
PART 1 - GENERAL

1.1 WORK OF THIS SECTION

- A. This section of the specifications details the components to be provided by the BMCS subcontractor relating to the following:
 - 1. Communication Control Panels (CCP).
 - 2. Distributed Control Panels (DCP).
 - 3. Unitary Controllers (UC).
 - 4. Lighting Control Relay Panels (LCRP).

1.2 CONTROLLERS - LOCATIONS

- A. Controllers shall only be located in control panel locations as specified in the BMCS General Requirements section of these specifications and within unit mounted enclosures provided as part of the terminal units.
- B. The control panel installation shall meet the requirements detailed in the BMCS General Requirements section of these specifications.

PART 2 - PRODUCTS

2.1 COMMUNICATION CONTROL PANELS (CCP)

- A. CCP shall be software programmable controllers on the Management Local Area Network (MLAN) and shall fulfill one or both of the following roles:
 - 1. A gateway between the BMCS Management Level LAN and the BMCS Field Level LAN.
 - 2. A gateway for software interfaces to third party monitors/controllers.
- B. Provide, at minimum, CCP at the following locations in the building:
 - 1. Lower Loop CHW Plant.
 - 2. Upper Loop CHW pumping station.
 - 3. Cooling Towers.
 - 4. Lower Loop Heating Hot Water Plant.
 - 5. Upper Loop Heating Hot Water pumping station.
 - 6. Every other floor within the building as required to meet the field level LAN requirements in the BMCS Networks and Workstations section of these specifications.
- C. CCP shall be fully programmable controllers with operating sequences maintained in non-volatile EEPROM or flash ROM.
- D. Provide integral network communication connections.
- E. The CCP shall incorporate software as necessary to provide communications on the primary network. Additionally, if the CCP acts as a gateway to secondary LAN, then the CCP shall also incorporate all software as necessary to perform this function including any change of protocol between the networks.
- F. CCP shall be totally independent of any LAN nodes for their operating functions.
- G. CCP failure shall not be place the BMCS or any component controlled in a situation that may cause damage to equipment or harm or discomfort to building occupants. The failure of a CCP shall not affect the operation of any other management level network node.
- H. The failure of any CCP shall be annunciated as a critical alarm at the OIW.

- I. Cabling shall be terminated on rugged and easily accessible terminal strips. Each termination shall be clearly marked and shall be as detailed in the shop and record drawings.
- J. Each CCP shall have its own power supplies, which shall be rated such that they will adequately accommodate all foreseeable uses of the CCP.
- K. Each CCP shall have, at minimum, a 16-bit microprocessor.
- L. Provide a UPS for each CCP. CCP shall remain fully operational during the transition from normal power to standby power.
- M. Provide a real-time hardware clock at each CCP. The hardware real-time clock shall be used to synchronize all other hardware and software clocks in the BMCS. Synchronization shall take place at least once every 24 hours and immediately following start up of a component such as a CCP, DCP, UC and PC which has an integral real-time clock. The hardware clock shall have a battery back-up of at least 72 hours.
- N. The CCP shall have a port for the connection of the ROW.
- O. If the CCP supports a secondary network, then there shall be the necessary interface card(s) at the CCP.
- P. CCP shall be housed in enclosures, which shall meet the requirements detailed in the BMCS General Requirements of these specifications. Mounting of CCP to panel enclosure door shall not be permitted.

2.2 DISTRIBUTED CONTROL PANELS (DCP)

- A. DCP shall be software programmable controllers on the field level LAN and shall fulfill one or more of the following roles:
 - 1. Gateway interface to software interfaces of monitors/controllers provided by other Divisions.
 - 2. An interface via Point Interface Modules (PIM) to the field instrumentation and final control elements.
- B. DCP may be used for any equipment monitored and controlled by the BMCS. DCP shall be used to monitor and control the following equipment:
 - 1. Lower Loop CHW system.
 - 2. Upper Loop CHW system.
 - 3. Condenser water system and associated water treatment system.
 - 4. Lower Loop HHW system.
 - 5. Upper Loop HHW system.
 - 6. AHU.
- C. DCP shall be fully programmable controllers with operating sequences maintained in non-volatile EEPROM or flash ROM.
- D. The DCP shall control its own communications so that the failure of any one node, including the PC, shall not inhibit communications on the network between the remaining nodes. Provide integral network communication connections.
- E. DCP shall be totally independent of any other LAN nodes for their monitoring and control functions. DCP shall monitor and control entire systems, multiple DCP for a single system shall not be allowed. If multiple DCP are required for a large system, such as the central chilled water or condenser water system, then monitoring points not essential to the operating sequences shall be monitored by separate DCP and the monitoring and control of the operating sequences shall be provided within a single DCP. Where a DCP receives data from other nodes, such as an outdoor air temperature, which is used for a global system program strategy executed at that DCP, then alternative control strategies shall be automatically initiated, based on operator definable default values, if there is a loss of communication of the required data.
- F. DCP failure shall not be place the BMCS or any component controlled in a situation that may cause

damage to equipment or harm or discomfort to building occupants. The failure of a DCP shall not affect the operation of any other network node.

- G. The failure of any DCP shall be annunciated as a critical alarm at the OIW.
- H. Cabling shall be terminated on rugged and easily accessible terminal strips. Each termination shall be clearly marked and shall be as detailed in the shop and record drawings.
- I. Each DCP shall have its own power supplies, which shall be rated such that they will adequately accommodate all foreseeable uses of the DCP.
- J. Each DCP shall have, at minimum, a 16-bit microprocessor.
- K. All applications programs and operating sequences shall reside at the DCP.
- L. Provide a UPS for each DCP. DCP shall remain fully operational during the transition from normal power to standby power.
- M. Provide a real-time hardware or software clock at each DCP. The system hardware real-time clock at the CCP shall be used to synchronize all other hardware and software clocks in the BMCS. Synchronization shall take place at least once every 24 hours and immediately following start up of a component such as a CCP, DCP, UC and PC which has an integral real-time clock. The software clock shall have a battery back-up of at least 72 hours.
- N. The DCP shall have a port for the connection of the ROW.
- O. DCP shall be housed in enclosures which shall meet the requirements detailed in the BMCS General Requirements of these specifications. Mounting of DCP to panel enclosure door shall not be permitted.
- P. Interfaces to field instrumentation and final control elements shall have Point Interface Modules (PIM) that will:
 - 1. Enable the DCP to receive signals from the digital and analog instrumentation.
 - 2. Enable the DCP to output control signals to the final control elements.
- Q. PIM shall be incorporated into the DCP by one or the following methods:
 - 1. Plug in type modules with specific or universal input/output capabilities.
 - 2. Integral to the DCP controller board.
- R. PIM shall accommodate the following point types:
 - 1. Analog and digital inputs.
 - 2. Analog and digital outputs.
 - 3. Pulse inputs.
- S. Analog input PIM shall have a minimum 10 bit analog-to-digital conversion and shall interface to all signal types listed in the Field Termination Schedules.
- T. Analog output PIM shall have a minimum 10 bit digital-to-analog conversion and shall meet all output signal requirements detailed in the Field Termination Schedules.
- U. Digital input and output PIM shall have electrical isolation and all relay contacts shall be suitably rated for the application.
- V. All PIM shall be easily exchanged and the failure of one PIM shall not affect any other PIM. Field terminations shall be such that the removal of a failed PIM shall not require the removal and reconnecting of field device cable terminations.
- W. Provide LED on the PIM to indicate the status of each PIM.
- X. All PIM shall be such that all output points can be manually positioned via an on board on-off-auto or potentiometer dial as applicable to the individual point.

- Y. Control shall be based on either three term algorithms, i.e. proportional plus integral plus derivative, or two term algorithms, i.e. proportional plus integral, unless specified otherwise.
- Z. DCP mounted on vibrating equipment, such as on heat pumps, shall have vibration isolation protection that ensures their satisfactory operation.

2.3 UNITARY CONTROLLERS

- A. Unitary Controllers (UC) shall be fully programmable controllers with operating sequences maintained in EEPROM or flash ROM. Customization of sequences of operation, operating parameters, control loop parameters, control constants, and schedules shall be changeable on-line by the operator. UC shall provide an interface via PIM to the field instrumentation and final control elements of the following types of equipment:
 - 1. One terminal unit.
 - 2. Up to three miscellaneous fans.
 - 3. One fan coil unit.
 - 4. One group of motorized floor diffusers.
 - 5. Miscellaneous input monitoring.

All other types of equipment and systems shall be controlled by panels meeting the requirements of DCP.
- B. The UC shall be a node on one of the field level LANs and shall control its own communications so that the failure of any one node shall not inhibit communications on the network between the remaining nodes and the OIW.
- C. UC shall be totally independent of other LAN nodes for their monitoring and control functions, except time based scheduled operation which may be stored in the associated CCP serving the associated field level LAN.
- D. UC failure shall not be place the BMCS or any component controlled in a situation that may cause damage to equipment or harm or discomfort to building occupants.
- E. The failure of any UC shall be annunciated as an alarm at the OIW.
- F. Cabling shall be terminated on rugged and easily accessible terminal strips. Each termination shall be clearly marked and shall be as detailed in the shop and record drawings.
- G. UC that are not powered from the electrical service to the equipment in which it is controlling shall have its own power supplies which shall be rated such that they will adequately accommodate all foreseeable uses of the UC.
- H. Each UC shall have, at minimum, a 16-bit microprocessor.
- I. Provide each UC with a battery back up for the protection of volatile memory for a minimum of 72 hours. Batteries shall be rated for a seven-year life. Batteries shall be easily removed for replacement.
- J. Provide software clock at each UC. The system hardware real-time clock at the CCP shall be used to synchronize all other hardware and software clocks in the BMCS. Synchronization shall take place at least once every 24 hours and immediately following start up of a component such as a CCP or PC, which has an integral real-time clock. The clock shall have a battery back up of at least 72 hours.
- K. UC shall be housed in enclosures, which shall meet the requirements detailed in the BMCS General Requirements of these specifications. Mounting of UC to panel enclosure door shall not be permitted.
- L. Interfaces to field instrumentation and final control elements shall have integral PIM that will:
 - 1. Enable the UC to receive signals from the digital and analog instrumentation.
 - 2. Enable the UC to output control signals to the final control elements.

- M. PIM shall accommodate the following point types:
 - 1. Analog and digital inputs.
 - 2. Analog and digital outputs.
 - 3. Pulse inputs.
- N. Analog input PIM shall have a minimum 8-bit analog-to-digital conversion and shall interface to all signal types listed in the Field Termination Schedules.
- O. Analog output PIM shall have a minimum 8-bit digital-to-analog conversion and shall meet all output signal requirements detailed in the Field Termination Schedules.
- P. Digital input and output PIM shall have electrical isolation and all relay contacts shall be suitably rated for the application.
- Q. UC shall control and monitor all points associated with a system. Multiple UC shall not be used to control and monitor a single system.
- R. All applications programs shall reside at the UC.
- S. Operating sequences for UC shall be resident at the UC.
- T. Control shall be based on either three term algorithms, i.e. proportional plus integral plus derivative, or two term algorithms, i.e. proportional plus integral, unless specified otherwise.
- U. UC mounted on vibrating equipment, such as on heat pumps, shall have vibration isolation protection that ensures their satisfactory operation.

2.4 UNITARY CONTROLLER – CONSTANT VOLUME TERMINAL UNITS

- A. Each CVTU terminal unit shall have a UC. The number and location of terminal units and air flowrates shall be as indicated on the Mechanical Drawings. The CVTU UC shall be fully programmable and shall not be application specific.
- B. The terminal unit manufacturer shall provide the following components for each toilet exhaust constant volume terminal unit for interface and mounting of the UC:
 - 1. Primary air dampers to be controlled by the UC.
 - 2. Enclosure to house the UC and associated components or suitable mounting brackets within the terminal unit enclosure.
 - 3. Multi-point averaging type flow sensor at the primary air inlet to the terminal unit.
- C. The BMCS subcontractor shall furnish the terminal unit manufacturer the following components for factory installation for each terminal unit:
 - 1. UC.
 - 2. Damper actuator.
- D. Provide the terminal unit manufacturer with the following documentation to coordinate the mounting of the UC and related components:
 - 1. Multi-color point to point wiring diagram detailing the wiring and tubing of the UC and other control equipment installed on the terminal devices.
 - 2. Written instructions and drawings containing sufficient information to enable the terminal unit manufacturer to undertake the installation satisfactorily.
- E. The BMCS subcontractor shall visit the terminal unit manufacturer's facility before commencement of fabrication to ensure that the terminal unit manufacturer's installation procedures are satisfactory. The terminal unit manufacturer shall prepare a drawing of the wiring for the UC and all associated instrumentation and final control elements based on the information provided by the BMCS subcontractor. The terminal unit manufacturer and the BMCS subcontractor shall both certify on the drawing that the drawing is correct and the drawing shall be submitted as a shop drawing for review by the Owner, Consultant and Engineer.
- F. UC for each production run shall be at the terminal unit manufacturer's factory at least six weeks prior to the scheduled shipment dates to the job-site. Obtain the terminal unit shipping dates from

- the Mechanical subcontractor.
- G. The BMCS subcontractor shall visit the terminal unit manufacturer's facility at the completion of the initial production run, prior to the shipping of any terminal units to the project site, to inspect the installation of the UC and to verify proper operation via the subcontractor's ROW.
- H. The terminal unit manufacturer shall not make any adjustments to the UC, enter any data into the UC or test the UC in any way. All entry of data and adjustments of any kind to the UC shall be undertaken by the BMCS subcontractor at the project site.
- I. It shall be the responsibility of the BMCS subcontractor to verify the following with all potential terminal unit manufacturers prior to their bid submittal:
1. The pressure differential generated by the multi-point sensors is compatible with the instrumentation to be provided by the BMCS subcontractor for the specified accuracy requirements.
 2. The damper assembly is compatible with the actuator to be provided by the BMCS subcontractor.
- J. Provide as part of the UC differential pressure transducers for the monitoring of the terminal unit primary air flowrate. The differential pressure transducer shall meet, at minimum, the requirements:
1. Monitor the differential pressures generated by a multi-point averaging device, such as the Barber Colman flowcross sensor, located in the primary air duct. The terminal unit manufacturer shall provide the multi-point averaging sensors. Coordinate with the terminal unit manufacturer for range of pressure differential.
 2. The pressure differential transducers shall be on the UC. The terminal unit manufacturer as part of the factory installation shall provide tubing from these sensors to the multi-point averaging devices.
 3. The differential pressure sensors shall be Honeywell Microbridge DP sensors or equivalent and shall monitor the flowrates with an accuracy of + or - 5 percent in the flow range of 1.5 to 15 meters per second (300 to 3,000 feet per minute). The BMCS subcontractor shall calibrate each differential pressure sensor in the field following installation.
 4. Provide a one-micron filter on the pressure differential sensor if it monitors a moving air stream.
 5. If an automatic calibration program requires the automatic zeroing of the flow sensor and transducer, provide a coordinated sequence of operation that ensures the associated AHU is not operating during the automatic calibration procedure.
- K. Furnish primary damper actuators, for factory mounting, meeting the following requirements:
1. Direct shaft mounting.
 2. Adequate torque, 35 inch pound force minimum, to properly operate the damper from fully open to fully close without binding.
 3. Locking "V" groove or similar means to prevent slippage between actuator and shaft.
 4. Removable without the requirement to remove any ductwork or flexible connections.
- L. The UC shall monitor and control the following parameters for constant volume (non fan powered) terminal units:
1. Primary air flowrate.
 2. Damper modulation.
- M. PID algorithms shall maintain the system operation within + or - 5 percent of the exhaust air flowrate setpoint.
- N. The operator shall be able to access the constant volume UC by connecting the ROW, as applicable, to the secondary LAN at the UC. At minimum, the operator shall be able to undertake the following functions via the ROW and OIW:
1. Change a flowrate setpoint for a single terminal unit.
 2. Change a flowrate setpoint for all terminal units in the same riser.
 3. Change an alarm limit/values.
 4. Set the primary air damper on a terminal unit to:
 - a. The closed position.

- b. The fully open position.
 - c. Flowrate setpoint.
- O. Following the installation of the constant volume terminal units in the ceiling space the BMCS subcontractor shall undertake the following tasks:
1. Provide low voltage power to the UC.
 2. Connect the UC into the BMCS secondary LAN.
 3. Install all data into the UC as necessary for the correct operation of the terminal unit including:
 - a. Terminal unit-UC LAN address.
 - b. Primary air damper flowrate setpoints.
 - c. All other parameters which may not have been entered before shipment of the UC to the terminal unit manufacturer, such as control constants, engineering units conversion factors, default operating schedules, definition of terminal unit type, etc., as necessary to define the operation of the terminal unit in accordance with these specifications.
 4. Verify that the UC modulates the primary air duct dampers from fully open to fully closed and vice versa within the specified time and verify either visually or by feel that the damper closes fully under UC control.
 5. Verify that the terminal unit UC is satisfactorily integrated into the LAN.
 6. Verify that the operating sequences are correct and that there is stable modulation of the primary air damper.
 7. Assist the Air Balancing subcontractor as required for the complete commissioning, calibration and operational verification of the HVAC and terminal unit systems.

2.5 UNITARY CONTROLLER - OVERHEAD FAN POWERED TERMINAL UNITS

- A. Each FPTU terminal unit shall have a UC. The number and location of terminal units and air flowrates shall be as indicated on the Mechanical Drawings. The FPTU UC shall be fully programmable and shall not be application specific.
- B. The terminal unit manufacturer shall provide the following components for each fan powered terminal unit for interface and mounting of the UC:
1. Primary air dampers to be controlled by the UC.
 2. Enclosure to house the UC and associated components or suitable mounting brackets within the terminal unit enclosure.
 3. Multi-point averaging type flow sensor at the primary air inlet to the terminal unit.
 4. 24 VAC control transformer.
 5. 0-10 Vdc fan flowrate and start/stop controller to the ECM motor.
- C. The BMCS subcontractor shall furnish the terminal unit manufacturer the following components for factory installation for each terminal unit:
1. UC.
 2. Damper actuator.
- D. The BMCS subcontractor shall field install the following components for each fan powered terminal unit:
1. Room temperature sensor.
 2. Discharge air temperature sensor located, at minimum, 5 feet from the terminal unit discharge.
 3. Heating hot water valve actuator.
- E. The BMCS subcontractor shall furnish the following components for each fan powered terminal unit for field installation by the Mechanical subcontractor:
1. Heating hot water valve.
- F. Provide the terminal unit manufacturer with the following documentation to coordinate the mounting of the UC and related components:
1. Multi-color point to point wiring diagram detailing the wiring and tubing of the UC and other control equipment installed on the terminal devices.
 2. Written instructions and drawings containing sufficient information to enable the terminal unit manufacturer to undertake the installation satisfactorily.

- G. The BMCS subcontractor shall visit the terminal unit manufacturer's facility before commencement of fabrication to ensure that the terminal unit manufacturer's installation procedures are satisfactory. The terminal unit manufacturer shall prepare a drawing of the wiring for the UC and all associated instrumentation and final control elements based on the information provided by the BMCS subcontractor. The terminal unit manufacturer and the BMCS subcontractor shall both certify on the drawing that the drawing is correct and the drawing shall be submitted as a shop drawing for review by the Owner, Consultant and Engineer.
- H. UC for each production run shall be at the terminal unit manufacturer's factory at least six weeks prior to the scheduled shipment dates to the job-site. Obtain the terminal unit shipping dates from the Mechanical subcontractor. The BMCS subcontractor shall visit the terminal unit manufacturer's facility at the completion of the initial production run, prior to the shipping of any terminal units to the project site, to inspect the installation of the UC and to verify proper operation via the subcontractor's ROW.
- I. The terminal unit manufacturer shall not make any adjustments to the UC, enter any data into the UC or test the UC in any way. All entry of data and adjustments of any kind to the UC shall be undertaken by the BMCS subcontractor at the project site.
- J. It shall be the responsibility of the BMCS subcontractor to verify the following with all potential terminal unit manufacturers prior to their bid submittal:
1. The pressure differential generated by the multi-point sensors is compatible with the instrumentation to be provided by the BMCS subcontractor for the specified accuracy requirements.
 2. The damper assembly is compatible with the actuator to be provided by the BMCS subcontractor.
- K. Provide a wall mounted space temperature sensor for the monitoring of the fan powered terminal unit space temperature. The sensor shall meet the following minimum requirements:
1. RTD or thermistor sensors meeting the specifications detailed in the BMCS Field Devices - Air section of these specifications together with their associated signal conditioning facilities.
 2. Temperature sensor shall be calibrated following installation.
 3. Install at locations as shown on the Mechanical Base Building Drawings or as in the Mechanical Interiors Drawings. All room sensors for base building terminal units shall be installed as part of this contract. For fan powered terminal units within the base bid and alternate prices that do not have a location shown on the Base Building drawings, provide 50 feet of room sensor cabling coiled, enclosed in plastic wrap and tie wrapped to the side of the unit during construction.
 4. Provide cabling between the sensor and the UC at the terminal unit. Provide the required distance of cabling and conduit for sensors shown. Mount room sensor 48 inches above finished floor level. Coordinate exact locations with Architectural Plans.
 5. Space temperature sensors for UC serving the public areas shall utilize button type sensors as specified in the BMCS Field Devices - Air section of these specifications. Refer to the Mechanical Drawings for button sensor locations.
- L. Provide as part of the UC differential pressure transducers for the monitoring of the terminal unit primary air flowrate. The differential pressure transducer shall meet, at minimum, the requirements:
1. Monitor the differential pressures generated by a multi-point averaging device, such as the Barber Colman flowcross sensor, located in the primary air duct. The terminal unit manufacturer shall provide the multi-point averaging sensors. Coordinate with the terminal unit manufacturer for range of pressure differential.
 2. The pressure differential transducers shall be on the UC. The terminal unit manufacturer as part of the factory installation shall provide tubing from these sensors to the multi-point averaging devices.
 3. The differential pressure sensors shall be Honeywell Microbridge DP sensors or equivalent and shall monitor the flowrates with an accuracy of + or - 5 percent in the flow range of 1.5 to 15 meters per second (300 to 3,000 feet per minute). The BMCS subcontractor shall calibrate each differential pressure sensor in the field following installation.

4. Provide a one-micron filter on the pressure differential sensor if it monitors a moving air stream.
 5. If an automatic calibration program requires the automatic zeroing of the flow sensor and transducer, provide a coordinated sequence of operation that ensures the associated AHU is not operating during the automatic calibration procedure.
- M. Furnish primary damper actuators, for factory mounting, meeting the following requirements:
1. Direct shaft mounting.
 2. Adequate torque, 35 inch pound force minimum, to properly operate the damper from fully open to fully close without binding.
 3. Locking "V" groove or similar means to prevent slippage between actuator and shaft.
 4. Removable without the requirement to remove any ductwork or flexible connections.
- N. Furnish heating hot water valves and provide actuators as specified in the BMCS Valves of these specifications. Floating point type control valve actuators are not allowed.
- O. The UC shall monitor and control the following parameters for fan powered terminal units:
1. Space temperature.
 2. Primary air flowrate.
 3. Damper modulation.
 4. Heating coil valve control.
 5. Fan on/off and fan flowrate control.
 6. Fan flowrate monitoring (via control signal algorithm provided by unit manufacturer).
 7. Discharge air temperature.
- P. PID algorithms shall maintain the system operation within + or - 1.0 Deg. F. of the space temperature setpoints.
- Q. The operator shall be able to access the FPTU UC by connecting the ROW to the secondary LAN at the space temperature sensor enclosure. It shall not be necessary for the operator to obtain access to the ceiling plenum in order to obtain an operator interface to the UC. At minimum, the operator shall be able to undertake the following functions via the ROW and OIW:
1. Change a space temperature setpoint for a single terminal unit.
 2. Change a space temperature setpoint for a group of terminal units.
 3. Change an alarm limit/value.
 4. Change the operating mode for a single terminal unit.
 5. Change the operating mode for a group of terminal units.
 6. Change the occupancy schedules for a single terminal unit.
 7. Change the occupancy schedules for a group of terminal units.
 8. Set the primary air damper on a terminal unit to:
 - a. The maximum cooling flowrate setpoint.
 - b. The closed position.
 - c. The fully open position.
 - d. Minimum cooling flowrate setpoint.
 - e. The heating flowrate setpoint.
 9. Turn the fan on/off for a single fan powered terminal unit.
 10. Turn the fans on/off for a group of fan powered terminal units.
 11. Open/close heating valves for a single fan powered terminal unit.
 12. Open/close heating valves for a group of fan powered terminal units.
 13. Set the fan volume setpoint limits and range for a fan powered single terminal unit.
- R. Following the installation of the FPTU in the ceiling space the BMCS subcontractor shall undertake the following tasks:
1. Physically connect the UC into the BMCS secondary LAN.
 2. Install and wire the discharge air temperature sensor.
 3. Install and wire the heating valve actuator.
 4. Install all data into the UC as necessary for the correct operation of the terminal unit including:
 - a. Terminal unit-UC LAN address.
 - b. Primary air damper flowrate setpoints.
 - c. Space temperature setpoints.
 - d. Night setup/setback start up temperatures.

- e. Night setup/setback shutdown temperatures.
 - f. Fan flowrate setpoints.
 - g. All other parameters which may not have been entered before shipment of the UC to the terminal unit manufacturer, such as control constants, engineering units conversion factors, default operating schedules, definition of terminal unit type, etc., as necessary to define the operation of the terminal unit in accordance with these specifications.
5. Reconfigure the ECM motor controller from the factory set manual mode to the automatic mode. This reset shall be dipswitch settings on the ECM controller.
 6. Calibrate the space and discharge air temperature sensors.
 7. Verify that the UC modulates the primary air duct dampers from fully open to fully closed and vice versa within the specified time and verify either visually or by feel that the damper closes fully under UC control.
 8. Verify that each of the heating valve modulates from the full open to full closed positions.
 9. Verify that the terminal unit UC is satisfactorily integrated into the LAN.
 10. Provide a laptop PC software to the Air Balancing Subcontractor for their use in performing the air balancing tasks. Provide training of the proper use of the laptop PC software to the Air Balancing Subcontractor.
 11. Assist the Air Balancing subcontractor as required for the complete commissioning, calibration and operational verification of the HVAC and terminal unit systems. Refer to Section 23 05 93, Testing, Balancing and Adjusting.
 12. Verify that the operating sequences are correct and that there is stable modulation of the primary air damper and the heating valve.

2.6 UNITARY CONTROLLER – MOTORIZED FLOOR DIFFUSER

- A. Each motorized floor diffuser groups UC. The number and location of floor diffusers shall be shown on the Mechanical Interior Drawings. The motorized floor diffuser UC shall be fully programmable and shall not be application specific.
- B. The motorized floor diffuser unit manufacturer shall provide the following components for each unit for interface and mounting of the UC:
 1. Floor diffuser motor.
 2. Mounting bracket for the UC.
 3. 24 VAC control transformer.
 4. Connections to allow up to two different groups of six slave units to be controlled from the single motorized swirl diffuser controller.
 5. 0-10 Vdc swirl damper modulation interface.
- C. The BMCS subcontractor shall field install the following components for each group of motorized floor diffusers (serving the same room) at the master diffuser:
 1. UC.
 2. Room temperature sensor.
 3. Connection from the UC to the power supply for UC power.
 4. 0-10 Vdc connection from the UC to the master motorized floor damper controller.
 5. Cabling between the master motorized diffuser and the slave motorized diffusers.
- D. Provide a wall mounted space temperature sensor for the monitoring of the fan powered terminal unit space temperature. The sensor shall meet the following minimum requirements:
 1. RTD or thermistor sensors meeting together with their associated signal conditioning facilities.
 2. Temperature reported shall have an accuracy of + or - 0.5 Deg. F.
 3. Enclosure shall be as follows:
 - a. Rugged plastic or metal.
 - b. White color.
 - c. There shall be no logos, trademarks, names or evidence of their removal on the enclosure.
 - d. Cover shall be removable to allow access to the plug for the ROW.
 4. Temperature sensor shall be calibrated following installation.
 5. Install at locations as shown on the Mechanical Base Building Drawings or as in the Mechanical Interiors Drawings. All room sensors shall be installed as part of this contract.
 6. Provide cabling between the sensor and the UC at the terminal unit. Provide the required

distance of cabling and conduit for sensors shown. Mount room sensor 48 inches above finished floor level. Coordinate exact locations with Architectural Plans.

- E. The UC shall monitor and control the following parameters for motorized swirl diffuser groups:
 - 1. Space temperature.
- F. Proportional algorithms shall maintain the system operation within + or - 1.5 Deg. F. of the space temperature setpoints.
- G. The operator shall be able to access the UC by connecting the ROW to the secondary LAN at the space temperature sensor enclosure. It shall not be necessary for the operator to obtain access to the floor plenum in order to obtain an operator interface to the UC.
- H. Following the installation of the motorized diffuser in the under floor space the BMCS subcontractor shall undertake the following tasks:
 - 1. Physically connect the UC into the BMCS FLAN.
 - 2. Install all data into the UC as necessary for the correct operation of the terminal unit including:
 - a. Terminal unit-UC LAN address.
 - b. Space temperature setpoints.
 - c. Night setup/setback start up temperatures.
 - d. Night setup/setback shutdown temperatures.
 - 3. Calibrate the space temperature sensor.
 - 4. Verify that the UC modulates the motorized damper from fully open to fully closed and vice versa within the specified time and verify either visually or by feel that the damper closes fully under UC control.
 - 5. Verify that the terminal unit UC is satisfactorily integrated into the LAN.

2.7 LIGHTING CONTROL RELAY PANELS (LCRP)

- A. Furnish lighting control relay panels as indicated on the Electrical Drawings and Specifications and in the BMCS Field Termination Schedules section of these specifications for installation by Electrical subcontractor. The electrical subcontractor shall provide all conduit, conductors, and make all terminations for all lighting circuits as shown on the Electrical Drawings. Coordinate the requirements of this Section with all other trades.
- B. Lighting Control Relay Panels shall meet, at minimum, the following requirements:
 - 1. NEMA 1 enclosure with hinged door and lockable enclosure.
 - 2. 18 gauge backplane with one-half inch knock outs for relay mounting.
 - 3. Capable of housing 24 or 48 lighting relays as indicated on the Electrical Drawings.
 - 4. Provide the quantity of relays required at each location as indicated on the Electrical Drawings.
 - 5. Transformer assemblies with 277 Volts primary, internal overload, and power line spike protection capable of simultaneous switching of all relays.
- C. Lighting relays shall meet, at minimum, the following requirements:
 - 1. 21-30 VAC (class 2) momentary 30-38 VDC momentary supply voltage.
 - 2. SPST maintained mechanically latching relays,
 - 3. 20A at 277 VAC contactor ballast rating.
 - 4. 1/2 hp @ 120 VAC, 1/2 hp @ 220-277 VAC motor rating.
 - 5. Pilot contact for status feedback.
 - 6. Terminal connections suitable for 14-10 AWG solid or stranded wire.
 - 7. Rated for 50,000 full load cycles and 100,000 no load cycles.
- D. Communication Interface:
 - 1. The lighting relay control panels shall be fully integrated into the BMCS. All features, programming and functions shall be programmable via the BMCS without any third party software.
 - 2. The BMCS shall interface to the Lighting Relay Control Panels at each panel location.
 - 3. The LCRP communication shall be one of the following communication protocols compatible with the BMCS:
 - a. BACnet TCP/IP.

- b. BACnet MS/TP.
 - c. LonWorks.
 - d. Modbus RTU.
 - e. Modbus TCP/IP.
4. The communications interface shall be configured to provide, at minimum, the following monitoring and control points:
- a. Lighting relay on and off control for each relay.
 - b. Lighting relay status for each individual relay.
- E. If it complies with these Specifications, the LCRP manufactured by one of the following manufacturers will be acceptable:
1. General Electric.
 2. Lumisys.
 3. Lutron.
 4. Synergy.
 5. Wattstopper.
 6. BMCS manufacturer.

PART 3 - EXECUTION

3.1 LCRP CONFIGURATION

- A. Configure the relays into the control zones identified within the Electrical Drawings and the Field Termination Schedules. Provide floor plan graphical displays for each zone of lighting control identified throughout the building. All grouping of zones and override control shall be through the BMCS.
- B. Interface zone definitions such that zone status will not be proven unless all relays associated with that zone have proven to be operational.
- C. Provide operator changeable override timer setpoints on a zone by zone basis.
- D. Provide flash off indication that an override time period is about to expire. Flash notification warning times shall be operator definable.
- E. All BMCS commands including zone time control, on/off control, and operator override shall be executed by the lighting control relay panel within 2 seconds of BMCS command. The lighting control relay panel status shall be updated by the BMCS within 4 seconds of change in value.

END OF SECTION