25 05 01 General Requirements

1. General

1.1. Building Automation System (BAS), Direct Digital Control (DDC), and Queens University Energy Management System (QUEMS) are used interchangeably to mean the building automation system.

1.2. All projects requiring BAS hardware shall install hardware to match the existing system. All BAS projects are to connect back to the central server.

1.3. Ventilation heating coils shall be controlled even when the fan is not operating.

1.4. Multiple heaters, air conditioners or heat pumps located in one room should have a common thermostat and controls.

1.5. Pneumatic actuators may only be used inside of mechanical rooms with control air being supplied by a dedicated controls compressor in the mechanical room. Control air is not to leave mechanical room. Actuators outside of mechanical rooms to be electric.

1.6. Union cocks shall not be used on pressure gauges. Shut off valves for pressure gauges shall have packing or elastic seals on valve stems. Ball valves are an acceptable alternative.

1.7. Strap-on thermometers are not acceptable.

1.8. For new builds and project replacing major mechanical equipment: The BAS must be on line and available on the central server before commissioning any mechanical equipment.

1.9. Demand response programming to be incorporated in control sequencing.

2. Responsibility for Supply

2.1. All DDC control panels, expanders and multiplexors, etc. shall be supplied by the contractor. The panel cabinets and all necessary installation components shall be supplied by the contractor.

2.2. The successful supplier shall be responsible for all work under the contract.

2.3. Controls contractor to supply all controls wiring and conduit.

3. Field Control Work

    3.1. Work shall include all the required services to complete the system.

    3.2. Work shall include the supply and installation of all field devices including sensors, interface devices, individual room controls, transducers, relays, valves, dampers, actuators, solenoid valves, field wire, tubing, BIX terminations, connections, panels, etc., to create a fully functional system.

    3.3. The contractor shall provide all necessary co-ordination to achieve a successful project.

4. Building Automation System (BAS)

    4.1. Work shall include installation of DDC panels including all programming. Where start/stop is specified the installer shall establish programs and schedules suitable to the equipment controlled.

    4.2. Where analog control is specified, the installer shall establish programs suitable to the equipment controlled. To be accepted the programs must be functional and demonstrate stable control, conserve energy and meet Ontario Building Code requirements.

    4.3. The contractor shall provide engineering and commissioning of all field components.

    4.4. The contractor shall provide a full two (2) year warranty on all hardware and installation.

5. Removal of Existing Devices

    5.1. All pneumatic devices, freezestats, etc. which are removed shall be turned over to the owner.

6. DDC Control Panel

    6.1. The DDC control panel shall match the existing installation, or if a new installation, be one of the following installed with latest software:
    - Delta panel
    - Automated Logic panel

7. Power Supply

7.1. Each control panel shall be powered from a dedicated, resettable breaker, Class 2 type transformer, minimum 50 VA. There shall be a UPS for backup power feeding the mechanical room control panels. The UPS must have a dry contact to indicate fault or battery fault. The dry contact must be connected to a controller to indicate such condition, including a graphic showing UPS status.

8. Remote Server and Web Access

8.1. The building automation system (BAS) will be accessible remotely through the use of the central server using any web browser. A static IP address will need to be given to the hardware, coordinate with PPS. The BAS server will be housed on a virtual server in the Queen's Dupuis Data Centre. The existing BAS campus map will be updated with a link to the new building.

8.2. The BAS shall allow an unlimited number of concurrent users.

8.3. The BAS manufacturer shall provide all software and tools necessary to create and/or edit programming and graphics in the system.

9. DDC Graphics

9.1. The DDC system shall be provided with a graphical user interface allowing the display and modification of system parameters. The graphical interface shall include "point and click" navigation to allow users with read only access to navigate all graphics intuitively and easily.

9.2. The graphical user interface shall include but not be limited to:

9.2.1. Floor plans showing the location and current reading in engineering units of all space condition sensors (i.e. temperature, humidity, CO2, pressure).

9.2.2. System schematics for heating and cooling systems showing all related sensor readings, all related control device values and setpoints, as well as related pump and fan command and status values.

9.2.3. Ventilation system schematics showing all related sensor readings, all related damper and valve control values and setpoints as well as and related fan and pump commands and status values.

9.2.4. A graphically oriented means by which the owner may adjust system parameters such as operating schedules and set points.

9.2.5. An “As-built” page with links to;

- Floor Plans with panel and controller locations and control wiring routing.
- Shop drawings.
- Control Narratives.

10. Equipment Status

10.1. Where the status of electrical devices such as motors or heaters must be monitored, the preferred interface with the control panel is via a current donut.

11. Freezestats

11.1. Freezestats shall be manual reset for all systems and shall be capillary type sensitive to the nearest 0.3 ft. The element shall be of sufficient length to traverse ducts, coils or plenums three times (see 17.517). Replace existing 1 pole freezestats with suitable 2 pole freezestats to provide alarm connection.

11.2. Freeze stats shall be dual pole, one of the relay contacts to be wired to the fan starter and the other contact to be wired to the BAS controller for indication, alarming and proper equipment shutdown sequence.

11.3. Low condensate temperature freezestats shall not be installed or connected.

12. Pressure Sensors

12.1. Pressure sensors shall be differential pressure type with range and output to suit application.

12.2. Acceptable sensor types are: Enercorp Model LPTB

13. Current Operated Switches

13.1. Acceptable current operated switches are: Greystone CS-100, Enercorp Model D150-1

14. Solid State Relays

14.1. Interface to motor controllers or other electrical loads shall be through a high "coil" impedance solid state relay. Where the controlled load exceeds two (2) amperes, provide an electro-mechanical relay controlled by the solid state relay to make and break the controlled circuit.

14.2. Acceptable types are:
Grayhill #70S2-04-B-06-S (120V, 6A)
Grayhill #70S2-04-B-12-S (120V, 12A)
Delta #SSR700 (240V, 12A)
Syrelec #ARSF 15AD (15A, 24/240 VAC)
(hockey puck mount to snap track adapter required)

15. Electric to Pneumatic Transducers

15.1. Pneumatic equipment shall be controlled using electric to pneumatic transducers (EPTs). Acceptable types are:
Delta EPT750
Greystone ETP-8500
Enercorp VIP-9000
Barber Colman CP-8551
Acceptable filters to be installed with EPTs:
Johnson A-4000-137
Barber Colman AL-431
Balston 9900-05DX

15.2. Air pressure gauges installed with EPTs shall be 1-1/2" in diameter and have a range of 0-30 psig. Gauges shall be firmly supported by mounting in brass gauge blocks which are to be securely attached to enclosures with mechanical fasteners.

16. Cabling

16.1. Cabling to Field Interface Box (FIB)

16.1.1. Cabling to the field interface box shall be accomplished using copper multi-pair cable with uniquely colour-coded pairs. AWG 24 wiring shall be used for runs of 300 feet or less. AWG 22 shall be used for runs of 300 feet or more. Aluminum conductor cable shall not be used for signal transmission purposes. Size cables for 25% spare conductors. CAT6 cable shall be used for Ethernet-enabled devices.

16.2. Floor Distribution

16.2.1. Cabling from the floor distribution box to sensor/actuator location shall be accomplished with 24 AWG stranded cable Beldon 9501 or equivalent.

16.3. Room Temperature Sensor Cable

16.3.1. Cable between room temperature sensors and remote I/O units shall be Belden 9501 single pair cable or approved equivalent.

16.4. Remote I/O Unit Network Cable

16.4.1. Cabling between the main control panel and remote I/O units shall be FT6 CAT6 data cable containing 2 pairs of conductors minimum.

16.5. Installation Practices

16.5.1. All installations shall be performed in a neat and professional manner throughout and shall comply with applicable codes and legislation.

16.6. Conduits

16.6.1. Unless explicitly specified by PPS, all wiring outside electrical enclosures shall be installed in EMT. Conduits shall not be filled past 75% of capacity. A pull rope shall be left in each conduit when the installation is complete. Bend radius shall be greater than 3 times the conduit diameter. A maximum of three 90 degree bends is permitted between pull boxes. The installation shall follow horizontal and vertical lines to fit the layout of the area and shall be properly installed.

16.6.2. Conceal conduits except in mechanical and electrical service rooms and other unfinished areas.

16.6.3. Where it is not practical to conceal conduits in finished areas, obtain written authorization from PPS to use surface mounted raceway (SMR). Use a commercially available SMR acceptable to PPS with compatible components.

16.6.4. All surface mounted boxes shall have covers designed to fit the box without exposed sharp corners.

16.7. Cable Labelling

16.7.1. Each multi-conductor cable shall be indelibly labelled at both ends with its cable number. A list identifying the signal carried by each pair in the cable and the cable colour code shall be provided as part of the documentation package.

16.7.2. Single pair cable, such as is used in floor distribution (17.402), shall be indelibly labelled at both ends with the name of the signal conveyed.

17. Pneumatic Installation

17.1. An air pressure gauge shall be installed on the control side of each electric to pneumatic transducer and on the supply to each transducer enclosure. An inline air filter shall be installed on the supply side of each electric to pneumatic transducer. Exposed control air piping shall be type "M" copper. The installation shall follow horizontal and vertical lines to fit the layout of the area and shall be properly installed. Copper tubing joints shall be solder fittings except at the instruments where compression fittings may be used. Nonmetallic tubing joints shall use barbed connectors. The use of tubing as connectors is not acceptable. Pneumatic tubing shall be tagged at both ends with the name of the signal conveyed. All pneumatic components removed shall be turned over to the owner.

17.2. Exposed tubing below a dropped ceiling or less than 3m above the floor in rooms without a dropped ceiling shall be type "M" copper.

18. Component Labelling

18.1. Engraved lamacoid plastic name plates with white lettering and a black background shall be installed at all sensors, control panels, field interface boxes and all other instruments to clearly indicate the service of a particular device.

18.2. On all sensor nameplates provide the point descriptor name (e.g. DUN_A01_MAT). Point descriptor names shall follow the Descriptor Naming Guideline presented in Section 25.601.

18.3. Provide a nameplate at each computer connection labelled "COMPUTER CONNECTION".

18.4. Attach a nameplate to the outside of each FIB and control panel. Nameplate shall indicate panel type and panel number (e.g. FIB-2A).

18.5. Each FIB nameplate shall also indicate associated control panel and control panel location.

18.6. Beside each relay, EPT etc. attach a permanent nameplate indicating the point descriptor associated with the relay.

18.7. Mechanically fasten nameplates.

18.8. On each motor starter attach a nameplate indicating point descriptor of the starter.

19. Component Attachment

19.1. Components, as well as cable, conduit and tubing, shall be attached to a means of support using suitable hardware. Adhesive mounting devices are not acceptable.

20. Outdoor Air Temperature Sensors

20.1. Outdoor Air Temperature Sensors (OAT) shall be installed on the north side of the building, well away from sources of heat such as lamps or exhaust vents. OAT sensors shall not be mounted in locations where there is a horizontal surface less than five feet below the sensor.

20.2. All acceptable OAT sensors have a solar shield. The sensor shall be oriented so that the shield opens downward. The conduit running to the sensor box from the building interior shall be sealed to prevent ingress of warm building air. Sensor shall be mounted to an FS type box. An FS cover and gasket shall be installed.

20.3. OAT sensors shall not be mounted in fan intakes.

21. Control Panel Installation

21.1. The control panel shall be installed in a non-locking electrical enclosure with hinged cover and with minimum dimensions of 30" in height, 20" in width and 6" in depth. The panel shall be mounted in such a way as to allow the installation and access to expander modules.

21.2. Control panel cabinets shall have a removable inner mounting plate.

21.3. Field interface devices such as relays and pneumatic transducers shall not be mounted in the same enclosure as the control panel.

21.4. The control panel 24Vac supply transformer shall be mounted in a 12"x12"x6" electrical enclosure with hinged cover. A dedicated 120Vac circuit shall be wired to the transformer enclosure with hinged cover. The contractor shall provide a 120Vac, 15A duplex receptacle at the transformer enclosure for use by maintenance personnel. No 120Vac shall be in the control panel cabinet.

21.5. A power supply filter shall be provided on the primary side of the control panel supply transformer and the transformer shall be fused appropriately.

22. Field Interface Devices

22.1. Field interface devices such as relays and pneumatic transducers shall be mounted in suitably sized electrical enclosures with hinged covers. Multiple devices may be installed in each enclosure, however, pneumatic devices and relays shall not be mounted in the same enclosure.

22.2. Where it is necessary to control an electrical load drawing more than 2.0 A RMS current, or where it is necessary to control a load supplied from more than 240 VAC, provide an electromechanical relay to open and close the control circuit. Mount in an enclosure near the associated FIB. The coil of the electromechanical relay shall be controlled by a solid state relay.

23. Thermowell Installations

23.1. Piping shall be fitted with 1/2 NPT saddles or threadolet fittings to accommodate brass wells. Wells shall be filled with a thermally conductive compound.

24. Communication Installations

24.1. Network communications connections are to be coordinated with PPS. BAS to use dedicated BAS network inside the building. Communication to the BAS server in Dupuis Hall shall be through a subnet IP Address.

25. Cutting, Patching and Painting

25.1. The contractor shall do all cutting and breaking works, removal of rubbish, etc. required in the building for the installation of the work. The contractor shall be responsible for patching and painting to match existing finishes damaged during construction.

26. Cleaning

26.1. Leave area clean at the end of the day. Remove waste materials and rubbish from the site.

27. Fire Prevention

27.1. All necessary precautions must be taken to eliminate any possible fire hazard. Provide sufficient and adequate firefighting equipment in first class order, to protect against any fire emergency in the area of the work. Provide firestop caulking when a penetration has been made through a fire separation.

28. Existing Enclosures

28.1. Where approved by PPS, existing enclosures containing equipment made redundant by this installation may be reused provided they are of sufficient size and are undamaged. Remove redundant equipment. When reusing enclosures ensure any reference to cable numbers in or on the enclosure are corrected to indicate the current cable number.

29. Sensor Installation

29.1. Mount sensors to manufacturers' instructions. Duct temperature averaging sensors shall have capillaries of sufficient length to traverse the duct three times. Averaging type duct temperature sensors shall be used for measuring:

29.1.1. mixed air temperatures;

29.1.2. supply air temperatures when the sensors cannot be placed downstream of both coils and fans;

29.1.3. hot deck temperatures;

29.1.4. cold deck temperatures;

29.1.5. temperatures that are to be sensed immediately downstream of coils.

29.2. Return air temperature sensors shall be installed upstream of return fans.

29.3. Supply air temperature sensors shall be installed downstream of supply fans.

29.4. Dampers and Valves

29.5. It is the responsibility of both the controls contractor and equipment suppliers to ensure the proper operation of valves, dampers, and linkages.

29.6. Damper operators shall not be mounted in the air stream. Damper operators shall be easily accessible for adjustment, maintenance and replacement.

30. Naming Convention

30.1. Names shall be reviewed with PPS before implementation.

30.2. QUEMS II computer names are composed of 8 to 16 characters, including two underscores (###_###_########).

30.3. The first three characters (***_###_####) define location, or logical grouping (e.g. JEF for Jeffery Hall, GOO for Goodwin Hall).

30.4. The next two or three characters (###_***_####) define the system. Air handling systems are named as A## (i.e. A01 to A99).

30.5. Last set of (3 or up to 8) characters (###_###_********).

30.6. The first two characters (###_###_**) define the "device" (e.g. PU for pump, HC for heating coil, IV for chiller inlet vanes, SW for supply water, ZN for a zone, etc. ...).

30.7. The third or fourth character (###_###_##* or ###_###_###*) usually defines the function of the point (e.g. C for control of equipment (start/stop or analog output), S for status of equipment (such as on or off), T for temperature, Z for setpoint.

30.8. Extra characters MAY be needed to identify particular devices. Such is the case with multiple zones (zone l to zone n), multiple pumps (induction heating loop, reheat heating loop, etc.), or any system with more than one item of similar function. This "qualifier" character will appear (when needed) as the character before the function (last) character (###_###_##*#). This character may be digits or letters.

EXAMPLE: Dunning Hall Air Handling Unit #1 mixed air temperature DUN _AO1_MAT

EXAMPLE: Dunning Hall Heating System Pump #1 status: DUN_HTG_PU1S

31. The contractor shall program the panels with programs suitable to the equipment controlled. To be accepted the programs must be functional, demonstrate stable control, conserve energy and meet Ontario Building Code requirements.

32. Control of Major Equipment

32.1. Major equipment such as chillers and boilers shall be equipped with controllers from the manufacturer to control the equipment. The equipment controller shall be used to control related equipment critical to the proper function of the system such as pumps, valves and cooling towers. The BAS shall be hardwired to the equipment controller for enable, disable, and status signals. Other non-critical monitoring can be accomplished using BACnet.

33. Building Load Monitoring

33.1. Building heating and cooling loads shall be monitored through the use of flow meters, supply water temperature and return water temperatures on chilled water loops, and space heating water loops. Based on above values, the BAS shall calculate heating and cooling demand. BAS shall record peak readings annually and trend demand data.

34. Commissioning

34.1. Procedure

34.1.1. The contractor shall give 5 working days' notice to PPS before starting commissioning of a system. PPS reserves the right to witness commissioning.

34.1.2. As part of commissioning the contractor shall verify that each sensor and actuator is correctly wired back to the control panel input and that the wiring is free from opens, short circuits and ground faults. Switch or contact inputs shall be checked to ensure that the state is interpreted correctly by the panel and graphics Actuator response to commands shall be verified. Record actuator pressure control ranges and if values are N.O. or N.C.

34.1.3. The contractor shall coordinate system shutdowns with PPS in order to minimize inconvenience to the building occupants.

34.1.4. During commissioning the contractor shall record on a form acceptable to PPS the status of each point when commissioning. Any deficiencies shall be noted. When deficiencies are corrected the point shall be rechecked for proper operation and recorded.

34.2. Provide a copy of all signed verification reports to PPS.

34.3. Documentation

34.3.1. The following documentation shall be provided:

34.3.1.1. Schematic of each system showing component names

34.3.1.2. Floor plan showing areas served and location of equipment

34.3.1.3. Cross referenced point names to be provided on paper and in Excel or compatible format on USB drive.

34.3.1.4. Description of dampers and valves including whether normally open or normally closed

34.3.1.5. Commissioning signed verification report

34.3.1.6. Sensor calibration data

34.3.1.7. Catalogue cuts for parts supplied

34.3.1.8. Diagram of each FIB showing location of components, control circuit wiring, point descriptor and name of equipment controlled or monitored. Indicate relay type.

34.3.1.9. Control narrative, describing in detail the sequence of operation.

34.4. Standards and Format

34.4.1. Drawings shall be provided on paper and in AutoCAD format on a USB drive.

34.4.2. Drawings shall contain the standard Queen's University at Kingston drawing block supplied by PPS

34.4.3. Each system shall be on an individual drawing with the sequence of operation for that system on the drawing in Queens University at Kingston format.

34.5. Schedule for Provision of Documentation

34.5.1. Draft documentation package shall be delivered to PPS on or before the start of commissioning. Final documentation shall be delivered following completion of commissioning and revision of draft documentation.