers with integrated export files. Protocol for all systems shall be BACnet MS/TP. The following "3rd Party" systems shall be integrated into the FX-80 MS/TP trunk through the following equipment requirements by basis manufacturer:
 - 1. Mitsubishi: Provide and install a PAC-YG50ECA expansion controller, M-Net communication cabling, a LAN line to a BAC-HD150 BacNet/M-Net Adapter. Then CAT 6 cabling from the BAC-HD150 to the System FX-80 Ethernet 10/100Mbps port.
 - 2. Johnson Controls (ABCS): Provide and install a FX-80 as noted above. Provide a building wide shielded twisted pair RS-485 interface MS/TP communication truck to all required field controllers and 3rd party devices. This to include all controllers to integrate all new exhaust fans as noted.
 - 3. Daikin Equipment (Rooftop Units): Provide and install a MicroTech III Controller on each rooftop unit that will be programmed to enable/disable all unit operational points. An export file will be provided for point discovery into the FX-80 MS/TP trunk.
 - 4. Trane (Rooftop Units): Provide and install a UC600 Unitary controller in the "Horizon" (RTU-1A) and ReliaTel controller for the "Voyager". Both to be set for RS-485 MS/TP Communications. This to include a preset export file for points as required.
 - 5. Greenheck (Make-Up Air Unit): Provide and install a CAREL microprocessor controller with each unit for MS/TP integration with the FX-80 MS/TP communications Trunk.
- B. Complete new building communication cabling in and from Contract areas cabling shall be stranded, shielded and Plenum Rated. Operating Protocol shall be BACnet. Communication for all noted HVAC equipment shall be through a new communication line throughout the school as noted on the contract drawings. Building Supervisory Controller shall be an FX-80 as noted on

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Contract Drawings. FX-80 shall be provided with Dual Drivers (BACNET) and dual trunk connections (including an Ethernet RJ45-8P8C connection type). The FX-80 shall be the central system controller and shall be mounted in Office 115.

- C. The FX-80 shall integrate an MS/TP Bus around the building to pick up and integrate all third party equipment as required.
- D. FX-80 shall be provided with full scheduling, monitoring and trending capabilities (trending of up to 24 points for a 12-month period of time).
- E. Contract requirements must provide for 16 hours of system training for FX-80 operations.
- F. Contract requirements require all the points listed below under "Display" be sourced and mapped through the server and graphically represented.
- G. Provide and install new Temperature Sensors and Current Transducers as noted in sequence requirements below to conform to the operational sequencing.
- H. Provide all exhaust fans with unit mounted current transducers for operational proof. ALL fan motors listed in the following sequence shall be newly provided and installed Current Sensor or Transducer to operational proves. This will be transmitted (mapped and sourced) graphically to system unit specific front end.
- I. Contract requirements include the complete graphical representation of the building. This to include the identification of all exhaust fans as listed in the sequences below and all other HVAC equipment as noted in the sequence of operations below. This to include a FULL graphical map of the school with individual room units clearly labeled in sub screens with all applicable points as listed below.
- J. All equipment defined below will be part of an integrated occupancy schedule that will allow the end user to modify individual or groups of units to an occupied and unoccupied schedule. FX-80 shall also control all setpoints (with individual thermostat occupancy override (1 hour-adjustable) and a 2 degree +/- adjustment at the thermostat. The FX-80 server shall have full override capability on all setpoints and occupancy periods.
- K. All units shall be labeled individually on the graphical interface and all indexed references.
- L. It is a contract requirement to provide, install and program all required equipment to make the following operational requirements function in an effective, operational and contract compliant manner.
- M. New Network Engine (FX-80) shall be web enabled for Ethernet integration. Coordinate with owner on coordination requirements (addressable IP, integration requirements (JAVA) etc.). Owner shall bring connection to JACE 10/100 Mb Ethernet port. Mechanical Contractor to assign/program IP and integrate server to Client Ethernet.

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- N. The Johnson Controls System shall consist of a series of sensors, field controllers, MS/TP Communications trunk and an FX-80 controller mounted as noted on the contract drawings. This to include Ethernet RJ45 connection between BAC-150HD and FX-80.
- O. All noted controllers are a contract requirement. It is the responsibility of the Mechanical Contractor to provide 120/24V control transformers and all required communication and low voltage power wiring to all required equipment. Each "exposed" controller shall be provided with a transformer and NEMA 1 enclosure "Clamshell" and shall be mounted above the ceiling or in storage and janitorial areas near the serviced equipment.
- P. The system protocol shall be BacNet.
- Q. FX-80 shall reflect a complete building layout and placement of controlled units on an operational interface screen for the owner.
- R. Provide and install a Touch Pad interface (EasyIO System View 10" tablet with mounting bracket SH-Systemview 10) and mount on the FX-80 NEMA enclosure. This system shall be provided with a full graphics package. This shall be for owner interface.
- S. Provide CHASE Security Systems PTG 653 Thermostat Guard for all zone thermostats/sensors in General Public Access Areas.
- T. Provide and install and exterior ambient Temperature/Humidity and integrate into FX-80 both graphically and operationally.
- U. NOTE on Contract Control Drawings for any Smoke Dampers, Smoke/Fire Dampers and Fire Dampers. The provision and installation of all three are a requirement of the Mechanical Contractor as noted below:
 - 1. Smoke and Smoke/Fire Dampers: All Dampers shall be Johnson Controls FS-1630 Series dampers with UL/FM approved listed 24 Volt 2 position 350-degree F actuator. It is the responsibility of the controls contractor to provide and install an addressable smoke detector for each smoke damper location as noted on the controls contract drawings. Mechanical Contract requirements shall be as follows:
 - a. Provide and install smoke (or smoke/fire) dampers as required.
 - b. Provide and install a UL Listed smoke detector with-in 5 feet of the dampers as shown.
 - c. Provided detector must be dual pole (contact) such that on contact enables the smoke damper(s) to activate.

- d. Power for the smoke detector shall be through the local PCG or EC provided junction 120-volt junction box.
- e. EC shall be responsible for providing an addressable relay connection to smoke detector for integration and programing.
- f. MC is responsible for the provision, installation and operation of all smoke, smoke fire and fire dampers. This to include all power and communication wiring.
- 2. Upon activation of the damper the unit controller shall notify the FX-80 which will then in turn note an alarm through the FX-80 and disable the servicing unit. Reset shall be through the FX-80/passcode protected.
- 3. Fire Dampers: These dampers shall be spring link activated and shall be Johnson Controls FD-1600 series dampers. ATC requirements shall be such that they shall monitor the position of the damper only through the local controller. Upon activation of the damper the PCG shall notify the FX-80 which will ten in turn note an alarm through the owner interface and disable the servicing unit. Reset shall be through the FX-80/passcode protected.

1.03 ROOFTOP UNITS (RTU#1) NORTH WING GUEST (OUTSIDE AIR)

- A. Basis of Design Daikin DPS012A. Provide and install a MicroTech III Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a communication interface on the unit mounted MicroTech III as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.
- B. RTU-1 shall incorporate low discharge air alarms where if the supply DAT falls below a definable setpoint (initial setting 45) the unit shall disable and an alarm will be sent to the FX-80 for conformation and system reset.
- C. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.

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- D. Sequence of Operations:
 - 1. Occupied/Unoccupied mode. The microprocessor shall index the supply fan on to run continuously at a constant volume while in occupied mode only (There is no unoccupied mode). Occupied temperatures shall be preprogramed directly through the FX-80 to the unit microprocessor. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):
 - a. Time:
 - 1) Occupied: As scheduled
 - 2) Unoccupied: N/A
 - b. System Discharge Temperature (Adjustable through FX-80):
 - 1) Occupied DAT:

Cooling: 72 degrees with ambient above or equal to 69 degrees F. Heating: 68 degrees with ambient below 69 degrees F.

- 2) Unoccupied: N/A.
- 2. Occupied Mode: The unit shall open outside air damper to minimum position (initial OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The DX coil shall enable in the cooling mode and the hydronic valve shall open full to coil (and then modulate to maintain DAT as noted) to meet setpoints as noted above.
- 3. Unoccupied Mode: N/A.
- 4. Warm-up Period: N/A.
- 5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.
- 6. Discharge Temperature Maintenance: Utilize DAT mounted in the discharge duct collar sensor to maintain discharge temperature as noted above. If in either the occupied cooling or the heating mode the DAT is satisfied, the fan shall remain running.

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- 7. Low Temperature Protection (Software). The microprocessor shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj).
- 8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor shall enable when zone temperature rises above set-point and disable when the zone temperature falls to 1 degree below setpoint. Dead band setpoint to be adjustable. Provide reset schedule as follows:
 - a. Input Device: Electronic temperature sensor in discharge air
 - b. Input Logic: Unit Microprocessor/FX-80 Occupied/Unoccupied setpoints.
 - c. Output Device: Microprocessor outputs
- 9. Heating Demand: Upon call for heating utilize a 1 degree setpoint dead band such that the valve shall open to the coil when the zone temperature falls below setpoint. The valve shall modulate to the coil to maintain a 90-degree discharge. Once space temperature has been satisfied, the PCG shall modulate the valve to maintain 75-degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:
 - a. Input Device: Electronic temperature sensor in discharge air.
 - b. Input Logic: Unit Microprocessor/FX-80 Occupied/Unoccupied setpoints.
 - c. Output Device: Microprocessor outputs.
- 10. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from Microp. Power to be provided as indicated above. Operation shall be as follows:
 - a. Occupied Mode: Minimum position (initial 20% until set by balancer).
 - b. Economizer Mode: Maximum position (100% outside air).
 - c. Unoccupied Mode: Closed Position (0% outside air).
- E. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:
 - 1. DDC system graphic.
 - 2. DDC system on-off indication.

- 3. DDC system occupied/unoccupied mode.
- 4. Outdoor-air-temperature indication.
- 5. Supply-fan on-off indication (command).
- 6. Supply fan status.
- 7. Economizer enabled/disabled.
- 8. Return-fan on-off indication (command).
- 9. Return fan status.
- 10. Heating-coil gas-valve position.
- 11. Heating furnace air-temperature setpoint.
- 12. Heating Furnace DAT.
- 13. Cooling-coil air-temperature setpoint.
- 14. Compressor operational status.
- 15. Cooling Coil (DX) DAT.
- 16. Recovery Wheel operational proof.
- 17. Recovery Wheel Command.
- 18. Recovery discharge and intake temperature.
- 19. Smoke Detector Status.
- 20. Unit Alarm (specific to fault).
- F. FX-80 (Writeable) Adjustable Points:
 - 1. Occupied/unoccupied scheduled time periods.
 - 2. Discharge Setpoints (summer/winter).
 - 3. Correlated Ambient setpoints cooling/heating.

- 4. Unit shutdown/enable.
- 5. Recovery wheel start stop
- 6. Alarm reset.

1.04 ROOFTOP UNITS (RTU#1A) SOUTH WING GUEST (OUTSIDE AIR)

- A. Basis of Design Trane Horizon. Provide and install a UC600 Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a communication interface on the unit mounted UC600 as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.
- B. RTU-1A shall incorporate low discharge air alarms where if the supply DAT falls below a definable setpoint (initial setting 45) the unit shall disable and an alarm will be sent to the FX-80 for conformation and system reset.
- C. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.
- D. Sequence of Operations:
 - 1. Occupied/Unoccupied mode. The microprocessor shall index the supply fan on to run continuously at a constant volume while in occupied mode only (There is no unoccupied mode). Occupied temperatures shall be preprogramed directly through the FX-80 to the unit UC600. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):
 - a. Time:
 - 1) Occupied: As scheduled.
 - 2) Unoccupied: Any other time.

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- b. System Discharge Temperature (Adjustable through FX-80):
 - 1) Occupied DAT:

Cooling: 72 degrees with ambient above or equal to 69 degrees F. Heating: 68 degrees with ambient below 69 degrees F.

- 2) Unoccupied: Off.
- 2. Occupied Mode: The unit shall open outside air damper to minimum position (initial OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The DX coil shall enable in the cooling mode and the hydronic valve shall open full to coil (and then modulate to maintain DAT as noted) to meet setpoints as noted above.
- 3. Unoccupied Mode: N/A.
- 4. Warm-up Period: N/A.
- 5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.
- 6. Discharge Temperature Maintenance: Utilize DAT mounted in the discharge duct collar sensor to maintain discharge temperature as noted above. If in either the occupied cooling or the heating mode the DAT is satisfied, the fan shall remain running.
- 7. Low Temperature Protection (Software). The UC600 shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj).
- 8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor shall enable when zone temperature rises above set-point and disable when the zone temperature falls to 1 degree below setpoint. Dead band setpoint to be adjustable. Provide reset schedule as follows:
 - a. Input Device: Electronic temperature sensor in discharge air.
 - b. Input Logic: UC600/FX-80 Occupied/Unoccupied setpoints.
 - c. Output Device: UC600 outputs.

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- 9. Heating Demand: Upon call for heating utilize a 1 degree setpoint dead band such that the valve shall open to the coil when the zone temperature falls below setpoint. The valve shall modulate to the coil to maintain a 90-degree discharge. Once space temperature has been satisfied, the PCG shall modulate the valve to maintain 75-degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:
 - a. Input Device: Electronic temperature sensor in discharge air.
 - b. Input Logic: Unit UC600/FX-80 Occupied/Unoccupied setpoints.
 - c. Output Device: UC600 outputs.
- 10. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from Microp. Power to be provided as indicated above. Operation shall be as follows:
 - a. Occupied Mode: Minimum position (initial 20% until set by balancer).
 - b. Economizer Mode: Maximum position (100% outside air).
 - c. Unoccupied Mode: Closed Position (0% outside air).
- 11. Smoke Condition: If one of the unit smoke detectors goes into alarm, there shall be a contact signal to the UC600, which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80.
- E. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:
 - 1. DDC system graphic.
 - 2. DDC system on-off indication.
 - 3. DDC system occupied/unoccupied mode.
 - 4. Outdoor-air-temperature indication.
 - 5. Supply-fan on-off indication (command).
 - 6. Supply fan status.
 - 7. Economizer enabled/disabled.
 - 8. Return-fan on-off indication (command).

- 9. Return fan status.
- 10. Heating-coil gas-valve position.
- 11. Heating furnace air-temperature setpoint.
- 12. Heating Furnace DAT.
- 13. Cooling-coil air-temperature setpoint.
- 14. Compressor operational status.
- 15. Cooling Coil (DX) DAT.
- 16. Recovery Wheel operational proof.
- 17. Recovery Wheel Command.
- 18. Recovery discharge and intake temperature.
- 19. Smoke Detector Status.
- 20. Unit Alarm (specific to fault).
- F. FX-80 (Writeable) Adjustable Points:
 - 1. Occupied/unoccupied scheduled time periods.
 - 2. Discharge Setpoints (summer/winter).
 - 3. Correlated Ambient setpoints cooling/heating
 - 4. Unit shutdown/enable.
 - 5. Recovery wheel start stop.
 - 6. Alarm reset.

1.05 ROOFTOP UNIT (RTU#2) BALL ROOM A & B (INCLUDING PREFUNCTION)

A. Basis of Design Daiken MPS035F. Provide and install a MicroTech III Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a

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communication interface on the unit mounted MicroTech III as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.

- B. Zone Requirements: This unit shall be provided with the following zone sensors. Each of the noted sensors shall be integrated directly into the MicroTech III SA Bus located in the RTU. The Wall Window Sensors controller as noted in "C" below may be integrated directly into the FX-80, which will then be programmed to send a "disable" signal to RTU-2 once the contact is "open".
 - 1. Daikin combo digital temperature and humidity sensor with tenant override and setpoint adjustment mounted in Ball Room A,
 - 2. Daikin combo digital temperature and humidity sensor with tenant override and setpoint adjustment mounted in Ball Room B.
 - 3. Daikin combo digital temperature and humidity sensor with tenant override and setpoint adjustment mounted in Prefunction/PDR 109.
 - 4. Wall Door sensors as listed in "C" below for each ball room wall window set such that if the wall door is open, the unit will be idle until the door is closed again (contact is closed).
- C. Wall Window Sensor: Provide and install a wired Kadtronix HVAC Smart Relay Switch (HSRS) for Ball Room A and B. Integrated the 24V contact directly to the Carel controller such that when the wall window is opened, the corresponding RTU will become idle (shutdown).
- D. Unit VFD: The installed VFD is for balancing purposes only and there is no automated duct pressure control required. VFD speed will be integrated into the MicroTech III through analog 0-10vdc output for speed adjustment through FX-80. Feedback for VFD speed required as well (analog input) into the MicroTech III controller.
- E. Space (Zone) Sensors Operation: The three zone sensors noted above in three different areas. Each unit shall have a zone occupancy override set for 2 hours (owner adjustable through FX-80 interface). Unit operation for each room shall be "Aggregate Average Demand Override". Such that the RTU shall operate in the heating and cooling mode through an average of the zone temperatures as defined in the sequence below (or as adjusted by the owner through the FX-80 interface). HOWEVER: If in the "heating" mode and one space falls 1 degree below setpoint and "average" temperature of the three zones is satisfied, the microprocessor shall raise the average setpoint one degree to enable the heating function in the unit until the compromising space temperature is with-in setpoint. This function shall occur for a total of a 2 degree increase in setpoint. If the compromising room is still below the low limit setpoint then the FX-80 will indicate an alarm in this area and the system shall remain at the 2 degree increase. The same

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function shall occur in the cooling function with the exception that the enable point will be an increase of temperature at 1 degree above setpoint to a maximum of 2 degrees above setpoint.

- F. Dehumidification Cycle: If the average zone relative humidity ration rises above 60%, the unit shall enable its "dehumidification" cycle by enable the compressor stage commands for a DX DAT of 52 degrees F and then utilize the unit hot gas reheat to modulate the DAT to 70 deg. F in the heating cycle and 65 deg. F in the cooling cycle. If the zone temperature is satisfied and the average humidity rises above 60% (FX-80 adjustable) the unit shall enable the "dehumidification" cycle and set the DAT to the zone setpoint.
- G. Smoke Condition: If one of the unit smoke detectors goes into alarm, there shall be a contact signal to the MT III (MircoTech III), which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.
- H. Sequence of Operations:
 - 1. Occupied/Unoccupied mode. The MircoTech III shall index the supply fan on to run continuously at a constant volume while in occupied mode and on temperature requirements in unoccupied mode. Occupied and unoccupied temperatures shall be preprogramed directly through the FX-80 to the unit MircoTech III. There shall be an occupied override switch on the Zone Sensor that will program a (2) hour override into unit for occupancy. There shall also be an Zone Sensor modulation of +/- 2 degrees around programmed setpoint. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):
 - a. Time:
 - 1) Occupied:
 - a) As scheduled through FX-80 Schedule Program
 - b) Zone Sensor occupied override switch enabled.
 - 2) Unoccupied: Any other time.
 - b. Zone Temperature (Adjustable through FX-80) in "Aggregate Average Demand Override mode as listed above":

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1) Occupied:

Cooling: 72 degrees with ambient above or equal to 69 degrees F. Heating: 68 degrees with ambient below 69 degrees F.

2) Unoccupied:

Cooling: 80 degrees with ambient above or equal to 69 degrees F. Heating: 60 degrees with ambient below 69 degrees F.

- 2. Occupied Mode: The unit shall open outside air damper to minimum position (initial 20% OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The evaporator enable in the cooling mode through compressor staging and Compressor #1 speed control and the gas plenum valve shall open full to plenum runners (and then modulate to maintain DAT as noted) to meet setpoints as noted above.
- 3. Unoccupied Mode: The outside air damper shall remain closed and the return damper shall be full open. The unit shall cycle on temperature maintenance only activating both the compressor staging and modulating the gas furnace to provide a DAT to maintain space temperature. The compressor staging shall enable in the cooling mode and the gas valve/furnace shall open full to coil to meet setpoints as noted above.
- 4. Warm-up Period: The MircoTech III shall command a warm-up period to begin ½ hour before occupied (as noted above). The fan shall enable with DAT Heating/Cooling control to maintain a DAT until the served space is at setpoint temperature.
- 5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.
- 6. Discharge Temperature Maintenance: Utilize DAT sensor to maintain discharge temperature at 90 degrees (Adjustable in the heating cycle). In the cooling mode the MircoTech III shall stage compressors to maintain 55 degrees F. If in either the occupied cooling or the heating mode the space temperature is satisfied, the fan shall remain running. The DAT shall modulate to maintain zone setpoint temperature through compressor staging and gas valve modulation.
- 7. Low Temperature Protection (Software). The MircoTech III shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj). This safety is in addition to the A70 as noted below.

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- 8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor set shall stage when zone temperature rises above set-point and stage compressors to the "Cooling" DAT of 55 degrees F (adjustable). When the zone temperature falls to .5 degree below setpoint the system shall stage the compressors to maintain the zone setpoint temperature. The fan is always on in the "occupied" mode.
 - a. Input Device: MircoTech III through zone sensor average.
 - b. Input Device: Electronic temperature sensor in discharge air.
 - c. Input Logic: FX-80 Occupied/Unoccupied setpoints.
 - d. Output Device: MircoTech III compressor stage control.

Cooling shall enable when the zone temperature rises above the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously. Unless the space is in the cooling mode and the low temperature protection as noted above.

- 9. Heating Demand: Upon call for heating utilize a .5 degree setpoint dead band such that the gas valve shall open to the furnace when the zone temperature falls below setpoint. The gas valve shall modulate to the furnace to maintain a 90-degree discharge. Once space temperature has been satisfied, the MircoTech III shall modulate the valve to maintain 75-degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:
 - a. Input Device: MircoTech III through zone sensor average.
 - b. Input Device: Electronic temperature sensor in discharge air
 - c. Input Logic: FX-80 Occupied/Unoccupied setpoints.
 - d. Output Device: MircoTech III Analog signal to gas valve actuator.

Heating shall enable when the zone temperature falls below the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously.

- 10. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from MircoTech III. Power to be provided as indicated above. Operation shall be as follows:
 - a. Occupied Mode: Minimum position (initial 20% until set by balancer).

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b. Economizer Mode: Maximum position (100% outside air).

c. Unoccupied Mode: Closed Position (0% outside air).
I. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:

- 1. DDC system graphic.
- 2. DDC system on-off indication.
- 3. DDC system occupied/unoccupied mode.
- 4. Outdoor-air-temperature indication.
- 5. Supply-fan on-off indication (command).
- 6. Supply fan status.
- 7. Economizer enabled/disabled.
- 8. Heating-coil gas-valve position.
- 9. Heating furnace air-temperature setpoint.
- 10. Heating Furnace DAT.
- 11. Cooling-coil air-temperature setpoint.
- 12. Compressor operational/staging status.
- 13. Dehumidification setpoints.
- 14. Dehumidification Status.
- 15. Discharge relative humidity.
- 16. Return Relative Humidity.
- 17. Cooling Coil (DX) DAT.
- 18. VFD Actual Speed (Hertz).
- 19. Smoke detector status.

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- 20. Damper positions.
- 21. Unit Alarm (specific to fault).
- 22. Service Zone Temperatures.
- 23. Service Zone Humidity.
- 24. Service Zone "Occupancy" override status.
- 25. Zone average temperatures and humidity.
- J. FX-80 (Writeable) Adjustable Points:
 - 1. Occupied/unoccupied scheduled time periods.
 - 2. Discharge air setpoints (summer/winter).
 - 3. Zone temperature override.
 - 4. Dehumidification control enable setpoints.
 - 5. Unit shutdown/enable.
 - 6. VFD speed.
 - 7. Alarm reset.
 - 8. Unit enable/disable.
 - 9. Return and Outside air damper positions.
 - 10. Economizer enable/disable.

1.06 ROOFTOP UNIT (RTU#3) PENTHOUSE

A. Basis of Design: Daiken MPS015A. Provide and install a MicroTech III Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a communication interface on the unit mounted MicroTech III as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility

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of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.

- B. Zone Requirements: This unit shall be provided with the following zone sensors. Each of the noted sensors shall be integrated directly into the MicroTech III SA Bus located in the RTU. The Wall Window Sensors controller as noted in "C" below may be integrated directly into the FX-80, which will then be programmed to send a "disable" signal to RTU-2 once the contact is "open".
 - 1. Daikin combo digital temperature and humidity sensor with tenant override and setpoint adjustment mounted in Penthouse (Lounge 402).
- C. Wall Window Sensor: Provide and install a wired Kadtronix HVAC Smart Relay Switch (HSRS) for the window wall in the lounge. Utilize two sensors for open detection. Integrated the 24V contact directly to the MicroTech III such that when the wall window is opened, the corresponding RTU will become idle (shutdown).
- D. Unit VFD: The installed VFD is for balancing purposes only and there is no automated duct pressure control required. VFD speed will be integrated into the MicroTech III through analog 0-10vdc output for speed adjustment through FX-80. Feedback for VFD speed required as well (analog input) into the MicroTech III controller.
- E. Dehumidification Cycle: If the average zone relative humidity ration rises above 60%, the unit shall enable its "dehumidification" cycle by enable the compressor stage commands for a DX DAT of 52 degrees F and then utilize the unit hot gas reheat to modulate the DAT to 70 deg. F in the heating cycle and 65 deg. F in the cooling cycle. If the zone temperature is satisfied and the average humidity rises above 60% (FX-80 adjustable) the unit shall enable the "dehumidification" cycle and set the DAT to the zone setpoint.
- F. Smoke Condition: If one of the unit smoke detectors goes into alarm, there shall be a contact signal to the MT III (MircoTech III), which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.
- G. Sequence of Operations:
 - 1. Occupied/Unoccupied mode. The MircoTech III shall index the supply fan on to run continuously at a constant volume while in occupied mode and on temperature requirements in unoccupied mode. Occupied and unoccupied temperatures shall be preprogramed directly through the FX-80 to the unit MircoTech III. There shall be an occupied override switch on the Zone Sensor that will program a (2) hour override into unit for occupancy. There shall also be an Zone Sensor modulation of +/- 2 degrees

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around programmed setpoint. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):

- a. Time:
 - 1) Occupied:
 - a) As scheduled through FX-80 schedule program.
 - b) Zone Sensor occupied override switch enabled.
 - 2) Unoccupied: Any other time.
- b. Zone Temperature (Adjustable through FX-80):
 - 1) Occupied:

Cooling: 72 degrees with ambient above or equal to 69 degrees F. Heating: 68 degrees with ambient below 69 degrees F.

2) Unoccupied:

Cooling: 80 degrees with ambient above or equal to 69 degrees F. Heating: 60 degrees with ambient below 69 degrees F.

- 2. Occupied Mode: The unit shall open outside air damper to minimum position (initial 20% OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The evaporator enable in the cooling mode through compressor staging and Compressor #1 speed control and the gas plenum valve shall open full to plenum runners (and then modulate to maintain DAT as noted) to meet setpoints as noted above.
- 3. Unoccupied Mode: The outside air damper shall remain closed and the return damper shall be full open. The unit shall cycle on temperature maintenance only activating both the compressor staging and modulating the gas furnace to provide a DAT to maintain space temperature. The compressor staging shall enable in the cooling mode and the gas valve/furnace shall open full to coil to meet setpoints as noted above.
- 4. Warm-up Period: The MircoTech III shall command a warm-up period to begin ½ hour before occupied (as noted above). The fan shall enable with DAT Heating/Cooling control to maintain a DAT until the served space is at setpoint temperature.

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- 5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.
- 6. Discharge Temperature Maintenance: Utilize DAT sensor to maintain discharge temperature at 90 degrees (Adjustable in the heating cycle). In the cooling mode the MircoTech III shall stage compressors to maintain 55 degrees F. If in either the occupied cooling or the heating mode the space temperature is satisfied, the fan shall remain running. The DAT shall modulate to maintain zone setpoint temperature through compressor staging and gas valve modulation.
- 7. Low Temperature Protection (Software). The MircoTech III shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj). This safety is in addition to the A70 as noted below.
- 8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor set shall stage when zone temperature rises above set-point and stage compressors to the "Cooling" DAT of 55 degrees F (adjustable). When the zone temperature falls to .5 degree below setpoint the system shall stage the compressors to maintain the zone setpoint temperature. The fan is always on in the "occupied" mode.
 - a. Input Device: MircoTech III through zone sensor average.
 - b. Input Device: Electronic temperature sensor in discharge air.
 - c. Input Logic: FX-80 Occupied/Unoccupied setpoints.
 - d. Output Device: MircoTech III compressor stage control.

Cooling shall enable when the zone temperature rises above the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously. Unless the space is in the cooling mode and the low temperature protection as noted above.

- 9. Heating Demand: Upon call for heating utilize a .5 degree setpoint dead band such that the gas valve shall open to the furnace when the zone temperature falls below setpoint. The gas valve shall modulate to the furnace to maintain a 90-degree discharge. Once space temperature has been satisfied, the MircoTech III shall modulate the valve to maintain 75-degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:
 - a. Input Device: MircoTech III through zone sensor average.

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- b. Input Device: Electronic temperature sensor in discharge air.
- c. Input Logic: FX-80 Occupied/Unoccupied setpoints.
- d. Output Device: MircoTech III Analog signal to gas valve actuator.

Heating shall enable when the zone temperature falls below the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously.

- 10. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from MircoTech III. Power to be provided as indicated above. Operation shall be as follows:
 - a. Occupied Mode: Minimum position (initial 20% until set by balancer).
 - b. Economizer Mode: Maximum position (100% outside air).
 - c. Unoccupied Mode: Closed Position (0% outside air).
- H. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:
 - 1. DDC system graphic.
 - 2. DDC system on-off indication.
 - 3. DDC system occupied/unoccupied mode.
 - 4. Outdoor-air-temperature indication.
 - 5. Supply-fan on-off indication (command).
 - 6. Supply fan status.
 - 7. Economizer enabled/disabled.
 - 8. Heating-coil gas-valve position.
 - 9. Heating furnace air-temperature setpoint.
 - 10. Heating Furnace DAT.
 - 11. Cooling-coil air-temperature setpoint.

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- 12. Compressor operational/staging status.
- 13. Dehumidification setpoints.
- 14. Dehumidification status.
- 15. Discharge relative humidity.
- 16. Return air relative humidity.
- 17. Cooling Coil (DX) DAT.
- 18. VFD Actual Speed (Hertz).
- 19. Smoke Detector Status.
- 20. Damper positions (Return/Outside air).
- 21. Unit Alarm (specific to fault).
- 22. Service Zone Temperature.
- 23. Service Zone Humidity.
- 24. Service Zone "Occupancy" override status.
- 25. Zone average temperatures and humidity.
- I. FX-80 (Writeable) Adjustable Points:
 - 1. Occupied/unoccupied scheduled time periods.
 - 2. Discharge Setpoints (summer/winter).
 - 3. Zone temperature override.
 - 4. Dehumidification Control enable setpoints.
 - 5. Unit shutdown/enable.
 - 6. VFD Speed.
 - 7. Alarm reset.

- 8. Unit enable/disable.
- 9. Economizer enable/disable.

1.07 ROOFTOP UNIT (RTU#4) RIVERSIDE DINNING AND FLEX SPACE

- A. Basis of Design TraneYCH420 "Voyager". Provide and install a Trane UC600 to communicate with the unit mounted ReliaTel Controller with unit with preprogramed export file (BacNet) with all required unit sensors and MS/TP trunk connection for Building JACE integration. Controls for this unit shall be self-contained to operational sensors and operational requirements. The only interface with the JCI MS/TP bus shall be through a communication interface on the unit mounted ReliaTel as noted above. This unit shall be identified and integrated through the MS/TP Communication Trunk directly back to the FX-80 (Building JACE). All trunk and identification/integration requirements shall be the responsibility of Johnson controls from the tie in to the FX-80. A Bac Net Export File shall be set up by Daikin to be integrated operationally (with display) through the FX-80 with full graphics.
- B. NOTE: The UC600 is required due to the SA bus requirements and the control requirements as listed below. Power for the UC600 shall be as part of the package as provided by Trane and installed in the factory. Note that the UC600 can be mounted below in the space with approval from the engineer and owner.
- C. Zone Requirements: This unit shall be provided with the following zone sensors. Each of the noted sensors shall be integrated directly into the ReliaTel SA Bus located in the RTU. The Wall Window Sensors controller as noted in "C" below may be integrated directly into the FX-80, which will then be programmed to send a "disable" signal to RTU-2 once the contact is "open".
 - 1. Trane BAYSENS071A digital temperature sensor with tenant override and setpoint adjustment mounted in Riverside Dinning 125.
 - 2. Trane BAYSENS071A digital temperature sensor with tenant override and setpoint adjustment mounted in Riverside Dining 121.
 - 3. Trane BAYSENS071A digital temperature sensor with tenant override and setpoint adjustment mounted in mounted in Flex Space 125.
 - 4. Wall Door sensors as listed in "C" below for each ball room wall window set such that if the wall door is open, the unit will be idle until the door is closed again (contact is closed).
 - 5. Return Air Humidity Sensor.

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- D. Wall Window Sensor: Provide and install a wired Kadtronix HVAC Smart Relay Switch (HSRS) for both Riverside Dining Rooms. Integrated the 24V contact directly to the UC600 controller such that when the wall window is opened, the corresponding RTU will become idle (shutdown).
- E. Unit VFD: This unit is a single zone VAV (Variable Air Volume) unit. Operation shall continuous air flow with no VAV single zone operation. The installed VFD is for balancing purposes only and there is no automated duct pressure control required. VFD speed will be integrated into the UC600 through analog 0-10vdc output for speed adjustment through FX-80. Feedback for VFD speed required as well (analog input) into the UC600 controller.
- F. Space (Zone) Sensors Operation: The three zone sensors noted above in three different areas. Each unit shall have a zone occupancy override set for 2 hours (owner adjustable through FX-80 interface). Unit operation for each room shall be "Aggregate Average Demand Override". Such that the RTU shall operate in the heating and cooling mode through an average of the zone temperatures as defined in the sequence below (or as adjusted by the owner through the FX-80 interface). HOWEVER: If in the "heating" mode and one space falls 1 degree below setpoint and "average" temperature of the three zones is satisfied, the microprocessor shall raise the average setpoint 1 degree to enable the heating function in the unit until the compromising space temperature is with-in setpoint. This function shall occur for a total of a 2 degree increase in setpoint. If the compromising room is still below the low limit setpoint then the FX-80 will indicate an alarm in this area and the system shall remain at the 2 degree increase. The same function shall occur in the cooling function with the exception that the enable point will be an increase of temperature at 1 degree above setpoint to a maximum of 2 degrees above setpoint.
- G. Dehumidification Cycle: If the return air relative humidity ration rises above 60%, the unit shall enable its "dehumidification" cycle by enable the compressor stage commands for a DX DAT of 52 degrees F and then utilize the unit hot gas reheat to modulate the DAT to 70 deg. F in the heating cycle and 65 deg. F in the cooling cycle. If the zone temperature is satisfied and the average humidity rises above 60% (FX-80 adjustable) the unit shall enable the "dehumidification" cycle and set the DAT to the zone setpoint.
- H. Smoke Condition: If one of the unit smoke detectors goes into alarm, there shall be a contact signal to the UC600, which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80. The RTU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC.
- I. Sequence of Operations:
 - 1. Occupied/Unoccupied mode. The UC600 shall index the supply fan on to run continuously at a constant volume while in occupied mode and on temperature requirements in unoccupied mode. Occupied and unoccupied temperatures shall be preprogramed directly through the FX-80 to the unit UC600. There shall be an occupied

override switch on the Zone Sensor that will program a 2 hour override into unit for occupancy. There shall also be a Zone Sensor modulation of +/-2 degrees around programmed setpoint. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):

- a. Time:
 - 1) Occupied:
 - a) As scheduled through FX-80 Schedule Program.
 - b) Zone Sensor occupied override switch enabled.
 - 2) Unoccupied: Any other time.
- b. Zone Temperature (Adjustable through FX-80) in "Aggregate Average Demand Override mode as listed above":
 - 1) Occupied:

Cooling: 72 degrees with ambient above or equal to 69 degrees F.

Heating: 68 degrees with ambient below 69 degrees F.

2) Unoccupied:

Cooling: 80 degrees with ambient above or equal to 69 degrees F.

Heating: 60 degrees with ambient below 69 degrees F.

- 2. Occupied Mode: The unit shall open outside air damper to minimum position (initial 20% OA until set by balancer), The return damper to maximum (balanced) position, the unit supply fan and separate exhaust fan shall enable (to minimum position). The evaporator enable in the cooling mode through compressor staging and Compressor #1 speed control and the gas plenum valve shall open full to plenum runners (and then modulate to maintain DAT as noted) to meet setpoints as noted above.
- 3. Unoccupied Mode: The outside air damper shall remain closed and the return damper shall be full open. The unit shall cycle on temperature maintenance only activating both the compressor staging and modulating the gas furnace to provide a DAT to maintain space temperature. The compressor staging shall enable in the cooling mode and the gas valve/furnace shall open full to coil to meet setpoints as noted above.

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- 4. Warm-up Period: The UC600 shall command a warm-up period to begin ½ hour before occupied (as noted above). The fan shall enable with DAT Heating/Cooling control to maintain a DAT until the served space is at setpoint temperature.
- 5. Economizer Cycle: In the occupied cycle, if the ambient temperature and humidity (as sensed by the sensor noted above attached directly to the FX-80) This shall be an enthalpy based economizer as per ASHRAE 90.1-2013 and shall operate as noted in the standard. The unit must be in the "Cooling" mode as listed above.
- 6. Discharge Temperature Maintenance: Utilize DAT sensor to maintain discharge temperature at 90 degrees (Adjustable in the heating cycle). In the cooling mode the UC600 shall stage compressors to maintain 55 degrees F. If in either the occupied cooling or the heating mode the space temperature is satisfied, the fan shall remain running. The DAT shall modulate to maintain zone setpoint temperature through compressor staging and gas valve modulation.
- 7. Low Temperature Protection (Software). The UC600 shall monitor discharge air temperature and shut down the unit, close the outside air damper and open the valve to the coil. This action shall commence if the DAT falls below 32 degrees F (adj). This safety is in addition to the A70 as noted below.
- 8. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the compressor set shall stage when zone temperature rises above set-point and stage compressors to the "Cooling" DAT of 55 degrees F (adjustable). When the zone temperature falls to .5 degree below setpoint the system shall stage the compressors to maintain the zone setpoint temperature. The fan is always on in the "occupied" mode.
 - a. Input Device: ReliaTel/UC600 through zone sensor average.
 - b. Input Device: Electronic temperature sensor in discharge air.
 - c. Input Logic: FX-80 Occupied/Unoccupied setpoints.
 - d. Output Device: Relaitel compressor stage control.

Cooling shall enable when the zone temperature rises above the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously. Unless the space is in the cooling mode and the low temperature protection as noted above.

9. Heating Demand: Upon call for heating utilize a .5 degree setpoint dead band such that the gas valve shall open to the furnace when the zone temperature falls below setpoint. The gas valve shall modulate to the furnace to maintain a 90-degree discharge. Once space temperature has been satisfied, the Reliatel shall modulate the valve to maintain 75-

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degree discharge in the occupied mode and disable in the unoccupied mode. Dead band setpoint to be adjustable. Provide reset schedule as follows:

- a. Input Device: UC600 through zone sensor average.
- b. Input Device: Electronic temperature sensor in discharge air.
- c. Input Logic: FX-80 Occupied/Unoccupied setpoints.
- d. Output Device: UC600 Analog signal to gas valve actuator.

Heating shall enable when the zone temperature falls below the zone setpoint (occupied and unoccupied). There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously.

- 10. Outside Air Damper: The damper shall operate through three positions (Binary signals) from MircoTech III. Power to be provided as indicated above. Operation shall be as follows:
 - a. Occupied Mode: Minimum position (initial 20% until set by balancer).
 - b. Economizer Mode: Maximum position (100% outside air).
 - c. Unoccupied Mode: Closed Position (0% outside air).
- J. FX-80 (Readable) Graphical Interface (Object Export File) for the Rooftop Unit shall be as follows:
 - 1. DDC system graphic.
 - 2. DDC system on-off indication.
 - 3. DDC system occupied/unoccupied mode.
 - 4. Outdoor-air-temperature indication.
 - 5. Supply-fan on-off indication (command).
 - 6. Supply fan status.
 - 7. Economizer enabled/disabled.
 - 8. Heating-coil gas-valve position.

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- 9. Heating furnace air-temperature setpoint.
- 10. Heating Furnace DAT.
- 11. Cooling-coil air-temperature setpoint.
- 12. Compressor operational/staging status.
- 13. Dehumidification setpoints.
- 14. Dehumidification Status.
- 15. Discharge relative humidity.
- 16. Return Relative Humidity.
- 17. Cooling Coil (DX) DAT.
- 18. VFD Actual Speed (Hertz).
- 19. Smoke detector status.
- 20. Damper positions.
- 21. Unit Alarm (specific to fault).
- 22. Service Zone Temperatures.
- 23. Return Air Humidity.
- 24. Service Zone "Occupancy" override status.
- 25. Zone average temperatures and humidity.
- K. FX-80 (Writeable) Adjustable Points:
 - 1. Occupied/unoccupied scheduled time periods.
 - 2. Discharge air setpoints (summer/winter).
 - 3. Zone temperature override.
 - 4. Dehumidification control enable setpoints.

- 5. Unit shutdown/enable.
- 6. VFD speed.
- 7. Alarm reset.
- 8. Unit enable/disable.
- 9. Return and Outside air damper positions.
- 10. Economizer enable/disable.

1.08 MAU (Make-Up Air Units)

- A. There are a series of three Make-Up Air Units on this project: the following is by MAU#:
 - 1. MAU#1: Basis of Design: Greenheck IGX-112-H22.
 - 2. MAU#2: Basis of Design: Greenheck IGX-109-H12.
 - 3. MAU#3: Basis of Design: Greenheck IGX-109-H12.
- B. NOTE: The required VFD for these unit MUST be provided and installed by the ATC Contractor. Refer to Contract Drawing M-7 for requirements. VFD must integrate with the control center as listed below and be listed for the horsepower and fan on equipment. Controls to be provided with equipment:
 - 1. CAREL Microprocessor (MicroTech III).
 - 2. DAT Sensor.
 - 3. pCOe Expansion Board (furnace interface).
 - 4. Furnace controller.
 - 5. Ignition Controller.
 - 6. 120/24V Control Transformer.
 - 7. All sensors and control wiring.
 - 8. Smoke Detector.

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- C. The Controls Contractor will be responsible to provide and install the following:
 - 1. Provide all control and 24V wiring to all control sensors and actuators associated with all control parts as listed above.
 - 2. Provide and install a Discharge Air Temperature Sensor at the unit discharge.
- D. Provide integrated smoke shutdown with provided smoke detector. Install smoke detector as per manufacturer's instructions and attain addressable relay from Fire Alarm Contractor. Wire and program shutdown into CAREL controller.
- E. Communications from Captive Air Hood Controller Requirements:
 - 1. Provide communication connection to microprocessor from Captive Air Hood connection for the following:
 - a. Enable/disable.
 - b. Supply fan speed (4 to 20ma) or (0 to 10Vdc).
 - c. Operational Prove (if required).
 - d. Emergency Stop.
- F. Smoke Condition: If the unit smoke detector goes into alarm, there shall be a contact signal to the MicroTech III, which in turn shall disable the unit and send a "Smoke Condition" alarm through to the FX-80. The MAU shall be provided and installed with a return duct smoke detector(s). These duct detectors shall be installed in accordance with NFPA 72. The requirement for their provision is an ICC requirement in the return. All return mounted detectors must be the low ambient type. MC shall provide, install and power Smoke Detector. Smoke Detector shall be dual pole such that one pole (contact) shuts down unit and the other is communication for an addressable relay, provided and installed by EC
- G. Sequence of Operations:
 - 1. "Enable" mode. The Unit Master Controller upon enable signal from the Captive Air Hood Controller shall open the outside air damper and index the fan to a preset VFD speed. The VFD speed shall then reset to conform to a signal (4 to 20ma) from the Captive Air Hood Controller. Initial Settings (to be modified upon owner's request and adjustable through FX-80 interface):
 - a. Time:

- 1) Enable:
 - a) As commanded through Hood Controller.
 - b) FX-80 override control.
- 2) Unoccupied: N/A.
- b. DAT (Adjustable through FX-80):
 - 1) Enable: The MicroTech III shall enable and modulate the gas furnace (valve) to maintain a 68 to 72 degree F DAT. DAT shall be monitored through the unit discharge air temperature sensor.
- 2. Enable Mode: The unit shall open outside air damper to full position (100% OA), The unit supply fan shall enable to a present speed as noted above fan shall enable (to minimum position). The furnace shall modulate to maintain a DAT as noted above.
- 3. Unoccupied Mode: N/A.
- 4. Warm-up Period: N/A.
- 5. Economizer Cycle: N/A.
- 6. Discharge Temperature Maintenance: Utilize DAT sensor to maintain discharge temperature at 72 degrees (Adjustable in the heating cycle). If the DAT falls below 50 degrees F in the heating mode (exterior ambient less than 40 degrees F) a notifying alarm will be sent through to the FX-80.
- 7. Disable Mode: If a signal is sent from the Hood Controller (either Ansul Discharge or System Off) to disable, the unit will shut down (damper closed, furnace off and fan disabled) and send an alarm through to the FX-80.
- 8. Outside Air Damper: The damper shall operate through 3 positions (Binary signals) from the MicroTech III. Power to be provided as indicated above. Operation shall be as follows:
 - a. Enable Mode: Maximum position (100% outside air).
 - b. Disable Mode: Closed Position (0% outside air).
- 9. FX-80 Graphical Interface shall be as follows:
 - a. DDC system graphic.

- b. DDC system on-off indication.
- c. DDC system occupied/unoccupied mode.
- d. Outdoor-air-temperature indication.
- e. Supply-fan on-off indication.
- f. Supply Fan Command Speed (from hood controller).
- g. Fan-discharge air-temperature setpoint heating.
- h. Actual Fan speed (Hz-from VFD Feedback).
- i. Heating-furnace-valve position.
- j. Discharge Air Temperature.
- k. Smoke Detector Status.
- l. Unit Alarm (command fault).
- m. Unit Supply Fan Prove (VFD Feedback).
- 10. FX-80 Adjustable Points:
 - a. System Enable/Disable.
 - b. DAT Setpoints.
 - c. Alarm Reset.
 - d. VFD speed command.

1.09 AIR SOURCE HEAT PUMPS

A. This project has a series of Mitsubishi Heat Pumps as noted on Contract Drawing M-7. The communication system shall be a Mitsubishi proprietary system called M-NET. This "Communication" system shall be required to have a building wide communications trunk separate from that of the JCI MS/TP trunk noted above. The new "M-Net" communications trunk shall be separate and connect to the controller as listed in Paragraph 1.02 above. Note the following:

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- B. Controller: Each heat pump will be provided with a PAR-32MAA Zone Controller. To be mounted in each noted space for individual heat pump control.
- C Control Requirements:
 - Wall mounted NS Sensor to be as noted (MA). Provide and install MJ back to Heat 1. Pump.
 - 2. This unit WILL sit on the communications trunk and be integrated back to the M-Net BACNet Integrator.
- Sequence of Operations: D.
 - 1 Occupied/Unoccupied mode. There shall be an occupied override switch on the MA that shall index the supply fan on to run continuously at a "occupied" setpoint. Initial Settings (to be modified upon owner's request and adjustable through FX-80 BacNet interface): a.
 - Zone Temperature:
 - 1) Occupied:

Cooling: 72 degrees with ambient above or equal to 69 degrees F. Heating: 68 degrees with ambient below 69 degrees F.

2) Unoccupied:

> Cooling: 80 degrees with ambient above or equal to 69 degrees F.

Heating: 60 degrees with ambient below 69 degrees F.

- 2. Occupied Mode: The heat pump shall have the fan continuously operate to assure outside air is supplied to the zone. The heat pump shall heat and cool through temperature as sensed by the zone MA for temperature settings as noted in the "Occupied" time as noted above
- 3. Unoccupied Mode: The fan shall only operate in the cooling and heating mode to maintain the "unoccupied" space temperature. If the space temperature is satisfied to the "unoccupied" setpoints
- 4. Cooling Demand: Upon call for cooling utilize a .5 degree setpoint dead band such that the system shall enable when zone temperature rises above set-point and disable when the zone temperature falls to .5 degree below setpoint. Dead band setpoint to be adjustable.

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- 5. Heating Demand: Upon call for heating utilize a .5 degree setpoint dead band such that the system shall enable when zone temperature falls below set-point and disable when the zone temperature rises to .5 degree above setpoint. Dead band setpoint to be adjustable. There shall be an interlock between the cooling enable and the heating valve enable, such that the both cannot enable simultaneously.
- 6. FX-80 Graphical Interface shall be as follows:
 - a. DDC system graphic.
 - b. DDC system on-off indication.
 - c. DDC system occupied/unoccupied mode.
 - d. Outdoor-air-temperature indication.
 - e. Supply-fan on-off indication.
 - f. Heating Mode.
 - g. Cooling Mode.
 - h. Zone temperature indication.
 - i. Zone temperature setpoint.
 - j. Unit Alarm (command fault-CT,DAT).
- 7. FX-80 Adjustable Points:
 - a. Occupied/unoccupied scheduled time periods.
 - b. Occupied/Unoccupied Setpoints.
 - c. System Enable/Disable.

1.10 EXHAUST FAN CONTROL

- A. Refer to Contract Drawing M-7. There are nine exhaust fans on this project and they shall be controlled as follows:
- B. Exhaust Fan #1: This fan operates in conjunction with Kitchen Hood #52. This fan must be provided and installed with a GreenHeck "Vari-Green" VGD-100+ controller. This shall accept a signal from the Captive Air Hood Controller (0 to 10VDC) or (4 to 20ma). There also will be an enable and disable signal.

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- C. Exhaust Fan #2: This fan operates in conjunction with Kitchen Hood #90. This fan must be provided and installed with a GreenHeck "Vari-Green" VGD-100+ controller. This shall accept a signal from the Captive Air Hood Controller (0 to 10VDC) or (4 to 20ma). There also will be an enable and disable signal.
- D. Exhaust Fan #3: This fan operates in conjunction with the dishwasher hood. Provide a "relay "switch" on the side of the hood for operation. Utilize a current switch for operational proof.
- E. Exhaust Fan #4: This fan operates toilet exhaust and shall be programmed through a relay to enable and disable on "occupancy" through a relay. Utilize a current switch for operational proof.
- F. Exhaust Fan #5: This fan operates in conjunction with Kitchen Hood #122. This fan must be provided and installed with a GreenHeck "Vari-Green" VGD-100+ controller. This shall except a signal from the Captive Air Hood Controller (0 to 10VDC) or (4 to 20ma). There also will be an enable and disable signal.
- G. Exhaust Fan #6: This fan operates in conjunction with combustion relief for MAU-1 and MAU-2. This fan must be provided and installed with a GreenHeck "Vari-Green" VGD-100+ controller. This shall accept a signal from each individual MAU to enable to a balanced setpoint. The fan shall enable to individual setpoints as per their operational status.
- H. Exhaust Fan #7: This fan operates toilet exhaust and shall be programmed through a relay to enable and disable on "occupancy" through a relay. Utilize a current switch for operational proof.
- I. Exhaust Fans EF-8 and EF-9 shall be self-contained with 24V thermostats mounted in the noted served rooms. There is no ATC interface.
- J. FX-80 Graphical Interface shall be as follows:
 - 1. DDC system graphic.
 - 2. DDC system on-off indication.
 - 3. DDC system occupied/unoccupied mode.
 - 4. Fan command.
 - 5. Fan Speed (on Vari-Green Units).
 - 6. Fan command status.
 - 7. Fan operational proof (CT).

- 8. Unit Alarm (failure to adhere to a command).
- K. FX-80 Adjustable Points:
 - 1. Occupied/Unoccupied Setpoints.
 - 2. Unit Shutdown.
 - 3. Supply Fan Enable/Disable.
 - 4. Supply Fan Speed (on Vari-Green Units).
- L. Cabinet Unit Heaters and Electric Unit Heaters:
 - 1. These units shall be self-contained with no ATC interface.

END OF SECTION 23 0993