23 09 23 – DDC Systems for HVAC

Contents

PART 1 – GENERAL

1.1 WORK INCLUDED

Summary:

Provide labor, materials, equipment, services and warranty for complete installation, startup and commissioning of all HVAC equipment controls as required in the Contract Documents.

Provide all control wiring and the conduit as required to connect devices furnished as a part of, or integral to the automatic temperature control system, and for connections to the motor control regardless of the source of supplied power. Control wiring includes the 120 volt and lower voltage wiring as needed to utilize control signals directing the equipment operation.

Control circuits shall be 24VAC in general, and no more than 120 VAC where required, Voltage higher than 30V shall not be directly connected to a control module, but rather through a low voltage interface relay.

Provide wiring in coordination and accordance with the requirements specified in Division 26, "Electrical" of this document, and the National Electrical Code. Unless indicated otherwise, all in-the-wall conduits and mounting boxes, such as the ones used for the Zone Sensors (Thermostats) shall be provided by Division 26.

Provide all devices required for proper system's operation including electrical switches, transformers, disconnect switches, relays, device controllers and control modules, actuators, transducers, sensors, safety devices, power supplies, mode selecting switches, enclosures, circuit breakers and the control software with graphics.

Provide complete wiring, wiring terminations, pneumatic tubing with accessories and cross-flow sensors where required. Provide all assembly, programming and testing of all items as necessary to create a coherent system, encompassing all combined intents of the design, drawings, specifications, addenda, and completed in a true professional quality of work.

A. RIT has its own TC System Server and adequate Ethernet network; this contract shall provide the equipment to send the data to the Ethernet Server and back to control units where required.

B. Coordinate all work with Division 26, "Electrical".

1.2 WORK NOT INCLUDED

- Power wiring for motors, motor starters and associated control equipment requiring power, (except in the case of equipment specified to have packaged controls/starters) are included in Division 26, "Electrical," unless otherwise called for in the Project Specific Documentations.

1.3 QUALIFICATIONS

A. Wiring installed in compliance with all requirements of Division 26, "Electrical."

B. Control wiring installed in compliance with the NEC, Automated Logic and RIT requirements.

C. All control wiring within line voltage cabinets to conform to Class 2 wiring standards.

1.4 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with this specification the Automated Logic is the only acceptable product. Additionally, all installed modules, software and control components must be compatible with the most recent version of Automated Logic Control System in use at RIT.

B. All HVAC equipment provided with the factory-mounted controls will have such controls installed in accordance with this specification.

1.5 BID CLARIFICATIONS

A. Along with the bid package all Contractors are required to submit minimum scope letter with:

1. Detailed Points Lists as were provided with the bid invitation; those should be filled out with details of control modules types showing clearly the relationships and particular points allocations to each controller including clearly identified spare I/O.

2. Specification Conformance: State by individual paragraph where your system cannot meet the requirements.

3. Statement summarizing the warranty period for all control components that are part of this project – including any components that carry a warranty beyond the required 2 year minimum.

1.6 QUALITY ASSURANCE

A. Acceptable Products: All products shall be proven to be functional and suitable in accordance with this specification for a period of warranty commencing on the day of transfer of the completed project to HVAC Operations and Controls Department Manager at FMS. Demonstration of such warranty may be required prior to the submittal approval.

B. Contractor Qualifications: The Controls Contractor *called thereafter the TC* shall be factory-authorized by the respective manufacturer to provide pertinent installation and service.

C. Field Representation: The TC shall staff the project with a field representative project manager that has been factory-trained in the installation, programming and commissioning of the equipment specified. This representative must be in the direct employ of the TC.

D. Any subcontractors in employ of TC on this project must receive prior approval of HVAC Operations and Controls Department Manager at FMS to be permitted work on this project.

E. Coordination of Work During Construction:

1. The TC shall protect work installed by other trades.

2. The TC is to coordinate its work with parallel projects.

3. The TC shall repair any damage caused by his/her work.

4. The TC shall promptly correct all the new work that HVAC Operations and Controls Department Manager at FMS finds as defective or not conforming to Contract Documents.

5. The TC shall bear all costs required to correct the new work found defective as described above, or cost of any restitutions caused in result of the TC performance proven faulty of thereof.

6. The TC Contractor shall bear all actual, as charged to RIT incidentals; costs resulted from setting the Building Fire Alarm, which afterwards required an unscheduled intervention of Fire Department, where such setting was initiated in direct result of the TC Contractor activities. The cost is defined as one-per-accident charge incurred by RIT.

F. Satisfaction of User's Needs: The TC shall deliver a complete project, which shall include all the instrumentation added by this project and integral to its control elements and components. The deliverables shall be presented to HVAC Operations and Controls Department Manager at FMS as a

singular graphical system with any and all listed below functions, and shall be able to achieve as listed below:

1. Project completed according to all current control standards and construction practices published by Automated Logic.

2. WebCTRL Graphical Interface (GI) based on the current operating Windows Platform running on the campus.

3. GI depicting all added instrumentation by this project allowing its monitoring and control.

4. GI equipped to navigate to any and all added equipment, integral to, and matching the central navigation system already in place, including matching existing system's nomenclature, object names, file names, directory structures, etc.
5. Local access to GI from the multiple locations communicating with a dedicated central server, networked to each group of control devices utilizing RIT-owned IP network.

6. Prior to commissioning the system server shall commence an automated, 24 hour/day monitoring and trending of the entire system added by this project.

7. Automated Alarm Monitoring allowing alarm Acknowledgment and Logging to file.

8. Event Alarms generated with multiple classes of importance.

9. Operator Generated Change (or adjustment) recorded and stored in the GI Event Logging.

10. Global Scheduling of equipment, available from each viewing location.

11. Calendar Functions supporting holiday, day-of-the-week and special time-triggered schedule exemptions.

12. Group Scheduling of Equipment S/S.

13. User's Log on Screen.

14. GI Control System accessible exclusively on recognition of authorized user, his individual password and assigned level of privileges.

15. System shall recognize Multiple Levels of User Privileges.

16. System shall include Graphical Data Trending, capable to be updated at operator-defined intervals and capable to zoom-in of trend sections for more detailed examination.

17. Tuning trend package integrated with system to adjust all PID parameters of analog outputs.

18. Global Data Base Updates, where a change of parameter entered through any authorized viewing station is instantly projected to the rest of the authorized viewing stations that may be on line at the same time.

19. On-line programming, download, upload and automated error correction of field control devices from each authorized Windows Station, where a change of program can be entered remotely through any authorized station, with effect on designated controller, and without a need to manually connect in the field to such controller.

20. Server-based data collection, error corrections and distribution of data to terminal devices.

21. Multi-level Secure Access to server.

22. Encryption between the server and client for Web transmission.

23. Errors-free system operation and its communication free of system timeouts.

24. Navigation to each controlled device from multiple viewing stations in real time.

25. Logic represented in a real-time, interactive diagram of graphical logic blocks.

1.7 SHOP DRAWINGS AND SUBMITTALS

A. Product Data: Submit for approval the manufacturer's technical product data for each component furnished as part of control system. Data shall include dimensions, capacities, performance characteristics, electrical requirements, and material finishes. Data shall also include installation, start-up requirements and operational instructions.

B. Shop Drawings: Submit for approval control drawings detailing the following:

1. Network Block Diagrams and System Riser Diagrams: These diagrams shall depict all DDC components that make up the network. They shall provide specific detail on network terminations, and panel power requirements, including breaker allocation. Each DDC panel within the diagram shall list all the control equipment that it part of such panel.

2. Point-to-point Termination Detail: These drawings shall be created for each unique control application type. Drawings that are typical for similar application shall state the application and quantity of that what they represent and the specifics for each. All wiring and piping required to install and operate the system shall be represented in these details. For terminations that are unknown at the time of submittal, or introduced over the course of project, properly designate these as “Field Determined Terminations,” and include in the As-built Drawings after completion. All wiring and piping shall be either number or color-coded on the drawings.

3. Provide individual details for each control type, as described in the Sequence of Operation.

4. Provide spreadsheets of schedules for dampers, valves, wiring, fans and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.

5. For prefabricated control panels, provide panel’s interior and exterior layout details. These details shall depict the equipment layout and shall detail the panel wiring and piping.

C. Database Information: The submittal package shall contain detailed information on the point naming convention that is to be used. Consult HVAC Operations and Controls Department Manager at FMS for currently used nomenclature for equipment and database points and utilize it in the project.

D. Provide documentation for all sequences of operation of any equipment added by this project.

E. Provide documentation for all sequences of operation that cannot be performed by stand-alone controllers and require non-controller-resident programs, or programs requiring retransmission to be effective on the controller’s output.

F. Provide a schedule of module allocations for each segment of control equipment to be approved by the HVAC Operations and Controls Department Manager at FMS. Provide specifics for equipment that will be served by multiple modules.

G. Provide the Project Points List in the standard FMS spreadsheet form, annotated with assignment of

control modules as appropriate to execute the required control function.

1.8 OPERATION AND MAINTENANCE MANUALS PROVIDED AT PROJECT COMPLETION

A. Upon completion of installation and prior to the training, provide manuals containing the following information:

1. Installation O&M and Service Manuals for all products and components.

2. Calibration and Troubleshooting Procedures for all installed equipment and components that have built in calibration futures.

3. List of location of all control enclosures, controllers, sensors, transformers and other components as specified above.

4. As built control floorplan(s) clearly showing the equipment on the mechanical floorplan. Drawing must show the exact location of all controls including panels, modules, thermostats, field located sensors, network devices, field located power supplies, etc. Drawings must also accurately show the exact and correct location of the network and thermostat, sensor wiring (along with any other field wiring).

5. As-built Control Drawings as specified above with all modifications, changes and wiring details that depict actual installation.

6. Sequence of operation – Describing in detail the operation of every piece of equipment subject to control by the DDC system. Each section of the sequence should contain the following:

   a) Overview – describes what the intent is, what components are involved and provides a concise description of the piece of equipment to be described.

   b) Occupied Mode – Describes the operation of this system during occupied periods.

   c) Unoccupied Mode – Describes the operation of this system during unoccupied periods.

   d) Alarm Mode - Describes operation of the system in the event of alarm condition and steps to restore system to normal operation. List all anticipated alarm conditions.

   e) Each Component's individual Sequence - Describes the detailed operation of each component and how it interacts with the entire system.

   f) List of all external interlocks and condition of their response and reset.

   g) List of all tests required to check interlock responses.

7. Listing of all DDC controllers with details of points, point's functions and controlled equipment.

8. Provide spreadsheets of schedules for enclosures, control modules, dampers, valves, wiring, fans, well, tap and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.

B. Provide laminated control diagrams and points list in each control panel showing wiring details of each piece of equipment whose controller(s) resides in the enclosure.

C. CD backup disk(s) to be delivered to HVAC Operations and Controls Department Manager at FMS that will allow FMS to fully restore the entire ALC System, including programming point database, configuration, graphic screens and all libraries of typically composed objects, and details supporting the

navigation, screens and graphics.

D. Within five working days from the time of the final system commissioning, two (2) sets of Operation and Maintenance Manuals shall be turned directly to Manager HVAC Controls Department at FMS – coordinate with mechanical contract for exact number also provide electronic copies.

1. A Programmer's Manual shall be provided with graphic and text descriptions of all functions required for software modifications and developments. This can be provided in the form of the CD received from the factory, containing latest release of help manuals and other technical bulletins.

2. Section for each Major Piece of equipment – Contains the cut-sheets for the controllers, custom programs, and relevant information pertaining to that piece of equipment. (IE: schedules for VAV boxes or AHUs showing RIT specific Equipment Tag, Controller address, serial #, airflow, and pertinent engineering units like MBH, GPM, etc.). (See RIT Building System Design and Best Practice Guidelines)

3. Wiring Details – Contains 8-1/2" x 11" drawings of all the wiring details shown throughout the set of drawings.

4. Instrumentation Cut Sheets – Contains the Manufacturer's original cut sheets for all the instrumentation used on the job. (IE: Well sensor, transformers, enclosures, pressure sensors, etc.).

5. Equipment Cut Sheets – Contains the Manufacturer's original cut sheets for all the equipment that was supplied for this job. (IE: VAV Box, Control valves, damper actuators, etc.).

6. AutoCAD Drawings – All drawings shall be provided in Auto CAD format (IE: each file format should have the "dwg" extension), made as set of both, a set 11"x17" black and white and a set of 24"x36" (1 color set and 3 black and white sets). Drawing Sets consists of the following:

   a) System Description Drawing – Shows the overview of the job and what is being controlled.

   b) Network Riser Drawings – Shows how the network is connected between all the devices on the job. This drawing is to show the network connections in the order they are installed in the field.

   c) Detail Drawing(s) – Shows all the wiring and piping details for the entire job – all other drawings refer to these drawings.

   d) Individual Control panel drawings & Schematics (1 or 2 drawings per piece of equipment) Shows the e*xact* wiring and layout of each control panel. Also shows the schematic representation of the system that is being controlled. (IE: AHU, HW Plant, CHW Plant, VAV Box, Heat pump, etc.).

   e) Controls Floor Plan page for entire building showing thermo graphic status of building zone temperatures.

   f) Controls Floor Plans (at least 1 for each floor) – Shows the exact location of the control panels, thermostats, equipment, network wiring, thermostat wiring and any specific controls required for the job. All this information is overlaid on top of the mechanical floor plan showing the architectural layout (wall and room numbers).

E. All above should be copied to a CD, and/or flash drive and released to HVAC Operations and Controls Department Manager at FMS. All the electronic documentation shall be shown in paper format for the O&M, plus any relevant information or tools used during commissioning

1.9 SYSTEM COMMISSIONING

A. The Owner will provide to the TC Contractor a Commissioning Check List Form according to which the Commissioning process will be completed.

B. The Owner will conduct a commissioning. No final payment can be approved prior to a successful completion of the commissioning.

C. TC shall complete Pre-Commissioning to assure operational readiness of equipment prior to conducting of commissioning.

D. All points connected to the EMS shall operate fully in accordance with this specification before the final completion is determined.

E. Equipment Start-up: Upon completion of installation, all equipment being controlled shall be initially started and tested on site, using the contractor-provided temporary PC or Laptop; upon completion of this process whole content of the temporary PC should be reloaded to the RIT owned Windows Server, which thereafter should continue to operate in a manner required by this specification. Such reload shall be done by insertion rather than by override of entire existing database. Additionally perform the following:

1. Measure, calibrate and adjust all analog inputs.

2. Stroke all analog outputs at 5 different points 0%, 25%, 50%, 75%, 100% and verify that all linkage adjustments are set properly, valves travel full stroke, VSDs control a full range, etc.

3. Valves and Dampers shall fully close and provide reasonably tight shut-off.

4. Verify that all digital outputs are properly energizing the controlled device.

5. Adjust setpoints so that equipment operates properly. Tune all PID control loops to avoid unnecessary cycling of control equipment, overheating, sub-cooling, and tripping the Freezestat and other limit switches and safeties. Create the trends and print trend results to verify a correct tuning operation.

6. Adjust all alarm parameters so that nuisance alarms are eliminated, no alarms shall remain disabled.

7. Enable all trendable points and historians. Remove point assignments of unused points.

8. Provide reasonable control and operational assistance to the balancing personnel as needed to achieve reliable and energy-efficient system operation.

9. RIT personnel will conduct its own commissioning to which the TC shall provide assistance;

   a) RIT Project Coordinator will complete Project Ready Checklist and TC shall assure that all items on the list are completed.

   b) All questions arising in a course of commissioning shall be answered by TC as part of this project.

F. Communication Network Start-up: Verify from a host computer that all configured controllers are engaged in proper communication passing all configured points to viewing stations without time-outs.

1. Monitor and review all network alarms during the commissioning process for dead module and COV alarms. Take correction action to eliminate any nuisance alarms.

2. Enable all trendable and historian points and construct a multi-point trend containing all relevant points within the same graphics. Enable trendable wired and networked points related to equipment operation with analog points at 5 minute sample intervals and digital points at COV. Historian shall be enables on all trendable points at the FMS 10,000 day default. Verify operation and PID tuning of all controlled devices and demonstrate at RIT Building Controls Department project turnover.

G. Software Verification: All programs and software functions shall be verified for proper sequence of operation.

H. TC shall, during the ensuing four seasons (one year), conduct periodical inspections to fine-tune all dynamic elements of the system.

I. TC shall --at no additional cost to RIT-- dedicate one full day in each of the four subsequent seasons (total of 4 days), during which all necessary tuning of dynamic parameters shall be conducted in the field. Coordinate with HVAC Operations and Controls Department Manager at FMS the dates for this activity.

J. Coordination: Work with the air-balancing contractor, ventilation contractor, piping contractor and electrical contractor to provide proper and obstruction-free component location, and a complete system commissioning.

K. As built Drawings: All drawings shall be reviewed after the final installation is completed and corrected to provide accurate, as-built representation of the complete system.

L. Commissioning Report: This report shall detail who and when the TC performed the individual startups mentioned above.

M. Project commissioning is considered completed only if a physical walk-though of the project, together by TC and HVAC Operations and Controls Department Manager at FMS was concluded and the complete set of required documentation and software has been transferred to HVAC Operations and Controls Department Manager at FMS. HVAC Operations and Controls Department Manager at FMS has the right to refuse or delay a scheduled walk through. The Walk-through shall be rescheduled with HVAC Operations and Controls Department Manager.

N. Contractor shall provide detailed spreadsheet of all added points to match the existing point summary archived at RIT Building Systems Control Room.

1.10 TRAINING

After commissioning is completed, the TC shall provide on-site session detailing the layout of the EMS. This shall include network wiring routes, control panel locations, transformer locations, etc., and;

A. The TC shall then provide on-site session to review the entire Operations and Maintenance manual(s) with HVAC Operations and Controls Department Manager at FMS. This session shall also include but not be limited to:

1. Fundamental operation of the system

2. Training on set points adjustment and scheduling modifications

3. Operation and sequencing of control loops for all mechanical equipment being controlled

4. Understanding of interlocks and the test routine to verify them.

B. Throughout the warranty period provide telephone support to answer system related questions and concerns.

1.11 WARRANTY

A. Warranty for the entire control system shall commence upon completion of the system commissioning as specified. The warranty includes fine-tuning of all dynamic elements of control system to achieve reasonable, efficient end equipment-protective mode of operation.

B. Provide a two-year warranty on the DDC system including all associated field equipment. Contract is to include 24-hour support including parts and service. Any exclusion of this condition should be submitted prior to or included in bid documents.

C. Disclose to HVAC Operations and Controls Department Manager at FMS and accommodate longer warranty periods if such are provided by components manufactured at the time of purchasing.

D. Provide Warranty Declaration Summary containing starting and ending dates of warranty for the entire (added by this project) system, its subsystems and particular hardware. Obtain RIT consent for those dates.

E. During the warranty period RIT may request setting to manual control for all affected controls until system is repaired. Define specific cases or condition where such activity would void the warranty or its part, should RIT attempt to manually control the system until it is repaired by the TC.

F. During the warranty, RIT reserves its rights to make a tuning, scaling, range, and zero adjustments on devices found out of calibration, even if such activity would result in breaking factory seals, if lack of such action could result in the equipment damage, safety or freeze hazard, or severe discomfort to the occupants. Such action shall in no way void, decrease, or in any other way result in a detriment of the warranty. The TC may request postponement of such action if he or she guaranties an effective service response in no more than 3 hours from the initial repair request. To be considered, such reservation should be stated on the Warranty Declaration Summary.

PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION

A. General Requirements

1. A distributed logic control system, complete with Direct Digital Control (DDC) and Direct Analog Control (DAC) software shall be provided. System shall be based on ANSI/ASHRAE Standard 135-1995, BACnet. This system is to control all mechanical equipment specified in the contract documents, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc. and all air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components.

2. The system shall use BACnet protocols and LAN types throughout and exclusively.

3. The TC shall provide system software based on server-client architecture, designed around the open standards of web technology. The TC server shall communicate using ASHRAE BACnet/IP protocol. Server shall be accessed using a web browser over RIT's intranet and remotely over the Internet.

4. The TC shall assume complete responsibility for the entire controls system as a single source, providing installation, program debugging and service of all portions of logic control system. This shall include designated server, operator's terminal, global controllers, routers, terminal unit controllers, sensors and all other sections of the system.

5. The web browser GUI shall provide a completely interactive user interface and must offer the following features as a minimum:

a) Trending

b) Scheduling

c) Real time 'live' Graphic Programs

d) Tree Navigation

e) Parameter display, change and change of properties

f) Setpoints adjustments

g) Alarm / Event information

h) Configuration of control mode including HOA manipulation with display of current HOA state on graphic page

i) Execution of global commands

j) All standard functions provided by WebCTRL.

k) Graphical representation of program with live data display in pertinent nodes of program

B. Basic System Features

1. Zone-by-zone direct digital logic control of space temperature, scheduling, optimum start, equipment alarm reporting and override devices for unoccupied mode of operation. A zone is the area served by one HVAC logic controller unit, such as a heat pump, VAV box, etc., utilizing common control sequence to achieve singular conditioning results at all control points, all at the same time.

2. Operator's terminal software shall run under Microsoft Windows platform operating system. The HVAC controls application program shall be written to communicate utilizing BACnet protocols. Software shall be multi-tasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Software shall support Windows Active X interface. Software shall strictly follow Microsoft Windows API guidelines. Systems using proprietary software or operating systems other than that described above are strictly prohibited. Operation of the terminal software shall be simple and intuitive.

3. Operator's terminal software shall contain capability to allow configuration of system-wide BACnet native controllers, including management and display of the controller programming.

4. During construction, if needed, at least one terminal shall be equipped to act as a system server. This system server shall store copies of all installed software for all field components and shall be capable of automatic or manual reloading of such software into the field components as required. The system server shall also gather and archive system-operating data, such as trends, energy logs, and other historical operating data.

5. Complete energy management firmware, including self-adjusting optimum start, demand limiting, global control strategies and logging routines for use with total control systems shall be supplied. All energy management firmware shall be resident in field hardware and shall not be dependent on the operator's terminal for operation. Operator's terminal software is to be used for access to field-based energy management control firmware only. All schedules shall be module resident and shall not be affected in case of interruption network transport between the module and the

host station.

6. Upon completion of the project, the Contractor shall integrate new field controllers into an existing server used by RIT.

7. Priority password security systems shall prevent unauthorized use. Each user shall have an individual password. The user shall only be given access to the system functions required for individual job performance.

8. Equipment monitoring, alarm functions and help files including information for diagnosing equipment problems shall be included with the system.

9. The complete system, including, but not limited to terminal unit controllers, higher level controllers and operator's terminals shall auto-restart, without operator intervention, on resumption of power after a power failure. Database stored in any controller's memory shall reside error free for a minimum of 1 year.

10. System design shall be modular and have proven reliability.

11. All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the operator's terminal shall be provided.

12. System shall be capable of equipment runtime totalization of fans, heaters, boilers, etc. and capable of alarm generation and alarm dial-out.

13. System shall be able to respond to RIT energy demand input and adjust the setpoints accordingly, or provide a total unit shutdown as centrally commanded.

14. *System shall be linked to and shall provide the Emergency Shutdown when Campus Emergency Shutdown is executed.*

15. Room sensors shall be provided with digital readout that allows the user to view room temperature, adjust equipment operating schedule, room setpoints, etc.

16. All controllers shall communicate using protocol as recommended by Automated Logic Control System as described in ALC documentations.

17. All hardware shall be Listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the UL Standard for Safety 916 in both the US and Canada, with integral labels showing rating.

18. All hardware shall be in compliance with FCC Part 15, Subpart J, Class A.

C. Graphical Interface (GI)

Each GI page depicting the floor in a building shall, in addition to the scaled down floor plan with room numbers and the North Arrow, have the following minimum features: thermo graphic zone scales and statuses, zone equipment and sensor distribution, the list of all room numbers on the floorplans, where each zone serves as a link to its zone equipment, and the links to other floors, sub floors, and if applicable, the roof of the same building.

Each GI page depicting particular piece of equipment shall have, in addition to the schematic of the equipment, the following data points linked to and representing actual state of the equipment, and possessing all futures as listed below:

1. Complete set of graphical representation of all associated with the depicted equipment points, such as Analog Inputs, Analog Outputs, Digital Inputs and Digital Outputs, including each respective current State or Value, Units of State or Value, the Hand-Off-Auto Manipulation Block, the State of the Schedule, Alarm State for all alarms requiring manual reset, Alarm Reset for all software resets, and other pertinent information as applicable.

2. Positioning of above elements shall be easily identified with particular control component.

3. Each page shall have adequate number of Manipulation Blocks functioning as overrides for each Outputs. Such Manipulation Blocks shall be designed to execute the operator-entered Change of the State Requests such as the Hand-Off-Auto, On/Off, Start/Stop, Open/Closed, etc., or other specific requests like Change of Speed, Percent of Open Valve or Damper, etc. Coordinate with Manager of Controls for current examples.

4. There are cases when installing such graphical controls may increase possibility of damage to the unit due to an unacceptable violation of sequence. Such cases should be identified, coordinated and approved for installation, or removed from the main operating graphic pages in accordance with approval of HVAC Operations and Controls Department Manager at FMS.

5. While it is desired to have a maximum of information on the same page, it may be practical to add additional pages, especially, if should such information would be difficult to fit on a singular page.

6. Complete set of Navigation Buttons, which, without the need to use the Navigation Tree, shall link the equipment to its sources of Heating, Cooling, Ventilation, Refrigeration, Exhaust, Heat Rejection Equipment, Pumps, Water Loops Control, Steam Generating Equipment, Filtering Stations, Fire Alarm Controllers, Compressors, Condensing Units, Heat Exchangers, Boilers, Generators, Fire Suppression Systems, light controls and other supporting equipment.

7. Provide dedicated chilled water page for systems that have more than one chilled water equipment entries. This page will show the accurate schematic of the entire chilled water system for the building and tie in to the campus chilled water loop. The schematic will include piping, valves, pumps, sensors and associated equipment. The page will have links to each piece of equipment shown on the page. This page is not required on projects that do not involve the chilled water system.

8. Provide dedicated hot water page for systems that have more than one hot water equipment entries. This page will show the accurate schematic of the entire hot water system for the building and tie in to the campus hot water loop. The schematic will include piping, valves, pumps, sensors and associated equipment. The page will have links to each piece of equipment shown on the page. This page is not required on projects that do not involve the hot water system.

9. Information on current Outside Temperature and Humidity. Such information shall be placed consistently in the upper left corner of the page.

10. Provide navigation tree linking to all controlled equipment. Such tree should be presented in logical structure of unit allocations in the building, building's floor, mechanical room, roof, etc.

D. Reference Standards

The latest edition of the following standards and codes in effect and amended as of supplier's proposal date and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

2. ANSI/ASHRAE Standard 135-2016, BACNet

3. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US

4. National Electrical Code (NEC)

5. FCC Part 15, Subpart B, Class A

6. EMC Directive 89/336/EEC

7. City, county, state, and federal regulations and codes in effect as of contract date

8. Occupational Safety and Health Act (OSHA)

9. National Fire Code

10. Uniform Plumbing Code

11. Except as otherwise indicated the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

2.2 TEMPERATURE SENSORS

A. General Use Temperature Sensors shall be Thermistor 10,000 ohm at 77°F with Precon type-2 material. Accuracy shall be +/-0.36°F.

1. Room Sensors

a) The room sensor shall incorporate an on-board 10K Thermistor for room temperature sensing. Range 35 to 140°F.

b) The room sensor shall provide a slide switch to allow the occupant to offset the programmed temperature setpoint of the unit controller by a programmable amount.

c) The unit controller shall monitor a push-button switch located on the room sensor. The status of the switch shall be usable in a supervisory control logic or algorithm or to override to an occupied mode for a programmable amount of time.

d) For monitoring only, use an encapsulated temperature sensor installed in a secure wall mounted housing. Range 35 to 140°F.

e) Room sensor item shall display sensor temperature. Room sensor installed in occupied spaces shall be Primary ZS Pro, in unoccupied spaces shall be ZS Base.

f) Approved manufacturer: Automated Logic, Precon Corp.

2. Duct Sensors

a) Single point duct mounted sensors shall have a minimum 9" rigid probe and be used when the duct size is less than 24". Temperature range: -30 to 160°F. Unit to include handy box housing.

b) Averaging duct-mounted sensors shall have a minimum 12.5’ long averaging element for all ducts larger than 4 square feet. Use a 20.0’ long averaging sensor for duct larger than 15 square feet. Temperature range: -30 to 160°F. Unit to include handy box housing.

c) Approved manufacturer: Automated Logic, Precon Corp.

3. Well Sensors

a) Liquid immersion sensors shall have a stainless steel probe and stainless steel well. Length of the sensor well shall be selected based on the diameter of the pipe to provide accurate, reliable sensing of the liquid temperature. Temperature range: 10 to 230°F.

b) All liquid immersion sensors shall be installed with thermal compound appropriate for selected sensor and the temperature conditions.

c) Approved manufacturer: Automated Logic, Precon Corp, BAPI.

4. Outside Sensors

a) The sensing element shall be a Precon ST-R-R sensor installed in ventilated aluminum housing with a Stainless Steel sunshield to minimize the radiant energy and wind effects. Temperature range: -30 to 230°F.

b) Approved manufacturer: Automated Logic, Precon Corp.

c) Make sure that the sensors are located away from any exhaust air outlets, or a location that in any way may be detrimental to the proper representation of ambient condition of air.

5. Averaging Sensors

a) The sensing element shall be long as needed to make a complete “Z”-shape traverse across entire measured area. Sensing probe shall be properly fastened and separated from any metal parts utilizing plastic grommets or other fasteners and separators.

B. Utility Temperature Sensors

1. Utility temperature sensors include any sensor that is to be used in conjunction with a flow meter with the intent of metering the amount of thermal usage.

a) Typical examples include, but are not limited to:

(1) Heat Exchanger MTHW supply and temperatures

(2) Boiler loop supply and return temperatures

(3) Chiller loop supply and return temperatures

(4) Building connect supply and return temperatures

(5) Central plant loop supply and return temperatures

2. Medium Temperature Hot Water Temperature (MTHW)

a) Any immersion temperature sensor that is connected to the Medium Temperature Hot Water (MTHW) system is considered to be a MTHW sensor.

b) These sensors shall have the following characteristics:

(1) 1K Ω Platinum @ 0 °C, 3.85 Ω/°C temp. coefficient.

(2) Designed to accommodate 250°F temperature water media continuously.

(3) Come with integrated calibrated transmitter with range: 50-250°F

(4) Transmitter is to be calibrated at 3 points 125°F, 200°F and 240°F

(5) Come with CE Declaration of Conformity letter

(6) Acceptable models

(a) Sensor – BAPI - BA/1K[2]-I-4"-WP

(b) Transmitter – BAPI - BA/T1K[50 TO 250F]-XOR-BB-TS

(c) Enclosure – BAPI Box (BB)

3. Chilled Water Temperature
    a) Any immersion temperature connected to chilled water piping with an associated flow meter is considered to be a Chilled Water Utility Temperature sensor.
    b) These sensors shall have the following characteristics:
        (1) Precon Type II Thermister, 10,000 Ohms at 77°F
        (2) accuracy of ± 0.1 °C throughout the commercial temperature range of 0 to 70 °C
        (3) Acceptable models:
            (a) BA/10K-2[XP]-I-4"-BB
            (b) Enclosure – BAPI Box (BB)

2.3 CURRENT SENSORS

A. Low voltage, single phase:
    1. Sized to monitor and control small motors.
    2. Approved for installation in the following environmental conditions:
        a) 0-95% relative humidity, non-condensing.
        b) –15° to 60° C.
    3. Approved manufacturers: Veris Hawkeye Series, RIB or RIT approved equal.

B. High voltage, three phase:
    1. Clamp on style with positive closure, no external wrap or taping allowed.
    2. Factory programmed to detect belt loss on belt driven equipment.
    3. External indication of trip by LED.
    4. Approved for installation in the following environmental conditions:
        a) 0-95% relative humidity, non-condensing.
        b) –15° to 60° C
    5. Approved manufacturers: Veris Hawkeye Series, RIB or RIT approved equal.

2.4 HUMIDITY TRANSMITTERS

A. Transmitters shall be of 2-wire, 4-20 mA output type with a resistance or capacitance element having an accuracy of +/- 2% between 20-95% Rh. Transmitter shall include protection against reverse polarity and supply voltage transients. An accuracy adjustment shall be provided with each transmitter to allow for recalibration as necessary.
    1. Duct Mounted
        a) Sensor shall have a minimum 4”to 6" rigid probe with a durable enclosure.
    2. Wall Mounted
        a) The room sensor cover shall be provided with screws.
    3. Outside Mounted
        a) The sensing element shall be mounted inside a ventilated, treated, plastic PCV sun shield to minimize the radiant energy and wind effects.

b) The enclosure shall be pressure cast aluminum, weatherproof box with a gasket cover, or high quality UV rated Polycarbonate plastic with water tight NEMA-4 rating

c) Make sure that the sensors are located away from any exhaust air outlets, or a location that in any way may be detrimental to the proper representation of ambient condition of air.

2.5 PRESSURE TRANSMITTERS

A. Pressure transmitters shall be of 2-wire, 4-20 mA output type with a capacitance element having an accuracy of +/- 1% over the entire range. Transmitter shall include protection against reverse polarity and supply voltage transients. Accuracy and zero span adjustment shall be provided with each transmitter to allow for recalibration as necessary.

1. Duct Static Pressure

a) To be very low differential pressure, 0 to 1.0", 0 to 2.5" WC, 0 to 5" WC or engineers approved range.

b) LCD Display with live pressure reading.

c) Approved Manufacturers: Setra, Veris or RIT approved equal.

2. Filter Pressure

a) Pressure range 0-2" accuracy +/-2% of full scale.

b) LCD or analog display indicating live pressure reading.

c) 4-20ma output

d) Aluminum or copper tubing from sensor to pressure pickups

e) Pressure tubing to be terminated with appropriate pressure pickups to penetrate the side of the unit.

f) Separate pressure sensors for each filter section.

g) Approved Manufacturers: Setra-2671-2R5-W-11-XX-X-D, Dwyer-605

3. Building Differential Pressure

a) Maximum safe momentary overpressure shall be eight (8) times the pressure range.

b) Pressure transmitter shall be of solid-state design.

c) Approved Manufacturer: Setra Model 264 or equivalent

d) Typical Range: 0 to 0.1" W.C. with at least 0.001" increment readings.

e) LCD Display indicating live pressure reading.

3. Liquid Differential Pressure

a) The operating range shall be -40.0 to 176.0 Deg. F.

b) Maximum safe overpressure shall be 150% of the rated pressure.

c) Shall be contained in an aluminum NEMA-1 enclosure.

d) Shall be provided with the appropriate factory manifold with the ability to bleed air from the system without disconnecting fittings.

f) LCD Display indicating live pressure reading.

g) Approved Manufacturer: Setra 231G-MSX-3V-D with manifold or RIT approved equal.

h) Be sure to take into account total system pressure when selecting the differential pressure range.

4. Liquid or Steam Pressure

a) Stainless steel pressure transmitter housing.

b) 316 Stainless Steel wetted parts.

c) Wide range of pressure ranges: 0 to 30, 0 to 50, 0 to 100, and 0 to 200 psig.

d) High overpressure capability: 3 to 5 times range.

e) Approved Manufacturer: Johnson Model PSS2 series or RIT approved equal.

2.6 FLOW TRANSMITTERS

A. Airflow

1. The sensor shall be a 4-20 mA output type with the accuracy of +/- 1% with flow straighteners in circular duct applications. In rectangular duct applications, the accuracy shall be +/- 2% with flow straighteners.
2. Velocity range of 100 to 10,000 FPM air at S.T.P.
3. Flow station shall be constructed of steel with flanged face for easy mounting. The flow straighteners shall be constructed of aluminum or steel.
4. LCD Display indicating live flow value.
5. Approved manufacturer: Paragon, Ebtron

B. Liquid Flow

1. The sensor shall be a 4-20 mA output type with the repeatability of +/-0.1% of value.
2. Temperature limits: -20.0 to 850.0 Deg. F.
3. LCD Display indicating live flow value.
4. Material is dependent upon that of the size and type of pipe material. Approved manufacturer: GE Panaflow DF-868.

C. Duct Mounted Air Flow Stations:

1. Rectangular: 16 gauge galvanized casing 8 in. deep with formed 1 ½ in integral 90° connecting flanges.
2. Oval: 18 gauge galvanized casing, 8 in. long between beads with 1 in. connecting sleeve on each end (10 inch. Overall length). Actual O.D. dimensions are ¼ in. less that specified duct I.D. dimensions.

3. Accuracy: Within 2% throughout the velocity range of 600 FPM and over, when installed in accordance with published recommendations.
4. Temperature: 350°F continuous operation, 400°F intermittent operation.
5. Humidity: 0-100% continuous operation
6. Corrosion Resistance: Good salt air, excellent solvent and aromatic hydrocarbon resistance.
7. Element Material: 6063-T5 anodized aluminum.
8. Make: Ebtron or Thermal Dispersion

D. Fan Inlet Air Flow Stations:
1. Material: 6063-T5 anodized aluminum, galvanized mounting brackets.
2. Accuracy: Within 2% throughout the velocity range of 600 FPM and over, when installed in accordance with published recommendations.
3. Temperature: 350°F continuous operation, 400°F intermittent operation.
4. Humidity: 0-100% continuous operation
5. Connection Fittings: ¼ in. compression, suitable for use with thermoplastic or copper tube.
6. Corrosion Resistance: Good salt air and mild acid resistance, excellent solvent and aromatic resistance.
7. Make: Ebtron or Thermal Dispersion

E. Outside Air Flow Station:
1. Material: Element 6063-T5 anodized aluminum and casing 16 gauge G90 galvanized steel
2. Accuracy: Within ±0.5% of actual flow through the velocity range of 200 to 1,200 fpm when installed in accordance with published recommendation and within ±5% at a velocity of 100 fpm. Operating velocity range 100 to 2,800 fpm.
3. Temperature: 350°F continuous operation and 400°F intermittent operation.
4. Humidity: 0 to 100%
5. Make: Ebtron or Thermal Dispersion

F. Air Volume/Velocity Transducers for Duct Outside Air:
1. The transducer shall be a combination differential pressure transmitter, square rod extractor, scaling multiplier and output filter with process indication, complete in a single package.
2. The measured air volume shall be locally indicated on a door mounted LED display meter scaled in CFM.
3. The transducer package shall be factory calibrated for the flow-measuring element being served.
4. A transducer shall be provided for each individual air flow station.
5. Accuracy shall be plus or minus 0.25%
6. An output signal of 0-10 VDC or 4-20 mA shall be generated for monitoring by DDC system.
7. Make: Ebtron or Thermal Dispersion

2.7 AIR QUALITY TRANSMITTERS

A. The sensor shall be a 4-20 mA / 1-5 VDC output type and designed to monitor IAQ/CO2 levels in accordance with ASHRAE Standard 62.1-2016.

2.8 FREEZESTATS

A. Shall be heavy-duty temperature controls that incorporate a vapor charged sensing element. 20 ft. long.

B. The low temperature cutout must be adjustable. 35 to 45 °F.

C. The sensor shall SPDT open low contact.

D. Manual reset.

E. Approved manufacturer: Johnson Controls.

2.9 SMOKE DETECTORS

A. Provided and installed by Div. 26.

B. Auxiliary relay in BAS panel for monitoring.

2.10 AIR PROVING SWITCHES

A. The air proving switches shall have an operating range of 0.15 - 0.5" WC and have a setpoint adjustment.

B. Wiring connections shall be 3-screw type, common, normally open and normally closed.

C. Approved manufacturer: Dwyer 1900 series or approved equal.

2.11 LIQUID PROVING SWITCHES

A. The proving switch shall measure the difference in pressure exerted upon its sensing elements and operate an SPDT switch at the differential pressure setpoint.

B. Or a paddle switch mounted in a 1 ¼ inch FNPT fitting.

C. The differential pressure setpoint must be adjustable between the ranges of 8 - 60 psig and the switch differential shall be 1.5 psi. Paddle switch to have adjustability over a wide range of flows.

D. Approved manufacturer: Differential Pressure - Penn a-74 series or approved equal. Paddle – McDonnell & Miller FS7-4S or FS7-4SW.

2.12 DAMPER POSITION SWITCHES

A. Shall be crank mounted and provide two snap-action SPDT contacts.

B. Approved manufacturer: Barber-Colman AM-321 or equivalent.

C. Mercury switches are not permitted in DPS or any other hardware designated for RIT.

2.13 PNEUMATIC TRANSDUCERS

A. I/P transducers shall not be used without prior approval from HVAC Operations and Controls Department Manager.

2.14 ACTUATORS

A. Pneumatic: (not to be used without prior approval from HVAC Operations and Controls Department Manager).

B. Electronic:

1. Electronic actuators shall be driven directly by 0-10 VDC, Supply power: 24 VAC, as acceptable to its controller, and provide adequate torque to meet the application.

a) Actuators shall be direct-coupled type.

b) Actuators to have fail safe return capacity where required.

c) Approved Manufacturer: Belimo

d) Dampers and valves must be spring return for fail safe positioning. Assure execution of the fail-safe position in case of the Freezestat trip, loss of signal or power loss.

e) Provide actuator with necessary torque to assure fail safe position.

2.15 ENCLOSURES

A. Each controller shall be housed in the Enclosure.

B. Enclosures shall be NEMA-12 rated steel, painted gray, finished to control oxidation in a highly humid atmosphere.

C. Each enclosure shall have a hinged door with latch handle. Shall be Johnson Controls M8100 series or better or Hoffman.

D. Shall provide 40% of free space for future expansion of the system.

E. Shall be equipped with laminated wiring diagram showing all terminations, modules, relays, switches, reset and push buttons, indicating lights, inputs and outputs, power supplies, network connections, etc.

F. Each enclosure shall be equipped with internal 120VAC dual receptacle and ON/OFF switch to terminate power to the panel for the service repairs.

G. All penetrations shall be sealed with mechanical bushing or knockout filler, protected with water sealing compound.

H. All exterior enclosures shall be equipped with adequate thermostatically controlled fan and drip and insect screen protected vents, if internal temperature could increase in excess of permitted operating range of equipment housed in the enclosure.

I. Each enclosure shall be equipped with a back plate firmly secured and grounded to the enclosure.

J. Each enclosure shall be fitted with the Emergency Power (EM) fed from the nearest EM panel; TC is responsible for providing the EM power, unless this requirement was specifically excluded from the bid by the TC, HVAC Operations and Controls Department Manager at FMS or design engineer by including it in the Division 26 of the specification. On all new construction projects this requirement shall be included in and coordinated with the Division 26.

K. All metal filings and debris shall be vacuumed from each enclosure prior to mounting the hardware.

L. Magnetic enclosures for Heat Pump controllers are acceptable.

2.16 CONTROL VALVES

A. Provide factory fabricated control valves with operators as required by this specification. Provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with specified maximum pressure drop across control valve. Equipment control valves with heavy duty actuators, with proper shut off rating for each individual application.

.B. All HVAC water valves to be pressure independent control valves sized for the proper flow of the HVAC device.

C. Steam Service Valves: Linear characteristics for 90% of closing stroke and equal percentage for final 10 percent with range of 30 to 1, and maximum full flow of 80% of inlet pressure for low pressure systems, and 42% for high pressure systems. Two-position valves shall be line size.

D. Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on “top and bottom” guided plugs.

E. Valve Trim and Stems: Polished stainless steel.

F. Packing: Spring-loaded Teflon, self-adjusting.

G. Bodies, 2" and Smaller: Bronze with screwed end connections, replaceable brass seat. 125 psig rated, minimum.

H. Bodies, 2 1/2" and Larger: Cast iron with flanged end connections, replaceable brass seat. 125 psig rated, minimum.

I. Approved manufacturer: Belimo, VSI, Danfoss.

J. Control valves will be setup so that 0% control signal causes the valve to be fully closed.

K. The valves will be tested at 0% signal =fully closed, 10% signal = partly open, 50% signal = mid position, 90% signal = almost but not fully open, 100% control signal = fully open valve. All positions are to be tested from both opening and closed directions.

2.17 DAMPERS

A. Provide automatic control dampers as indicated. All dampers shall be low leakage airfoil blade types (Johnson Controls or approved equal).

1. Construction:

i. Frames: Extruded aluminum hat channel, 0.125" minimum thickness.

ii. Blades: Extruded aluminum airfoil type, 6" maximum blade width.

iii. Hardware: Molded synthetic bearings. Zinc plated steel axles, linkage brackets, connecting rods, and mounting bolts.

iv. Seals: Flexible metal compression seals on frame at blade end; extruded vinyl inflatable blade edge seals.

2. Leakage: Not more than 6 CFM per square foot damper area at differential pressure of 4 inches with applied torque at damper of 50 inch-pounds.

3. Operating Limits:

Temperature:	-20 to 200° F
Pressure:	6 inches WG differential
Velocity:	Up to 4000 FPM

4. Select opposed blade dampers for proportional service. Parallel blade dampers may be used for two-position service, or in mixed air application which promotes air mixing.

5. Damper sizes shall be provided as indicated or defined in specifications. Damper sizes may be provided different from those indicated on the drawings if improved performance can be demonstrated with calculations.

6. Approved manufacturer: Johnson Equipment.

B. Generator dampers shall be monitored by BAS. Generator and Generator Room dampers shall be controlled by the generator. Generator shall have Modbus Communications.

C. Combination Fire/Smoke Dampers: Dampers are furnished under the work of Division 23 Section, “Fire and Smoke Dampers.” Refer to that section for operator type.

2.18 UTILITY METERING

A. General Requirements:
   1. The following meters shall be included in this system:
      i. All Electric Meters
      ii. Gas Meters
      iii. Water Meters
   1. Gas and domestic water meters shall be pulse outputs ro a dedicated metering controller.
   2. ALC controller shall be SE563A, single program units with NOT be accepted.

2.19 SOLAR SENSOR

A. Solar compensator consist of a black anodized aluminum collector contained in a sealed transparent enclosure designed to accept a cybertronic nickel wired sensing element. Compensator shall be Model M-2500 and sensor shall be Model TE-1900.
B. Ambient temperature limits of -40°F to 120°F.
C. Approved manufacturer: Johnson Controls

PART 3 - EXECUTION

3.1 WIRING

A. Unless noted otherwise, all electrical wiring required to interconnect the components of the control system, including all terminations, splices, shield management, proper sizing and tests shall be furnished and installed by the TC. Perform all wiring in accordance with the requirements listed below, code requirements and Division 26.

B. Power wiring required for controllers and control panels shall be furnished and installed by Division 26. Power for these components shall be dedicated power circuits for the express use of the individual controller or control panel. Circuits shall be furnished and selected by the Electrical Contractor. All circuit breakers and other electrical components required providing this dedicated circuit shall be the responsibility of the Electrical Contractor. Refer to Project Specific Requirements for additional information.

C. Power wiring required for the Area Controller shall also be dedicated as specified above, and if available in the building, shall be on the emergency power circuit.

D. All line voltage wiring shall be installed within EMT conduit. Conduit shall be adequately supported in accordance with local codes and Division 26.

E. All low voltage (Class 2) wiring shall be installed within EMT conduit, except when run above dropped ceiling spaces, which shall be jacketed wiring. Low voltage wiring installed in ceiling spaces must be plenum rated wiring in accordance with all local codes. All wiring in ceiling spaces must be properly supported in cable trays or ring runs, on 3 foot centers, and fastened to the building so as not to droop on the suspended ceiling and other appliances installed nearby. Install wiring as close to the deck as possible to avoid damage from other trades, materials, construction and service activities.

F. Low voltage (Class 2) control wiring under 50V shall not be used in line-voltage enclosures or locations, otherwise wiring to be THHN wire. No communication wiring to be run in high voltage enclosures.

G. All low voltage wiring shall be installed with additional lengths formed in organized loops to allow moving large objects in and out of the wire vicinity. Identification of such object is done by examination of construction drawings. Contractor should make a reasonable effort to comply with this requirement.

H. All conduit and wiring shall be installed in parallel lines to the building structure, its corridors, and

hallways.

I. Communication network wiring shall be clearly marked with a specific color code. Communication wiring shall not be installed near a noise producing equipment, such as ballasts, magnetic starters, etc. Communication wiring shall comply with the optimum requirements necessary to assure good communication of the control system.

1. All communications wiring shall follow standard best practices for the manufacturer.

2. Exceptions:

a) In addition, RIT has a design standard that is more stringent then the manufacturer's best practice. Reference "RIT Controls Design Standard" on the RIT FMS website.

b) Do not use repeaters.

c) When using Arcnet to Arcnet Routers (AARs) the equipment associated with the AAR should be related to each other.

(1) Example: An AHU and its associated VAVs

(2) Example: A floor of heat pumps.

d) Network devices, such as AARs shall be located in easily accessible areas, such as a control panel in a mechanical room. They shall not be located above a ceiling or other difficult to access area.

J. All controls input and output wiring shall be done by a single and continuous set of shielded stranded wire with plenum rated jacket, foil shield and drain. Such wire should be connected in the manner where:

1. Only one splice of the pair between the input or output and the termination on the control module were included.

2. Where going through the compartments and walls, no additional transitions of pin connectors or pin bushings, etc. are permitted.

3. All analog input and output wire shall be connected using individually separated and individually shielded (with drain) pairs of wires. Exception: All control wire connected to a dedicated piece of hardware can utilize a multi conductor cable with a common shield and drain wire; examples of the above rules are VSDs and actuators.

4. The shield should have only one ground at the terminal board ground receiving fastener, and network one ground connection at designated communication device, unless specified otherwise by manufacturer of the equipment.

K. Unless stated otherwise, all signals shall be wired using 18 gauge stranded wire as follows:

1. Comtran, 4859, Plenum rated, White Jacket wire, Foil shield with drain wire, 8 conductors, or

2. Comtran, 4857, Plenum rated, White Jacket wire, Foil shield with drain wire, 6 conductors, or

3. Comtran, 4855, Plenum rated, White Jacket wire, Foil shield with drain wire, 4 conductors, or

4. Comtran, 4853, Plenum rated, White Jacket wire, Foil shield with drain wire, 2 conductors.

L. All control wire shall be protected from pulling by utilizing fastening bushings at all knockouts crossed by

the wire.

M. No control wire should be directly fastened to the threaded rod or other sharp objects.

N. All wiring in mechanical rooms or occupied spaces shall be installed in EMT conduit. The conduit should be sized to allow no more than 60% fill factor measured with all wiring installed in such conduit. ¾" conduit minimum.

O. In addition to the above requirements, HVAC Operations and Controls Department Manager at FMS has established the following standards for wiring:

1. DDC Control Panels – (Class 2 wiring)

Stranded Hookup wire (MTW), 18 AWG (Simcona or Kele):

Red – 24VAC power
Blue – 24VAC common
White – Analog Inputs / Outputs
Black – Common
Orange/Purple – 24VDC power
Misc. – Misc. wiring connections (Digital Outputs, etc.)

2. Cabling – Plenum Rated Stranded Shielded (run separately from all line voltage wiring). All single pair black and white shall be wired with the white as positive.

18/2 (Black/White) – Duct, Well, Status
18/2 (Red/Black) – 24VAC Power (VAV boxes, etc.)
18/3 (Red/Black/White) – 3 wire devices and devices w/ switched 24VAC power
18/4 (Red/Green/Black/White) – Actuators & Control Valves,
18224 (Green/Black/White/Red) Orange jacket – Zone Sensors
18/12 (Brn/Org/Blu/Yel/Red/Green/Black/White/Pur/Grey/Pink/Tan) – VFD Drives.
Variable Speed Drive DDC wiring color allocations:
Red/Green – Speed Feedback
Blue/Yellow – Start/Stop
Orange/Brown – Proof
Black/White – Speed Command
Purple/Grey – KW feedback
Pink/Tan – Alarm (fault)
The TC shall submit their wire requirements for approval.

3. Terminal Blocks

a) No wires shall land directly on controller but rather shall be connected controller through DIN rail mounted termination strip.

b) All terminals shall be identified with a terminal number corresponding to the same termination number posted on control drawing.

c) All terminal blocks shall be provided with a removable fuse for any power wiring landing on terminal block.

d) All wires leaving the terminals to the field devices must be labeled with descriptive text generated by a professional quality wire label maker.

e) Provide spare terminal blocks corresponding to spare controller I/O.

f) All terminal blocks to be spring loaded. No screw terminals shall be installed.

4. Groups of terminals shall be separated as necessary utilizing the following color scheme.. (inputs / interlocks / outputs)

   Grey – Inputs / Network
   Blue – Outputs
   Red – Power (24VAC, 24vdc)
   Yellow – Interlocks
   Black – 120VAC Hot
   White – 120VAC Neutral
   Green – 120VAC Ground

5. Power Supply

   a) Each new panel shall be equipped with its own 24 VAC Power Source with On/Off Switch, Convenience Outlet and Circuit Breaker. To achieve all above use Kele T-PB 303-0 Panel Mount, Class 3 Power Source. Overcurrent Protection shall be provided on 24 VAC to DDC controller and filed power supply shall be separately protected.

   b) Provide dedicated 120V circuit for DDC panels.

   c) Transformers – Each of the following w/ low voltage fuse holder/disconnect.

      (1) DDC controller & DC power supply

      (2) All field wiring (24VAC leaving panel – switched in field)

      (3) Valves

      (4) Dampers

   d) DC Power Supply for 4-20ma devices must meet Class 2 wiring standards. Only provide UPS power when required and/or approved by RIT Building Controls Department.

6. Convenience Outlet –

   a) Dedicated circuit for 120VAC combination outlet w/ switch to turn off 120VAC to panel.

   b) Switched 120VAC to panel is fused before transformers (after outlet).

7. Din Rail (the following devices are din rail mounted)

   a) Terminal strips (inputs, outputs, network, and power).

   b) Fuse Holders.

   c) Interface Relays.

8. Wiring Panduit

   a) Wire ducts around exterior of panel for cables entering panel to be 3” to allow for wiring to be neatly run.

   b) Wire ducts as necessary on interior of panel to route hookup wires from terminals to controllers and other devices.

9. Panel Construction (sized to provide 40% future expansion w/ removable back panel)

   a) Indoors – Johnson M8100 series or Hoffman (Nema 12 or better)

   b) Outdoors – Hoffman fiberglass Nema 4x

10. Relays –

a) Din Rail mounted

b) Track mounted

11. Panel lights for local annunciation –

a) Provide LED type push to test all panel lights, 24VAC as needed.

b) Provide selector switches and pushbuttons as required.

c) Provide mechanically engraved descriptive panel labels for each device mounted on the face of the panel (light, switch & button) utilizing white letters on the black background.

12. All panels shall be named and labeled –

a) Each panel shall have a reference name on the face of the panel describing it association with the services. Example: ## - *Hot Water Plant-##, ## - Chiller Plant-##, ##-Hot Water Pumps-##, ##-Air Handler 01, Corridor Lights- A. Level,* etc. The face plate should also include the panel number. Contact Manager HVAC Controls for official panel name and number.

b) Each panel shall be clearly labeled with the breaker panel and breaker number. This may be part of the front label or it may be labeled on the panel power supply.

c) Panel's reference name shall be reflected on the drawings.

d) All panel-controlled equipment shall be listed on labels on face of the panel near the reference name or near a cluster of controls related to particular equipment.

e) Face mounted control knobs, switches and monitoring lights shall be coordinated with the labeling system so that there is no ambiguity of controls association with the equipment. Such coordination shall result in creating clearly distinct control clusters, separated from each other by adequate space, or by including embracing frames, plates, etc, bearing the common labeling engravings.

f) Labels should be made on black plastic material with white-engraved letters. Labels shall be neatly mounted with adhesive material providing strong bond with the face of panel.

g) Each individual panel labeling scheme shall be approved by HVAC Operations and Controls Department Manager at FMS.

3.2 DDC EQUIPMENT

A. All components shall be installed in protective enclosures. All wiring within the DDC enclosure shall be either number coded or color-coded. Both the enclosure and the controller shall be properly grounded in accordance with manufacturer's recommendation.

B. Documentation shall be firmly attached to the enclosure within a plastic envelope. Documentation shall state point-to-point termination detail, description of each individual point, location of power source for the controller and ID number or address within the network. Examples of drawings are included at the end of the specification.

C. All DDC Controllers shall be mounted in enclosures installed on walls within equipment rooms, custodial closets or electrical rooms. Only application-specific controllers for VAV boxes, heat pumps, unit ventilators, rooftop units or package units may be mounted on the equipment.

D. Stand-alone Controllers shall be microprocessor-based with a minimum word size of 16 bits. They shall also be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller

size shall be sufficient to fully meet the requirements of this specification.

E. Each DDC Controller shall have sufficient memory, a minimum of 1 megabyte, to support its own operating system and databases, including:

1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified
5. Maintenance support applications
6. Custom processes
7. Operator I/O
8. Dial-up communications
9. Manual override monitoring

F. Each DDC Controller shall support:

1. Monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:

a) Analog inputs
(1) 4-20 mA
(2) 0-5 or 0-10 VDC
(3) Thermistor

b) Digital inputs

(1) Dry contact closure
(2) Pulse Accumulator
(3) Voltage Sensing

2. Direct control of pneumatic and electronic actuators and control devices. Each DDC Controller shall be capable of providing the following control outputs without the addition of equipment outside the DDC Controller cabinet:

a) Digital outputs
(1) Contact closure

b) Analog outputs

(1) 0-20 psi
(2) 4-20 mA
(3) 0-10 VDC

G. Each DDC Controller shall have a minimum of 10 per cent spare capacity for future point connection. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than two spares of each implemented I/O type. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

1. Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.

2. DDC Controller types shall be approved by HVAC Operations and Controls Department Manager at FMS. Whenever the number of required points exceeds capacity of basic controller, expanders should be utilized. No SE/SP controllers will be accepted.

H. Utilization of multiple modules for the same equipment -- where equal functionality can be achieved by a singular module with expanders-- is not permitted, unless specifically approved by HVAC Operations and Controls Department Manager at FMS.

I. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any

detected component failures, low battery conditions or repeated failure to establish communication.

J. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

K. OFBBC or OFBBC-NR controllers and expanders shall be DC powered.

L. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via a network or local laptop PC.

M. Provide a separate DDC Controller for each AHU, RTU or other HVAC system. It is intended that each unique system be provided with its own DDC Controller.

3.3 CONTROL WIRE PROTECTION

A. Provide conduit protection for all control wiring between the floor and the ceiling space. Where there is no ceiling installed, provide conduit to protect wiring up to 9 feet AFF.

B. The end, unsupported section of conduit connecting to field hardware shall be made of seal-tight flexible conduit with vinyl jacket and the drip proof fittings.

C. Provide reasonable wire protection from all sharp elements that may get in contact with the wire jacket. This includes conduit outlets, junction boxes and devices supporting the wire.

D. Run wire clear of any access doors, removable components, space expected to be used for lifting suspended objects, hot pipe, pipe hangers, threaded rods, objects in motion, sharp edges, etc.

E. All control wiring shall be protected and neatly bundled with plastic tie wraps and properly supported and fastened to solid objects. Supporting the wire on the ceiling, ceiling's light fixtures, etc. is not permitted.

F. Control wiring shall comply with its class of insulation as per NEC code. Control wiring entering objects where higher class is enforced shall be protected accordingly. If change of wiring class require termination of two different wires, such termination shall be done in a separate enclosure or junction box, complete with a removable cover or access door.

G. Provide Initial Resistance Test for all installed Control and Network Wiring, including resistance between each member of cable set and the ground with identification of tested parts.

3.4 DDC CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. All necessary software to form a complete operating system as described in this specification shall be provided.
2. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:

1. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:

a) Two-position control

b) Proportional control
c) Proportional plus integral control
d) Proportional, integral, plus derivative control
e) PID Deadband
f) Control loop tuning
g) Input selections
h) Load shed offset of control setpoint
i) Intuitive learning
j) Control from remote input connected via the network
k) Controlling remote points via the network
l) Value broadcast via the network

2. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
3. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
4. Upon the resumption of normal power, each DDC Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

C. DDC Controllers shall have the ability to perform any or all the following energy management routines:

1. Time-of-day scheduling
2. Calendar-based scheduling
3. Holiday scheduling
4. Temporary schedule overrides
5. Start-Stop Time Optimization
6. Automatic Daylight Savings Time Switchover
7. Night setback control
8. Enthalpy switchover (economizer)
9. Peak demand limiting
10. Temperature-compensated duty cycling
11. Fan speed/CFM control
12. Heating/cooling interlock
13. Hot water reset
14. Chilled water reset
15. Condenser water reset
16. Chiller sequencing
17. Adaptive learning sequencer of multi stages

D. All programs shall be executed automatically without the need for operator intervention and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Sequence of Operations.

E. As much as possible use the same program for similar types of equipment in the same building and across campus.

1. In cases where one piece of equipment requires an extra control routine, but is otherwise similar to other equipment in the project, then create one program that has the ability to turn that feature on and off, so the same program can be used on equipment with that feature and on equipment without that feature.

F. If possible use one of the standardized RIT programs.

1. This library is continually expanding. Check with HVAC Operations and Controls Department Manager to see if there is a program in the library to meet the needs of the project.

G. Refer to “RIT Design Guideline and Best Practices” located on the RIT FMS website for program names and other program features.

H. DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers on the network.
2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
3. The custom control programming feature shall be documented via English language descriptors.
4. Process shall synchronize values entered locally from remote access pad and project new value on all access sites.

A. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
2. Each alarm shall have the event-alarm message followed by the event-restore message when the alarm conditions has restored to normal operation.
3. Alarm set and restore setpoints should be easily accessible.
4. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
5. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs.
6. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

    a) Each DDC Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the Controller.

7. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.

B. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.

1. DDC Controllers shall store point history data for selected analog and digital inputs and outputs:

    a) Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided.

2. Trend data shall be stored at the DDC Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in 3rd party personal computer applications.
3. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary. Provide capability to

view or print trend and tuning reports.

C. DDC Controllers shall automatically accumulate and store run-time hours for digital input and output points as specified in the point I/O summary.

1. The totalization routine shall have a sampling resolution of one minute or less.
2. The user shall have the ability to define a warning limit for run-time totalization. Unique, user-specified messages shall be generated when the limit is reached.

D. DDC Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for user-selected analog and digital pulse input type points as specified in the point I/O summary.

1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g., KWH, gallons, BTU, tons, etc.).
2. The totalization routine shall have a sampling resolution of one minute or less.
3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

E. DDC Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for points as specified in the point I/O summary.

1. The event totalization feature shall be able to store the records associated with a minimum of 9,999.9 events before reset.
2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

F. When applicable, the DDC Controllers shall provide recalculation of percentage of Outside Air entering the air handler, based on the algorithm, taking into consideration current OA, RA and MA condition. The computed result shall be distinctly posted on the Graphical Page alongside with the OA Damper position value.

3.5 SERVER/PC WORKSTATION

A. The permanent Server assigned to Automated Logic Control System is in place at RIT;

B. Provide fully configured database, graphics, reports, alarm/events trend and scheduling management and merge it with existing in server control system and provide matching navigation system to all added elements, pages, etc.

C. Provide daily management of all alarms generated as result of the construction cycle; Excessive alarms shall be maintained as needed without affecting other alarms on the server.

D. All control systems provided in this contract shall be connected to the existing campus-wide Ethernet system.

3.6 COLOR GRAPHIC SOFTWARE (CGS)

A. Provide graphic screens depicting the actual layout for all major equipment, including but not limited to:

1. Air Handling Equipment

2. VAV Boxes, Unit Heaters and other Zone Terminal Equipment

3. Central Plant Equipment

B. Provide graphic representation of the building, including building floor plans. Provide common information and status within these screens, such as zone temperature, equipment status, etc. Graphics shall use

non-intrusive colors and close proximity color associations.

C. Graphics shall allow manipulation of adjustable setpoints and show all pertinent dynamic data reasonably required to accurately representing system status and its functionality.

D. Coordinate with the Engineer and HVAC Operations and Controls Department Manager at FMS prior to loading and testing.

E. All graphic pages shall allow for the direct manipulation of all digital and analog outputs directly from the graphic screen through Hand-Off-Auto operators.

F. As much as possible use the same graphic for similar types of equipment in the same building and across campus.

1. In cases where one piece of equipment requires an graphic element, but is otherwise similar to other equipment in the project, then create one graphic that has the ability to turn that feature on and off, so the same graphic can be used on equipment with that feature and on equipment without that feature.

G. If possible use one of the standardized RIT programs.

1. This library is continually expanding. Check with HVAC Operations and Controls Department Manager to see if there is a graphic in the library to meet the needs of the project.

H. Refer to "RIT Design Guidelines and Best Practices" located on the RIT FMS website for graphic names, locations and other graphic features.

3.7 SENSING DEVICE INSTALLATION

A. Freezestat: Provide on every unit that has outside air intake where indicated by the contract documents. Locate on the downstream side of the hot water coil, upstream side of the chilled water coil or after the supply fan if the unit has no coils but there are downstream coils to be protected. Serpentine the element across the face of the coil and fasten using support rods.

B. Space Sensors/Transmitters: Provide as required according to the contract documents. Mount at 48 inches AFF to center – unless otherwise directed by ADA requirements. Wire to respective control system to provide control. Provide a label on the sensor for reference to the equipment served.

C. Duct Mounted Sensors/Transmitters: Provide as required according to the contract documents. Averaging type sensors shall be supplied for all mixed air and discharge air locations. Serpentine across the duct opening at even increments and provide proper fastening.

D. Each terminal unit, VAV, heat pump, fan coil, etc.., must have one monitored duct mounted sensor located on discharge side of the unit.

E. Liquid Immersion Sensor/Transmitter: Provide as required by the contract documents. The piping contractor shall provide and install all thread-o-lets for wells and other liquid sensors. Coordinate locations so that sensors are properly installed in an acceptable location. Actual sensors shall be provided and installed by the TC using thermal conductive compound. Strap on sensors are not acceptable, except for aqua-stats, or if specifically approved by Manager HVAC Controls Department at FMS.

F. Each building shall have an individual Outdoor Air Station Program that will read outside air temperature, outside air humidity and outside air enthalpy. The averaging program will automatically ignore any sensor that is in failure or reads 10° (adjustable) out of range. In case that such value is above or below the average, an alarm shall be generated to indicate that a problem exists with the sensor in question.

G. The building outside air station program shall read the outside air conditions from the campus outside air program through the network and use the campus outside air values for its status values. In the event that the building outside air program cannot communicate with the campus outside air program then the building outside air program will use the average of the outside air sensors inside the buildings network. Also as part of the outside air conditions is an Ambient Light Photo-Sensor that shall be used to control any of the building's exterior or interior lights based upon the amount of light outside. The photo-sensor shall read an analog signal representing the amount of light currently outside – not a 2 position switch photocell.

H. Outdoor lighting shall not be controlled by ALC system controller. All Outdoor lighting shall be controlled by a photocell.

I. Each unit that requires the outside air temperature, humidity or enthalpy shall first use the global campus average values with a 10 minute update time. Should the unit fail to receive an outside air temperature, humidity or enthalpy value the unit shall revert back to its local sensor(s) if it has them or the building average if it does not. Should both the local sensor and the global update values fail, the unit should default to a worst case scenario and assume the outside air is 0°F until either the local sensor or the global broadcast works again. In any case an alarm shall be generated to indicate a problem with this particular unit's outside air source.

3.8 CONTROLLED DEVICES

A. Dampers: Provide as required by the contract documents – installed by the sheet metal contractor. The TC shall mount all damper control devices and any associated linkage assemblies. Dampers shall operate smoothly throughout their entire stroke.

B. Valves: Provide as required by the contract documents – installed by the piping contractor. Coordinate locations so that valves are piped properly and installed in an acceptable location. Valves shall provide proper shut-off as specified in this section. Valves shall be wired by the control contractor.

C. Actuators: TC shall install all actuators, unless specified otherwise. All wiring to the devices shall be the responsibility of the TC.

PART 4 – TYPICAL PROJECT REQUIREMENTS

The purpose of this section is to clarify and highlight those parts of contract requirements that may require additional clarifications, or are slightly different or in contrast with the rest of the specification, or needs to be purposely emphasized because of additional importance or safety considerations.

A. Provide all control points as listed in the Building Bid Request Points list.
B. Provide new control panels as per schedule in the points list.
C. For each piece of equipment provide singular panel. If multiple panels are required, this should be approved by the Owner.
D. Provide new control modules to operate each controlled unit as per schedule (separate module for each piece of equipment).
E. Provide schedule of new module assignments for approval.
F. Control panels shall be either Johnson Style M8100-xx-xx Extruded aluminum type or Hoffman metal enclosures with back panel. All controls panels to have a minimum rating of Nema-12. Any panels mounted outdoors shall be a NEMA-4X fiberglass.
G. All control panels shall be sized to provide 40% extra space for future expansion. Manager HVAC Controls Department at FMS shall approve type, size and location of each enclosure. Please, note that some enclosures shall be furnished with surface mounted indicator lights and switches as called for in the sequence of operation.
H. In order to minimize negative impact on building environment during the system transition, switchover needs to be coordinated with Manager HVAC Controls Department at FMS
I. The switchover shall be done in such a way, that no interruptions of building services should be required. If needed, the TC will provide manual control of the equipment and will provide adequate labor to complete this task.

J. TC Contractor shall assume liability for and provide adequate protection of the points which, when triggered in result of the TC Contractor's activities, may result in setting off the fire alarm.
K. Mount new enclosures as directed by the Owner.
L. Replace all field temperature sensors with Precon type II. Provide factory calibration data for all installed sensors. (Exception: MTHW sensors shall be RTD with transmitter, Plant MTHW sensors shall be RTD with integrated factory calibrated and certified transmitter)
M. Provide averaging temperature sensors for all MA & coil locations. Provide adequate sensor's length to assure reasonable averaging of MA temperature.
N. For all air handlers provide Freezestat Alarm indicating light.
O. For all air handlers provide Fire Alarm Relay and Fire Alarm indicating light.
P. Fire Alarm Contact Received shall be a separate command for each unit controlled.
Q. All safety relay devices shall be tied in series through the terminal strips within the ALC control panel. Examples of safeties wired in series that can shut down the Fans are: Freezestat, Smoke Dampers, HIGH/Low Static Pressure switches on AHUs and BAS Safety. Each safety shutting down a VFD should also generate a corresponding input to the ALC system, and also be indicated on the "push-to-test" light on the face of the control panel.
R. All lighted pushbuttons shall be low voltage (24 VAC) and incorporate 2 sets of contacts (1 N.O. and 1 N.C.) wired such, that the "push to test" function is incorporated to test integrity of the light and the system. The N.C. contact shall be wired to the control point (freeze stat, high limit, etc.) and the N.O. contact shall be wired to a constant power source such, that when the lighted pushbutton is depressed the light will come on, independent of the control source. Bulbs will be LED.
S. VFD Shutdown shall be initiated by the fire alarm fan relay directly to the VFD interlock circuit. Fire Alarm relay to have a second alarm contact to the DDC panel. *All safety devices shall be hardwired through relays within the control panel, and work independently of the ALC controller*. The interlock circuit should also fail off with no power to the control panel.
T. All low voltage transformers shall be mounted within an enclosure (same or adjacent) and have a DIN rail mounted combination fused disconnect for fuse protection and means of disconnect. (see Kele Catalog #M10/16SFL or approved equal)
U. Control panels shall have transformer dedicated for individual usage – (Examples include 1 for DDC controllers, 1 for all 24VAC power leaving the control panel, 1 for valves, 1 for dampers, 1 for all panel equipment (DC power supplies, panel lights) etc. Size each transformer as to allow 20% margin of safety in total VA load of each.
V. Within each control enclosure, the modules shall have a minimum of 10% spare I/O (of the total) with no less than 2 spare inputs of any type on each module. All bids shall include a list of the free I/O per panel & module.
W. Each control panel will contain spare terminal blocks corresponding to the required 10% (minimum 2 each type) spare IO.
X. Within each enclosure provide convenience outlet with a light toggle switch (double gang box with cover) so that the control components and transformers can be independently de-energized separate from the outlet. To achieve all above use Kele T-PB 303-0 Panel Mount, Class 3 Power Source.
Y. Control panels shall be designed with power entering on the bottom portion of the panel and control terminations in the top and sides unless obstructions prevent doing so.
Z. Control panels shall be designed using wiring duct to section off different sections of the panel. Example: (transformers, relays, AHU-1, AHU-2, HW plant, terminals would all have their own section. The outside duct shall be oversized to allow for future expansion and to provide for a neat appearance without being crammed. Recommend using 3" duct on perimeter of panel. Kele T1-3030 or Horizon Fduct Wh6.
AA. Panel relays shall be Idec blade style relays with DIN rail sockets. Kele: RH-2B or RH-4B with SH2B-05 or SH-4B-05
BB. All control signal wiring should be plenum rated and provided with foil shield and drain. Analog inputs and outputs shall be additionally composed of separately shielded pairs of wires, complete with shield and drain wire. The drain wire shall be long enough to be grounded if required for future in the control panel. Wiring not confirming to those criteria shall not be approved as completed, until corrected to meet above requirements.
CC. Remove unused control wiring and components on equipment and spaces being modified.
DD. All control modules shall have overcurrent protection.
EE. Do not cut LIVE control and/or network wiring. If cut, contractor is responsible for replacing and reconnecting wiring, leaving in perfect operating condition.

FF. Contact RIT Building Control when encountering unknown wiring. Do not cut or disconnect, unless otherwise noted.

GG. Provide requested sequence of operation and test its performance including test of all interlocks and safeties. Consult with HVAC Operations and Controls Department Manager at FMS before proceeding with any test involving the MTHW or Steam.

HH. Provide for approval two submittals for equipment and hardware utilized on this project.

II. Provide functional commissioning of system including testing all active inputs and outputs. Include system testing, PID tuning and safety testing. Support your work with actual trend data.

JJ. Demonstrate to HVAC Operations and Controls Department Manager at FMS effect of commissioning by conducting this process with the presence of authorized representative of HVAC Operations and Controls Department Manager at FMS.

KK. Provide standard RIT documentation, CAD drawings, wiring details, equipment cut sheets and Point Summaries, detailed sequence of operation for each piece of installed equipment controls; this should be provided both, in text version and block of program drawing. All drawings shall be provided additionally on a CD disk. Simulated CAD drawings completed using the Visio software is not an acceptable substitute for a professional quality CAD drawings.

LL. Merge this project's work with the existing WebCTRL system, update all links and tree directory. Test completeness of WebCTRL graphical interface and correct all errors and inconsistency of equipment operation resulting from faulty programming, incomplete sequence of operation, etc.

MM. Provide 3-hour training seminar for RIT HVAC Operations and Controls Department personnel.

NN. Provide 2-year warranty on labor and materials installed in this project.

OO. It is expected that during the warranty period, the TC will occasionally review all equipment added by this projects with the intent of system improvements, tuning, adjustments and corrections, as needed to provide most efficient and accurate operation of equipment. In each case such corrections shall have a prior approval of Manager HVAC Controls Department at FMS. Such activity shall be done in the best interest of project outcome and will not require additional compensation from RIT.

PP. All graphics shall conform to the RIT standard and retain consistency with other buildings on campus. They should contain H-O-A operators for all equipment, Room numbers & zone numbers on floor plans..

QQ. Contractor Rules. Contractors shall follow all RIT regulations concerning but not limited to:

a) Parking
b) Keys
c) Shutdowns
d) Fire alarms
e) Safety
f) Lock and Tag

RR. Contractor shall be fully responsible for implementing and adhering to the above regulations including reimbursement of RIT with required compensations for fees and fines resulting from his or her, or their team and, or their subcontractors performances at RIT.

SS. Refer to "RIT Controls Design Standard Guidelines and Best Practices" located on the RIT FMS website for:

1. Program Standards
2. Graphic Standards
3. Preferred Network topology
4. Preferred WebCTRL configuration

TT. The TC shall return to site at the three (3) weeks and six (6) months after substantial completion. The TC shall provide eight (8) hours of onsite system review and adjustment for each visit. All work performed shall be documented and submitted to RIT.

END OF SECTION