

ADDENDUM NO. 1

DATE OF ISSUANCE: May 7, 2024
PROJECT: 2024 HVAC Improvements
Medora Community Schools
82 S. George Johnson Road, Medora, Indiana 47260
OWNER: Medora Community School Corporation
ARCHITECT'S PROJECT NO.: 23242.003
CMTA Project NO: VMSH24
ORIGINAL BID ISSUE DATE: April 23, 2024

SCOPE OF WORK

This Addendum includes changes to, or clarifications of, the original Bidding Documents and any previously issued addenda, and shall be included in the Bid. All of these Addendum items form a part of the Contract Documents. The Bidder shall acknowledge receipt of this Addendum in the appropriate space provided on the Bid Form. Failure to do so may result in disqualification of the Bid.

DOCUMENTS INCLUDED IN THIS ADDENDUM

This Addendum includes **two (2)** pages of text and the following documents:

- Specification Sections: **250500**
- Drawings: No drawings

CHANGES TO SPECIFICATIONS

ADD-1 Item No. S-1 - Control – Direct Digital (Web Based)

Refer to Specification Section: 25 04 400

Replace the existing with the attached.

CHANGES TO DRAWINGS

ADD-1 Item No. D-1 - Mechanical Plan – Roof – Demolition & Renovation

Refer to Sheet(s): **M204 & M404**

The existing roof cubs are to remain. The contractor is responsible for providing a curb adapter as required. It is the contractor's option to remove and replace the existing curb with new. The new equipment is coming with a curb. The roof will need to be patched to match existing conditions and to maintain the roof warranty.

END OF ADDENDUM.

DIVISION 25 – BUILDING AUTOMATION SYSTEM

SECTION 250400 - CONTROL - DIRECT DIGITAL (WEB BASED)

PART 1 – GENERAL:

- 1.1 The controls system for this project shall be a web-based digital controls system. All controllers, control interface hardware, services, installation, warranty, training, etc., shall be included as hereinafter specified. The system shall utilize a network controller and unitary" type controllers. Including such minor details not specifically mentioned or shown, as may be necessary for the complete operation of the system.
- 1.2 The Temperature Control Contractor (TCC) shall furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation System (BAS), utilizing Web Based Direct Digital Controls. All labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned shall be included for the complete, fully functional and commissioned temperature controls system.
- 1.3 The TCC shall provide all items, articles, materials, devices, operations, or methods listed, mentioned, or scheduled on the drawings including all labor, materials, equipment, and incidentals necessary and required for their completion to provide a complete and operating temperature control system. This will include connecting to any mechanical equipment furnished with a control interface device and contacting the equipment suppliers and/or manufacturers for information for the proper interface to the equipment being furnished.
- 1.4 These apparatus' shall consist of, but not limited to, all necessary thermostats, sensing devices, valves, automatic dampers, damper motors, actuators, (except automatic dampers, valves, and damper motors furnished with HVAC equipment), and with the necessary accessories for the complete control of all equipment hereinafter specified.
- 1.5 Control sequences are specified at the end of this section. Provide all control equipment required to perform sequences described. Coordinate all dampers with the sheet metal contractor and equipment provider. It is the responsibility of the control contractor to ensure all required dampers in the sequence of operations are provided.
- 1.6 Include all power wiring and cabling for the operation of the controls system. Refer to Electrical Division Specifications for additional requirements.
- 1.7 APPROVED MANUFACTURER'S: American Auto-Matrix, Alerton, Andover, Honeywell, Invensys, Johnson Controls, Siemens, Trane. These TCCs/manufacturers have prior approval with the Owner and Engineer and are the only allowed suppliers and/or installing TCCs.
- 1.8 The TCC shall have an established working relationship with the control manufacturer of not less than five years and shall have prior approval from the Owner and Engineer and are the only allowed suppliers and/or installing contractors. The TCC shall have a local office within 100 miles of the project site and provide service and/or replacement parts within a 24 hour notification of a control failure.

- 1.9 A mandatory pre-installation meeting shall occur prior to the TCC beginning any work on site. This meeting shall be attended minimally the prime contractor, mechanical contractor superintendent, TCC superintendent, Engineer, Owner, and Architect. The purpose of the meeting is to have the controls installer communicate their understanding of the system design and how the system is intended operate to the Engineer and get the Engineer's input and agreement. The agreement between the TCC and the mechanical engineer is to be thoroughly documented by the TCC for later reference.
- 1.10 The installation shall comply with the Local Authorities and State Fire Marshal code requirements, including normal operating and smoke mode functions (where applicable). The installation shall comply with the requirements of the NEC, NFPA, UL and the Building Codes, including referenced mechanical, electrical, energy codes, etc.
- 1.11 ABBREVIATIONS:
- TCC – Temperature Control Contractor

PART 2 – GENERAL SYSTEM REQUIREMENTS:

- 2.1 All labeling for this system shall utilize actual final room names and numbers. The room names and numbers on the Contract Documents may not be the Owner's exact requirements. Coordinate with the Owner to ensure compliance.
- 2.2 Include in the bid for the Controls Contractor to perform additional 40 on-site hours of on-site programming, adjustments, modifications, etc. as requested by the Engineer during the warranty period after the date of substantial completion for the project.
- 2.3 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the control's manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- 2.4 The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system integrated utilizing ANSI/ASHRAE Standard 135-2001 BACNet, LONWorks technology, OBIX TCP/IP, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system
- 2.5 The TCC shall connect to any mechanical and electrical (power monitoring) equipment furnished with a control interface device. The TCC shall contact the equipment suppliers and/or manufacturers for information for the proper interface to the equipment being furnished. All points not provided with the equipment control interface are the responsibility of the TCC.
- 2.6 The operating system shall be based on a distributed control system in accordance with specifications. All building controllers, application controllers and all input/output devices shall communicate via BACnet MS/TP or LonMark/LonTalk communication protocol. Network controller shall communicate via BACnet over Ethernet (IP).
- 2.7 The TCC contractor shall provide access to the system from a location determined by the Owner and from the Consulting Engineer's office (CMTA, Inc.). This shall include remote access requirements, set-up, passwords, and any software necessary to access the BAS system.
- 2.8 The TCC shall all have access to various types of WEB browsers which shall be included for access to the Direct Digital Control (DDC) system via the Owner's Wide Area Network (WAN) and/or Local Area Network (LAN).

- 2.9 The TCC shall be responsible for coordination with the Owner's IT staff to ensure that their system will perform in the Owner's environment without disruption to any of the other activities taking place on that WAN/LAN.

PART 3 – SUBMITTALS:

- 3.1 The TCC shall not start the project installation until the shop drawing submittals have been reviewed by the Engineer.
- 3.2 Submittals shall include hardware, end devices, ancillary control components, a written operating sequence, unitary control wiring, building floor plans showing communication cabling and labels as well as logic flow diagrams. All submittals shall be provided on paper and electronically in PDF format.
- 3.3 Submittals shall contain one control drawing per specified system and equipment. Drawing shall include point descriptors (DI, DO, AI, AO), addressing, and point names. Each point names shall be unique (within a system and between systems). For example, the point named for the mixed air temperature for AHU #1, AHU #2, and AHU #3 shall not be MAT but should be named AHU#1MAT, AHU#2MAT, and AHU#3MAT. The point names should be logical and consistent between systems and AHU's. The abbreviation or shorthand notation (e.g., MAT) shall be clearly defined in writing by the TCC.
- 3.4 Control diagrams shall identify: System being controlled (attach abbreviated control logic text, all digital points, analog points, virtual points, all functions (logic, math, and control) within control loop, legend for graphical icons or symbols, definition of variables or point names and detailed electric connections to all control devices and sensors.
- 3.5 Points list shall include all physical input/output. Points list shall be provided in both hard copy and in electronic format and shall include Name, address, engineering units, high and low alarm values and alarm differentials for return to normal condition, default value to be used when the normal controlling value is not reporting, message and alarm reporting as specified, identification of all adjustable points and description of all points.
- 3.6 Submittals shall contain floor plans depicting DDC control devices (control units, network devices, LAN interface devices, and power transformers as well as static pressure sensor in duct and temperature sensors in rooms) in relation to mechanical rooms, HVAC equipment, and building footprint.
- 3.7 Submittals shall contain DDC system architecture diagram indicating schematic location of all control units, workstations, LAN Interface devices, gateways, etc. Indicate address and type for each control unit, Indicate protocol, baud rate, and type of LAN per control unit.
- 3.8 Electrical wiring diagrams shall include motor start, control, and safety circuits and detailed digital interface panel control point termination diagrams with all wire numbers and terminal block numbers identified. Indicate all required electrical wiring. Provide panel termination drawings on separate drawings. Clearly differentiate between portions of wiring that are existing, factory-installed and portions to be field-installed.
- 3.9 Show all electric connections of the controls system to equipment furnished by others complete to terminal points identified with manufacturer's terminal recommendations.
- 3.10 TCC shall provide one complete drawing that shows the control-wiring interface with equipment provided by others.

- 3.11 Submittals shall include project specific graphic screens for each system including a picture of the screen with a list of the variables to be placed on the screen.
- 3.12 Submittals shall include TCC's hardware checkout sheets and test reports.
- 3.13 Submittals shall include the agenda for approval by the engineer and owner of the specified training periods. See training section for requirements.
- 3.14 Provide complete panel drawings that are:
- Clearly labeled and schematic or drawn to scale.
 - Show the internal and external component arrangement so that the operators can identify the components by their position if the labels come off.
 - Wiring access routes shall also be identified so that Class 1 wiring is separated from Class 2 and 3 and so high voltage wiring is segregated from low voltage wiring.
 - Complete identification of all control devices (manufacturer's type, number, and function).
 - Provide details for labeling all wiring, control devices, and controllers.
 - Material and equipment descriptive material such as catalog cuts, diagrams, performance curves, and other data to demonstrate conformance with specifications shall be provided.
- 3.15 Include room schedule including a separate line for each terminal unit, heat pump, etc. indicating location and address.
- 3.16 Include control valve schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: code number, configuration, fail position, pipe size, valve size, body configuration, close-off pressure, capacity, valve Cv, design pressure, and actuator type.
- 3.17 Include control damper schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: code number, fail position, damper type, damper operator, duct size, damper size, mounting, and actuator type.

PART 4 – O&M MANUALS AND CLOSEOUT DOCUMENTS:

- 4.1 Refer to Mechanical Specification Section – REQUIRED SHOP DRAWINGS, ETC. for additional requirements.
- 4.2 Operating instructions, maintenance procedures, parts and repair manuals shall be supplied. Repair manuals shall include detailed instructions in the setup, calibration, repair, and maintenance of all equipment furnished. Also supplied with these manuals will be a complete parts listing of all devices supplied which is to include part numbers and model numbers of all parts and component parts along with exploded views of devices.
- 4.3 All as built drawings (wiring diagrams, flowcharts, floor plans, etc.) shall also be supplied to the owner electronically in PDF format.
- 4.4 System specific wiring, control diagrams, sequence of operation and points lists shall be as installed in each control panel. This means as-built drawings, not design (submittal) drawings.
- 4.5 Supply all software necessary for configuration of, modification, editing or communicating to any of the unitary devices. Software shall be capable of uploading and down-loading the entire unitary data base or any part of the automated system for backup or archiving.

- 4.6 Supply one copy of the software programming manual (hard copy and PDF format). The manual shall describe all furnished software. The manual shall be oriented to programmers and shall describe calling requirements, data exchange requirements, data file requirements, and other information necessary to enable proper integration, loading, testing, and program execution.
- 4.7 Provide a Bill of Materials with each schematic drawing. List all devices/equipment and match to schematic and actual field labeling. Provide quantity, manufacturer, actual product ordering number, description, size, accuracy, operating ranges (voltage, temperature, pressure, etc.), input/output parameters, etc.
- 4.8 Maintenance manual shall include copies of signed-off acceptance test forms, commissioning reports, start-up reports, etc.
- 4.9 The TCC shall turn over to owner two (2) sets of computerized back-ups of the complete temperature control system.

PART 5 – WARRANTY & SOFTWARE LICENSES:

- 5.1 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after substantial completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.
- 5.2 The TCC shall respond to the Owner's request for warranty service within 24 hours during normal business hours. The TCC shall respond to the Owner's request for Emergency service (defined as life-threatening or creating the potential to cause property damage) during the warranty period within 4 hours.
- 5.3 The TCC shall provide technical phone support to the owner during the warranty period for warranty related issues and for two years after the warranty period. If the technical support location of the TCC is outside of the toll free calling area for the customer, the TCC shall have a toll free number or accept collect calls for the purpose of providing technical support.
- 5.4 During the warranty period, standard parts for the DDC system shall arrive at the facility within 48 hours of placing an order. Non-standard parts (requiring re-manufacturing or ordering from another supplier) shall be shipped within 96 hours.
- 5.5 Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the TCC shall be provided and correctly installed at no charge during the warranty period.
- 5.6 Provide licensed electronic copies of all software for each workstation, laptop, server. This includes but is not limited to: project graphic images (editing/modifying/creating), project database, troubleshooting and debugging programs, project-specific programming code and all other software required to operate and modify the programming code (including software at system level, primary control units, secondary control units, and all communication software). Any hardware devices (cables, protection devices) required to operate the software/hardware shall also be provided.

- 5.7 All additional licensing needed for this project shall be supplied by TCC. Software license shall not expire or utilize any sort of protection hardware device for its use. In any case owner shall be free to direct the modification of any software license, regardless of supplier to allow open access to all controllers. Owner shall hold the software and firmware licensing. Software license shall not expire or utilize any sort of protection hardware device for its use.
- 5.8 System software shall be the latest version available with upgrades provided at the end of the warranty period and shall be fully licensed to the Owner for the entire system. Supply all software necessary for configuration of, modification, editing or communicating to any of the unitary devices. Software shall be capable of uploading and downloading the entire unitary data base or any part of the automated system for backup or archiving. Software shall be "IBM compatible".

PART 6 – TRAINING:

- 6.1 A formal on-site "Hands On" training session shall be conducted for the owner's maintenance personnel. This session shall be a minimum of one (1) eight (8) hour days to train the staff on setup, operation, and maintenance of all system(s) and/or devices. This will be at a time and location selected by the owner. One (1) additional eight (8) hour session shall be provided as "opposite season" training – generally 6 months into the warranty period. One (1) additional eight (8) hour session shall be provided at a later date. (This may be requested any time during the warranty period.) All training materials and books shall be provided. Both sessions shall be given by the manufacturers "factory" technical representative. (This is defined as someone other than the installing contractor's representative.) All expenses are to be provided by the TCC. All training sessions shall be scheduled at owner's request.
- 6.2 TCC shall conduct training courses for designated personnel in operation and maintenance of system. Training shall be oriented to specific system being installed under his contract and shall be digitally recorded and submitted on DVD by the TCC.
- 6.3 Training shall be a mix of, test exercises, and actual keyboard entry and screen viewing at the operator's terminal. A curriculum shall be discussed and implemented based on the level of expertise of the employees. Hands-on experience and problem solving shall be emphasized.
- 6.4 If during any training session, the trainer/owner finds more than three (3) items that need repair, the training session will be immediately terminated. The session will be rescheduled for another date. The re-scheduled training session will be carried out at no additional cost to the Owner.
- 6.5 The training shall be oriented to making the owner self sufficient in the day-to-day use and operation of the DDC system.
- 6.6 Additionally, the training shall include:
- System start-up, shutdowns, power outage and restart routines, alarms, security levels, changing setpoints, changing schedules and other parameters, overrides, freeze protection, manual operation, return to automatic operation, and resetting equipment.
 - All screens shall be discussed, allowing time for questions.
 - Information specifically focused on showing the owner methods of troubleshooting the mechanical systems using the DDC.
 - Use of laptop and hand-held operator interface device, if applicable.
 - Creating, modifying, viewing, downloading, and reloading, trend logs.
 - Remote access to the system.
 - The other training sessions shall be oriented toward answering specific questions from Owner's staff.

- The trainer must be well grounded in both DDC system operation and in mechanical systems service and shall be the programmer.

6.7 This documentation and process shall be complete, approved and accepted by Engineer and Owner prior to acceptance. This information shall be documented as completed. A copy shall be delivered to the Engineer and Owner and included in the O&M manuals.

PART 7 – COMMISSIONING & VERIFICATION, FUNCTIONAL PERFORMANCE TESTING & CHECKLISTS:

7.1 100% compliance with the requirements of this section is a condition of the Owner's acceptance and start of the warranty period.

7.2 The TCC shall be responsible for completion of (1) their hardware checkout sheets and test reports, (2) Point-by-point confirmations of ALL points – this includes visual inspection of installed components, and (3) sequence of operation confirmation.

7.3 This documentation and process shall be complete, approved and accepted by Engineer and Owner prior to acceptance. This information shall be documented as completed. A copy shall be delivered to the Engineer and Owner and included in the O&M manuals. Each subcontractor shall be responsible for completion of their own System Verification Checklists/Manufacturer's Checklists. Sample checklists shall be submitted to the Engineer and Testing Agent for approval.

7.4 Air and water balancing shall be completed (and discrepancies resolved) before the TCC's final system check and before the acceptance test to be conducted in the presence of the Engineer.

7.5 Refer to Mechanical Specification Section – GENERAL PROVISIONS for additional information and requirements.

PART 8 – WIRE MANAGEMENT, ELECTRICAL POWER, ETC:

8.1 Refer to CABLING section of this specification for additional requirements.

8.2 Electrical work required for system interlock and installation of the temperature control system shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for installation of a complete system.

8.3 All wiring and cabling in mechanical and electrical rooms shall be in conduit. No wiring or conduit can be exposed to view in any other area. Conceal all wiring and cabling in conduit in wall from thermostats or other controls devices to above ceiling. Install conduit in wall from wall thermostats to above ceiling for cabling. Route wiring directly to cable tray from control points above the ceiling. Rough-in for control devices shall be in compliance with the requirements of the ELECTRICAL SPECIFICATIONS.

8.4 Any power for controls shall be fed from dedicated circuits in emergency electrical panels, when provided for a project, and shall not be obtained from receptacles, lighting, or equipment circuits. Unitary control power may be obtained from the equipment served. If power is obtained from the equipment served, the power may not be interrupted to the electronics if the equipment is off for any reason.

8.5 The TCC shall be responsible for the power source to any control panels, unitary controllers, etc. on any controlled equipment and all other control power requirements. This includes circuit breakers, wiring, conduit, etc. installed in strict accordance with NEC. The TCC may contract with the electrical contractor for the power wiring installation.

- 8.6 Prior to installation, insure through coordination with all trades, that appropriate clearances (36" minimum) as required by the N.E.C. are maintained at all control panels, including unitary controllers for VAV terminals, heat pumps, etc.
- 8.7 The TCC shall provide all CAT5 or CAT6 cabling network cabling for a complete system. This shall include cabling to the Owner's data drop. The main system data drop will be provided by others.
- 8.8 All control circuits within the electrical panels shall be marked to indicate equipment served.
- 8.9 The TCC shall perform all temperature control interlock wiring. This shall include control valves, dampers, thermostats, indoor/outdoor HVAC systems, etc. Electrical work required for system interlock and installation of the temperature control system shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for installation of a complete system.
- 8.10 The TCC shall be responsible for any power required for the unitary controls or control panels. This includes circuit breakers, wiring, conduit, etc. installed in strict accordance with NEC. The TCC may contract with the electrical contractor for the power wiring installation.
- 8.11 Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic control components. This receptacle may be served from the control panel 120 VAC power source.
- 8.12 All wiring shall be continuous runs. Any junctions must be made in metal enclosure.
- 8.13 Grounding terminals shall be color coded green and yellow and shall be compatible with the other specialty terminals specified above and shall mount on the same DIN rail system. Units shall be arranged so that the wiring connected to them is grounded to the enclosure via the mounting rail. These terminals shall be provided for grounding cable shields at the points where the cables enter a control panel and terminate on the control panel terminal strip. Terminals shall be Entelec M 4/5.3A.PI or equivalent by Weidmuller, Phoenix, or Allen Bradley.
- 8.14 The Department of Housing, Building and Construction's Electrical Division requires that all new lighting control panels, new Building Automation Systems control panels, and new conventional HVAC control panels be certified as being constructed and wired in accordance with NFPA 70 110.3 (a) (1) and article 409.
- 8.15 Contractor shall insure control panels have an identification label stating the "Certification Agency" such as UL, CSA, CE, etc. or a label of certification for each control panel by a Professional Engineer (P.E.) registered stating that the design of the control panel was under their direct supervisory control. Include with shop drawings.
- 8.16 The Electrical Advisory Council for the State requires that only an electrical contractor licensed by the State with a licensed Master Electrician and a licensed on-site electrician can install the electrical wiring for lighting controls systems or Building Automation Systems (BAS).

PART 9 – CABLING:

- 9.1 Refer to WIRE MANAGEMENT section of this specification for additional requirements.
- 9.2 ALL CONTROL WIRING SHALL BE INSTALLED IN A WIRE MANAGEMENT SYSTEM TO INCLUDE CABLE TRAYS, BRIDLE RINGS, & CONDUITS. NO EXCEPTIONS! COORDINATE WITH ELECTRICAL CONTRACTOR TO INSURE A COMPLETE WIRE MANGEMENT SYSTEM.

- 9.3 Acceptable cable manufacturers are Belden, West Penn, or Alpha.
- 9.4 A complete cabling system shall be furnished and installed, which shall adhere to the highest workmanlike standard of quality and appearance. Cabling shall be installed square with building lines and contained within a wire management system.
- 9.5 All sizing of cabling shall be according to manufacturer's recommendations but shall be a minimum of 18 AWG.
- 9.6 Furnish a floor plan of the building indicating communication cable labeling and routing as well as addresses and branch wiring from the unitary devices. All cabling shall be labeled on both ends. The type, size and label of all cabling shall be indicated on submittal floor plan drawings.
- 9.7 Wall space temperature sensor cabling (from the sensor to the unitary controller) shall have a minimum of four (4) conductors.
- 9.8 All cabling shall be stranded. "NO" solid conductors will be accepted. All cabling shall be 100% shielded with appropriate drain wire and insulation.
- 9.9 All cable connections shall be continuous run (including shield). Any junctions must be made in a metal enclosure, connections must be soldered, taped and the metal enclosure must be mechanically attached to the nearest ground. No wire nuts or crimped connections will be accepted. Note location of junction boxes on the as built floor plans. All cabling networking unitary controllers, and other networked equipment, shall be in soldered.
- 9.10 All shields must be terminated as per manufacturer's recommendation. Shield termination requirements by the manufacturer must be provided with submittals.
- 9.11 Wireless controllers are not approved unless specifically mentioned in the sequence of operations or noted on plans.

PART 10 – SYSTEM SOFTWARE:

- 10.1 System software will be the latest version available with upgrades provided for full warranty period and shall be fully licensed to the owner for all network controllers and servers. Refer to WARRANTY section of this specification for additional requirements.
- 10.2 The BAS shall include trend logging screens accessible from tabs on the home page for building utilities usage.
- 10.3 System software shall, at a minimum, provide:
- Monitor and supervise all control points.
 - Add new points and edit system database.
 - Change control setpoints, timing parameters and loop tuning of PID coefficients in all control loops in all control units.
 - Enter programmed start/stop schedules.
 - View alarm and messages.
 - Modify existing control logic (or sequence of operation) in all control units.
 - Upload/Download programs, databases, control parameters, etc.
 - Modify graphic screens.

- 10.4 Sequence of operation programming methodology - The application software shall be user programmable. Application programming shall be (1) Line type programming that uses text programming in a language similar to BASIC or FORTRAN, or (2) graphical block programming - The method of programming shall be by manipulation of graphic icon "blocks." Each block represents a subroutine containing the programming necessary to execute the function of the device that the block represents.
- 10.5 Unitary Control Unit Database Archiving - The host software shall provide capability to upload sequence of operation, database, and other control parameters from each controller. Uploaded programs shall be retained on hard disk for system backup. Programs may be modified using Editor functions and downloaded to individual controllers as desired. Downloading of databases shall not interrupt other multi-tasked functions that are ongoing.
- 10.6 THIRD PARTY SOFTWARE PACKAGES: The host software shall provide the capacity to run third party software packages for word processing, spreadsheets, or database management programs. Use of third party software shall not suspend operation of background tasks of multi-tasking operating system, such as alarm logging, and report generation.

PART 11 – NETWORK CONTROLLER

- 11.1 Install the Network Controller in a surface mounted panel, NEMA type 1 enclosures, with a removable hinged door. Provide a flush mounted key lock. All control panels must be painted the same color and identified. The boxes are to be made from 16 gauge material. Panels should not be provided with knockouts.
- 11.2 Control panels shall be constructed by a UL approved panel manufacturer. The standard used shall be UL508A. All proper labels are to be attached. Panel shall meet arc flash requirements.
- 11.3 The Network Controller shall be web-based and communicate BACnet IP. It shall issue all time schedules, summer/winter commands, customized trending, holiday scheduling, alarm handling, clock, or other shared commands to all unitary controllers within the building network. If for any reason communications between the unitary(s) and the Network Controller is lost, the unitary(s) shall operate in a stand-alone manner (in day operation) until communications is restored. It shall also operate in the "summer" or "winter" mode as last commanded.
- 11.4 The Network Controller shall be integrated and interoperable with the facility infrastructure and include user access to all system data locally over the Local Area Network (LAN) / Wide Area Network (WAN) within the building and remotely by a standard Web Browser over the Internet. Any computer connected to the network, utilizing a web browser, and having the proper password.
- 11.5 The Network Controller shall be a fully user-programmable, supervisory controller. It shall monitor the network of distributed unitary controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers.
- 11.6 The Network Controller shall have battery back-up to allow a minimum of seven days of operation. The Network Controller shall be composed of one or more independent, stand-alone, microprocessor to manage the network strategies described in Application software section. The network controller shall have ample memory to support its operating system, database, and programming requirements. The operating system of the Network Controller shall manage the input and output communications signals to allow distributed unitary controllers to share real and virtual point information and allow central monitoring and alarms. The database and custom programming routines of the Network Controller shall be editable from a single operator station.

- 11.7 The Network Controller shall be remotely monitored via the internet. Additionally, it shall include automatic emailing and texting out alarms, gathering alarms, reports and logs, programming and downloading database.
- 11.8 The Network Controller shall continually check the status of all processor and memory circuits. If a failure is detected, the controller shall:
- Assume a predetermined failure mode.
 - Emit an alarm.
 - Display card failure identification.
- 11.9 Under no circumstance shall more than 75% of the total number of sensor and control points be connected through a single Network Controller. Each DDC system component shall provide for the future addition of at least 20% of each type of the number of sensor and control points connected to that component including a minimum of one universal input and one universal output.

PART 12 – UNITARY CONTROLLER

- 12.1 Unless otherwise specified, each piece of equipment shall have its own Unitary Controller (i.e., heat pump, AHU, terminal unit, etc.). The Unitary Controller for each piece of equipment shall be mounted on the side of the unit. The Unitary Controller for all other equipment shall be mounted in a panel and properly labeled.
- 12.2 Unitary Controllers used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F. All Unitary Controllers shall have an RJ-11 or similar type connection for monitoring or programming access by room or local equipment level with access to any unitary within the network without modification.
- 12.3 Control panels shall be constructed by a UL approved panel manufacturer. The standard used shall be UL508A. All proper labels are to be attached. Panel shall meet arc flash requirements.
- 12.4 Unitary Controllers utilized in the network shall have full stand alone capability including time of day and holiday scheduling as well as all energy management functions such as optimal start/stop, duty cycling, etc. The terminal unit Unitary Controllers may be pre-programmed with the project specific sequence of operation as specified for the application. Any re-programming of the electronics shall be performed on location using a portable personal computer with appropriate software or through the Network Controller. The entire unitary data base shall have the capability of being backed up and or downloaded locally.
- 12.5 All points to have a unique digital input to the BAS system. The use of digital point count expanders is not an acceptable replacement to digital inputs to the unitary controller. The conversion of a single universal input channel to accept up to multiple voltage free contacts such as relay contacts, auxiliary starter contacts, differential pressure switches, etc. IS NOT ACCEPTABLE.
- 12.6 Unitary Controllers shall communicate via BACnet MSTP or LonMark/LonTalk communication protocol. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each Unitary Controller that will communicate on the BACnet MS/TP Bus.
- 12.7 All Unitary Controllers shall be fully application programmable. All control sequences within or programmed into the unitary controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery shall be retained.
- 12.8 Unitary Controllers shall have a 10% spare point capacity to be provided for all applications.

- 12.9 After a power failure, the Unitary Controller shall operate the control application using the current setpoints and configuration. Reverting to default or factory setpoints are not acceptable.

PART 13 – SENSORS AND MISCELLANEOUS DEVICES:

- 13.1 WEATHER STATION HOUSING: Provide Kele Model A21 Outdoor Aspirated Humidity/Temperature housing. NEMA 3R enclosure is painted white to reduce the effect of radiation, and the enclosure has a lockable latch for security. The outdoor air sensor will be installed on the north wall in the shade as not to be affected by sunlight, building ventilation or weather. This location shall be indicated on the control drawings. Installation in outside air ductwork or louvers is not acceptable. If not installed to provide "accurate" temperature readings, it shall be relocated (at the TCC's expense) until a suitable location is found.
- 13.2 SENSOR RESOLUTION: All temperature sensors shall have a minimum resolution of 1/10th of 1 degree F. (0.1 degree F.) Sensor stability shall be 0.24 degrees over a year period. Space sensors shall be tested and accurate to within 0.75 degrees F. Outside air, water and duct sensors shall be tested and accurate to within 2.0 degrees F.
- 13.3 SPACE SENSORS AND THERMOSTATS:
- Refer to the drawings for proper type and location.
 - All thermostat and sensors shall be provided with temperature indication, unless otherwise noted.
 - Programmed set-point shall be locally adjustable limited to 2 degrees above set-point and 2 degrees below set-point for supervised areas.
 - Unsupervised areas shall have non-adjustable set-point.
 - Generally, thermostats/sensors shall be installed 5'-0" above the finished floor.
 - Where thermostats/sensors are to be mounted next to a light switch, install at the same height as the light switch.
 - Sensors in hallways, vestibules, stairways, restrooms, and locker rooms shall utilize a stainless steel surface mount temperature sensor installed on an interior wall or partition (2"x4" blank plate). Care must be taken in the installation of these sensors to ensure proper insulation from the wall temperatures in order to properly sense space temperature.
 - If there is a question consult engineer prior to rough-in.
- 13.4 MIXED AIR SENSORS: These sensors shall be bendable averaging, type made of copper or aluminum elements. In unit ventilators, these sensors shall be at least five (5) feet in length and installed in the discharge air of the unit. For Air Handling Units, Outside Air Units, etc. the sensors shall be at least 20 feet in length.
- 13.5 DISCHARGE AIR AND DUCT ROOM RETURN AIR SENSORS: Shall be rigid insertion type. In all applications, care shall be taken to ensure that the sensors are securely mounted as not to allow any vibration and installed in such a manner as to indicate the truest possible temperature.
- 13.6 FREEZE/LOW-LIMIT THERMOSTAT: Provide a freeze/low-limit thermostat in each Air Handling Unit, Outside Air Unit, etc with a water coil for freeze protection. These devices shall be the manual reset type. This device shall be wired by using a normally closed contact in series with the motor starting circuit and a normally open set of contacts as an input to the unitary controller. The element shall be constructed of copper and be at least 20 feet in length. It shall be installed serpentine across the air entering the coil. In some cases, it may require being installed after the coil. Each application should be closely evaluated before installation. The device shall sense the lowest temperature by any one foot section of its element.

- 13.7 HUMIDITY SENSORS: These devices shall be 100% solid state, linear and temperature compensated with scaling 0-100% RH range with LED or LCD Display. Accuracy at 25°C from 10-80% RH* ±2%, operating Humidity Range 0 to 100% RH (non-condensing), Stability ±1% @ 20°C (68°F) annually, for two years, Hysteresis 1.5% typical, Temperature Effect ±0.1% RH/°C above or below 25°C (typical), 1% accuracy between 0% - 90% RH, Operating Temperature Range -40° to 50°C (-40° to 122°F) +/- 1%. -Do not submit products that do not meet this range. The output of the device shall utilize an analog output 4-20 mA, 2-wire, polarity insensitive, (clipped and capped), The device shall use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.
- 13.8 COMBINATION TEMPERATURE/HUMIDITY SENSORS: All temperature sensors shall have a minimum resolution of 1/10th of 1 degree F. (0.1 degree F.) Sensor stability shall be 0.24 degrees over a year period. Space sensors shall be tested and accurate to within 0.75 degrees F. The humidity sensing device shall be 100% solid state, linear and temperature compensated with a 0-100% RH range. The response time shall be a minimum of 30 seconds for a 60% change. They shall have a minimum of 2% accuracy minimum accuracy of +/-2% RH minimum rangeability 5 to 95% RH non-condensing and maximum hysteresis +/- 1.5% RH. - Do not submit products that do not meet this range. The output of the device must utilize a 0-10 VDC or 4-20mA signal as required. The device must use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.
- 13.9 LOW PRESSURE TRANSDUCERS: These devices shall be 100% solid state, linear and temperature compensated. Accuracy shall be no less than plus or minus 1% of its full range. Linearity, repeatability, and hysteresis shall be no less than plus or minus 0.1%. All pressure sensors shall utilize output averaging/output clipping to adjust and stabilize any fluctuations in the output. The output of the device shall utilize a 0 - 10 VDC signal. The device shall use a power supply of 24 VAC or VDC. The enclosure 16 gauge steel. For sensing internal static pressure of air handling ducts utilize sensors with a range of 0 to 5 inches water column. For sensing building static pressures (building compared to atmospheric) utilize a sensor with a range of -0.25 to +0.25 inches water column.
- 13.10 RELAYS: Relays for starting and stopping fractional horsepower motors shall be rated as follows:
- 1/4 horsepower motors or less use 15 ampere rated relays,
 - 1/3 horsepower motors use 20 ampere rated relays,
 - 1/2 horsepower motors use 30 ampere rated relays,
 - Relays used for pilot duty service shall be rated at a minimum of 10 amperes.
 - Provide auxiliary pilot duty relays on motor starters as required for control function.
 - Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- 13.11 CENTRAL STATION AIR HANDLERS: All Central Station Air Handlers, Outside Air Units, etc shall be provided with a D.A.P. (differential air pressure) switch across each the supply fan to provide fan status for each air handler.

- 13.12 **SMOKE SHUTDOWN:** All AHUs, OA units, Heat Pump Units, etc with fans of greater than 2,000 CFM are required to have smoke shutdown safeties as required by the Building Code. These smoke detectors shall have a set of auxiliary contacts wired to a dedicated input of the Unitary to provide status of the smoke detector. All units must be provided with a current sensor to provide fan status for each air handler. For projects with Outside Air (OA) units, any system fire alarm activation shall shutdown all OA units. Coordinate with the Fire Alarm Contractor to insure a complete, code compliant installation.
- 13.13 **CURRENT SENSING DEVICES:** Veris Industries model Hx08 Series and H701 or equal. All current sensors shall be capable of alarming to the BAS for belt losses, pump coupling shear or other mechanical failure on loads.
- 13.14 **CARBON DIOXIDE SENSORS:** This sensor shall have a range of 0-2000 ppm +/-5% and +/- 50 ppm. Analog output of 0-10 or 2-10 VDC. Power shall be 24VAC. Calibration interval rated for 5 years. Sensor shall not be provided with a digital display. Honeywell Model C7232 or equal. A replacement CO2 sensor shall be installed annually for 5 years after substantial completion by the control's contractor. Provide with LED display.

PART 14 - VALVES, DAMPERS AND ACTUATORS:

- 14.1 Unless otherwise specified, valves shall be furnished and sized by the TCC. The valves are to provide the required capacity and the close off rating shall be in excess of the system pressures encountered (minimum 40 psi differential). Proportioning-type valve bodies shall be packed type with throttling type inner valve (quick close plug shall not be acceptable). Proportional type valves to be rated at 125 psi static pressure. Modulating control valves shall be selected within a 3-5 psig pressure drop range. Two position control valves (open/close) shall be line size.
- 14.2 Dampers for various units requiring field mounting shall be tight closing, "ultra low leakage", opposed blade with side and edge seals. They shall be sized and furnished under this section. Installation of dampers shall be by the sheet metal contractor, coordinated by the TCC. Frames shall be no less than 16 gauge galvanized steel and furnished with mounting holes for duct mounting. Damper blades shall be no less than 14 gauge galvanized steel with maximum blade width of 8 inches. Blades shall be secured to 1/2 inch zinc plated axles and hardware with nylon bearings. Provide thrust bearings at the end of each blade. **All dampers shall have end switches to positively prove damper position. No Exceptions!**
- 14.3 All damper and valve actuators shall be fail safe spring return type with sufficient force to operate the dampers or valves under all normal operating conditions. They shall return to the normally open position upon a loss of power. Exceptions to the spring return applications are (1) face and bypass actuators, (2) boiler 3-way loop mixing valves, (2) boiler room seasonal changeover valves. Actuators for fan coil units, terminal units, etc. shall fail in the last position.
- 14.4 "ALL" Actuators shall be of the same manufacturer and have internal feedback circuitry to provide a positive action to insure proper positioning of the damper or valve through the entire sequence. Actuators shall have an adjustable starting point to accurately set the range of travel to the output of the controller. All actuators shall also utilize the same input signal (6-9 VDC, 0-010V, 2-10 VDC, 4-20 MA) in order to maintain some consistency in the control application. Analog actuation is 6-9 VDC, 0-010V, 2-10 VDC or 4-20 MA, floating point control with 2 digital outputs is NOT approved as analog actuation.
- 14.5 Actuators may be factory installed. If not factory installed, they shall be installed as per instructions by the terminal equipment manufacturer.
- 14.6 Locations mounted above ceiling shall be marked on ceiling grid.

- 14.7 Install damper motors on the outside of the duct in warm areas where possible, not in air stream or locations exposed to outdoor conditions.

PART 15 – GRAPHICS SCREENS AND TRENDS:

- 15.1 All graphics screens shall be submitted for review by Engineer. Provide the following animated, color graphics screens minimally:
- 15.2 Entire floor plan home screen with OAT, Time, and Date displays.
- Floor plan showing major zones,
 - Click major zone displays enlarged floor plan of the zone showing individual heat pump zones & numbers. Include link to respective mechanical room.
 - Click individual zone shows heat pump graphic. Display all data points from points list, occ/unocc schedule and setpoints, OAT, Time, and Date.
- 15.3 Color Graphic Screens shall be designed for all mechanical systems and shall include the following:
- A graphic shall be the starting page with the building graphically indicated. Break up the floor plan into zones to match Contract Documents. The building shall be the point of reference to enter into the respective building control system.
 - All heat pump units including filters, humidifiers, associated VAV boxes, etc.
 - All terminal equipment including but not limited to zone dampers, etc.
 - All OA units.
 - Domestic hot water heaters and pumps.
 - The summation of all supply OA for each unit shall be displayed on the AHU graphic pages.
 - All floor plans indicating all actual room numbers, thermostats, and mechanical equipment. Operator shall be capable of clicking on any equipment and pull up the respective graphic screen.
- 15.4 Graphics to include floor plans with room numbers (as-built room numbers) and thermostat locations, links to flow diagrams for heat pumps, zone dampers, hydronic loop systems, outside air systems, domestic hot water, and lighting controls.
- 15.5 All new graphics shall match the existing system graphics, unless noted otherwise.
- 15.6 The graphical programming software shall allow for interactive mouse-driven placement of block icons on the graphic screen and connection of block inputs to block outputs by means of drawing lines to form a graphic logic diagram. The user shall not have to manually input text to assign block input/output interconnections. Blocks shall allow entry of adjustable settings and parameters via pop-up windows.
- 15.7 The clarity of sequence shall be such that the user has the ability to verify that the system programming meets the specs without having to learn or interpret a manufacturer's unique programming language. Provide a means for testing and/or debugging the control programs off-line (not communicating with control units) using operator entered values for physical inputs and time. Provide a means for testing and/or debugging the control programs on-line (communicating with control units), showing actual physical inputs and all block outputs in real time.
- 15.8 Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time output values.

- 15.9 All graphic software shall be in the html web browser format and support multiple simultaneous screens to be opened and resizable in a "Windows" type environment. All functions, except text entry, shall be executable with a mouse. Graphic software shall provide for multitasking such that third party programs can be used while the Operator Workstation Software is on-line. Provide the ability to alarm graphically even when operator is in another software package. The software shall allow for Owner to create user defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics.
- 15.10 The contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, coils, filters, dampers, etc.), mechanical system components (e.g., pumps, heat pumps, etc.), complete mechanical systems (e.g., VAV, etc.) and electrical symbols.
- 15.11 The graphic development package shall use a mouse or similar pointing device to allow the user to perform the following:
- Define symbols
 - Position items on graphic screens
 - Attach physical or virtual points to a graphic
 - Define background screens
 - Define connecting lines and curves
 - Locate, orient and size descriptive text
 - Define and display colors for all elements
 - Establish correlation between symbols or text and associated system points or other displays.
 - Create hot spots or link triggers to other graphic displays or other functions in the software
- 15.12 The TCC shall including programming of 25 point trends as directed by the Engineer. These can be requested at any time during the project including the warranty period. Trend "change of state" for digital inputs. Trend analog points in 30 minute increments. Maintain trend history for 30 days.

PART 16 - TIME SCHEDULES (ALL TIMES SHALL BE USER ADJUSTABLE):

- 16.1 During construction, the time schedule (for all equipment except OA unit) will be Occupied at 5:00 AM, Unoccupied at 10:30 PM. seven (7) days a week.
- 16.2 When the system is fully tested and operational and after the Owner's staff have been fully instructed as to the operation of the system the schedule shall be as follows unless otherwise instructed:
- 16.3 Occupied: Monday through Friday Occupied mode at 7:30 AM, Unoccupied mode at 5:30 PM. Unoccupied for Saturday and Sunday.
- 16.4 All schedules shall be coordinated and confirmed with the Owner prior to final implementation.

SEQUENCE OF OPERATIONS:

PART 17 – VRF SYSTEM

- 17.1 Provide the VRF system with a Master controller (TE-200A or equal as basis of design) along with the necessary expansion controllers.
- 17.2 The VRF system shall interface to the building BMS system via BACnet communication. The BMS PC shall meet the minimum requirements for this interface. The VRF to BACnet interface shall reside on the BACnet system hub. Provide a master controller for the VRF unitary controllers. Provide quantity of master controllers as necessary to accommodate the VRF system components.

- 17.3 System shall include compressor monitoring, hi/low pressures, input/output status, operating functions, system points, monitoring, scheduling, and Trend data. System to include memory backup via the network along with downloading to a USB drive.
- 17.4 Provide all interconnection wiring between controller, units and DDC system.
- 17.5 In unoccupied mode the room setpoints shall be 5°F (adj.) higher/lower than cooling and heating setpoint.

HARDWIRE	Binary Status	Analog Point	Start/ Stop	Alarm	Trend
VRF System Heat/Cool	X		X	X	X
Room Temperature		X		X	X
Filter Status	X			X	
Return Water Temperature	X	X		X	X
Geothermal Loop Water Flow.		X			X

PART 18 - OUTSIDE AIR ENERGY RECOVERY UNITS (ERU-1, -2, -3, -4 and -5)

- 18.1 The systems shall operate under the control of a local, stand-alone, microprocessor based ddc controller.
- 18.2 The systems shall be placed into the occupied/unoccupied mode based upon the user adjustable schedule at the global control panel. These systems shall be in the occupied mode during regular building Hours only.
- 18.3 If communication is lost between the global control panel and the outside air system controller, then the outside air system shall be placed into the unoccupied mode until communication is restored.
- 18.4 Supply and exhaust air fans: the s/e air fans shall be controlled through a factory mounted variable frequency drive (vfd). Pressure sensors located in the ductwork, (refer to plans for location) shall control the operation of the fan vfd's. A pressure of 0.5" wc (adj.) Shall be maintained. The tcc shall individually optimize the required setpoint to obtain the design airflow in conjunction with the TAB. The units for the classroom wings only (ERU-1 and -2).
- 18.5 An occupancy sensor (provided by TCC) shall be provided and installed in the classrooms associated with ERU-1 and -2 along with a VAV box. The box shall be open with the room is occupied. When the room is unoccupied the box shall close after 20 minutes (adj.) of inactivity.
- 18.6 The rest of the units shall operate under constant air volume mode during occupied mode.
- 18.7 The exhaust fan VFD shall be controlled to maintain exhaust air flows. The supply fan shall be balanced ~10% (adj.) more than the exhaust.
- 18.8 Each system will be placed into a mode of operation based upon the following adjustable temperature schedule:
 - 18.8.1 Outside air temperature 65°F or greater (adj.) - Cooling mode
 - 18.8.2 Outside air between 55°F and 65°F (adj.) - Economizer mode

- 18.8.3 Outside air 55°F or less (adj.) - Heating mode
- 18.9 In the unoccupied mode and morning warm up mode:
 - 18.9.1 The supply fan and exhaust shall be off.
 - 18.9.2 The energy recovery wheel shall be off.
 - 18.9.3 The dx cooling and has heat are off.
 - 18.9.4 The outside air damper and exhaust air damper shall be fully closed.
- 18.10 When placed into the occupied mode, the following shall occur:
 - 18.10.1 The energy recovery wheel shall start and operation shall be provided via current switch.
 - 18.10.2 The outside air damper and exhaust air damper shall fully open and be proved via damper end switch, attached to damper blades.
 - 18.10.3 The supply fan and exhaust air damper shall fully open and be proved via damper end switch, attached to damper blades.
 - 18.10.4 The supply fan and exhaust fan shall start and operation shall be proved via current switch.
 - 18.10.5 The system shall not start if any one component does not prove operation.
- 18.11 In the occupied mode, the unit shall maintain a discharge air temperature (adj.) Based upon the following schedule:
 - 18.11.1 Cooling Mode - 68°F to 70°F (adj.)
 - 18.11.2 Economizer Mode – Varies
 - 18.11.3 Heating Mode - 70°F to 75°F (adj.)
- 18.12 Wheel control: the enthalpy wheel is turned on whenever the exhaust fan is running and the outdoor air dampers are at the minimum position. The wheel is shut off if the exhaust fan ever turns off or if the unit enters the economizer operating site.
 - 18.12.1 Wheel effectiveness control: the energy recover wheel will start/stop or modulate its speed to meet the discharge air temperature set point using factory mounted temperature sensors. The energy wheel is the first form of heating or cooling when active. Compressors or heat will only be active when the energy recovery wheel cannot satisfy the DAT.
 - 18.12.2 On/off defrost control - When the outside air temp is below an adjustable frost temperature the wheel is stopped for an adjustable period of time once every 60 minutes (adj.).
- 18.13 The above discharge temperature control shall be maintained through the operation of the modulating dx compressor(s), modulating gas heat and hot gas reheat.

- 18.14 Dehumidification mode (modulating hot gas reheat): If exhaust air humidity is greater than 55% relative humidity, the digital scroll compressor shall modulate up to 100% to maintain discharge air dew point of 55°F. If dewpoint setpoint cannot be maintained the second compressor shall start and the scroll compressor shall modulate maintain dewpoint setpoint. The hot gas reheat valve shall modulate to maintain 65°F (DB) discharge air setpoint. If valve is 100% open the temperature can drift between 60-70 deg f. The suction pressure will be monitored to verify refrigerant pressures does not drop below manufacturers recommendations. If suction pressure is not maintained reduce the dewpoint setpoint 2°F and alarm at the BAS.
- 18.15 The unit is provided with fully modulating, sub cooling, hot gas reheat coil. The control sequence used for dehumidification in the unit uses two separate points of control. The first point is the leaving coil temperature sensor, and the second point is the discharge air temperature sensor. During dehumidification the refrigeration circuit controls the compressors to maintain the setpoint (adj.) and the reheat coil is controlled to maintain the supply air reheat setpoint. The supply air reheats setpoint changes based on whether there is a call for both cooling and dehumidification or a call for dehumidification only. When a call for both cooling and dehumidification is made the reheat setpoint is set as the cooling setpoint. During a call for dehumidification only the reheat setpoint is reset in a linear manner between two endpoints referred to as the min and max reheat setpoints (adj). This reset is based on the cooling and heating setpoints for the unit. This logic will end warmer supply air when the space is approaching the heating chageover setpoint and cooler supply air when the space is approaching cooling changeover setpoint. This logic prevents unnecessary fluctuations between cooling and heating states.
- 18.16 The unit's dehumidification controls allow the unit to cool and dehumidify simultaneously or just dehumidify if no cooling is needed.
- 18.17 A smoke detector shall be located in the exhaust air stream of both units. If smoke is detected, then the system shall shutoff and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and shall return to normal operation. Coordinate with fire alarm system.
- 18.18 Upon detection of carbon monoxide, alarm the ddc system and shut down. System shall alarm at location as directed by owner.

HARDWIRE	Binary Status	Analog Point	Start/ Stop	Alarm	Trend
Outside Air Fan	X		X	X	
Exhaust Air Fan	X		X	X	
Energy Recovery Wheel	X		X	X	
Outside Air Damper (open/close)	X			X	
Exhaust Air Damper (open/close)	X			X	
Outside Air Temp (entering and leaving)		X		X	X
Exhaust Air Temp (entering and leaving)		X		X	X
Freeze Stat		X		X	
Outdoor RH		X			X
DX Cooling	X		X		
Gas Heat % Firing	X	X	X		
Hot Gas Reheat		X			
Exhaust Humidity		X			X
Supply Duct Static Pressure		X			X
Room Occupancy	X				X
VAV Box On/Close	X			X	
VAV Box Discharge Airflow		X			X
Filter Status (Outside and Exhaust Air)	X			X	

PART 19 – EXISTING BATHROOM EXHAUST FANS

- 19.1 There are several existing bathroom exhaust fans. The fans shall not operate when the building is unoccupied. The TCC shall interlock these fans into the room light switch to operate when the light is turned on. The fan shall automatically shut off after 5 minutes (adj.) of operation.

HARDWIRE	Binary Status	Analog Point	Start/ Stop	Alarm	Trend
Exhaust Fan	X		X		

PART 20 - ROOFTOP UNIT OPERATION

- 20.1 Supply Air Temperature Control: (Occupied cooling) The rooftop control shall maintain space temperature setpoint using DX compressor and gas heat. If outside air conditions are acceptable the economizer controls shall be used to maintain space setpoint. For the space served by two units (RTU-1 & 2) the units shall operate in a lead/lag operation with the second unit only coming on when needed to maintain space temperature setpoint. The units shall cycle which is lead monthly.
- 20.2 Units shall be off during unoccupied mode, unless space temperature is 10 degrees above or below setback temperature. Unit shall automatically switch into occupied mode until space temperature is meet. The outside air dampers shall be closed during this period.
- 20.3 The supply fan shall modulate on/off with compressor operation with the exception of RTU-1 & 2. The fan shall run continuously in occupied mode for these units.
- 20.4 The outside air dampers shall be interlocked to the compressors to open in minimum position when compressors are operational.

- 20.5 Humidity Control Operation: The unit is provided with hot gas reheat to aide in humidity control. A space humidity sensor shall measure space humidity. If space humidity exceeds 55% (adj.), the unit shall enter dehumidification control. When space humidity falls to normal levels (below 50%), normal unit operations shall continue.
- 20.6 A smoke detector shall be located in the exhaust air stream of both units. If smoke is detected, then the system shall shutoff and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and shall return to normal operation. Coordinate with fire alarm system.

HARDWIRE	Binary Status	Analog Point	Start/ Stop	Alarm	Trend
Supply Air Fan	X		X	X	
Supply Air Temperature		X		X	X
Space Temperature Setpoint		X		X	X
Space Humidity		X		X	X
DX Compressor Status	X		X		
Gas Heat		X			
Outside Air Damper Position		X			X
Smoke Detector	X			X	

PART 21 – EXISTING ELECTRIC HEATERS:

- 21.1 The TCC shall interlock the existing heaters DDC system to only allow operation when the outside air is below 60°F (adj.). Provide all relays as required. The units are controlled by factory thermostats. Provide a new thermostat in the room interconnected to the DDC system.

HARDWIRE	Binary Status	Analog Point	Start/ Stop	Alarm	Trend
Heater Enable/Disable	X		X		
Space Temperature		X	X	X	X

PART 22 – EXISTING COMPUTER ROOM SPLT SYSTEM:

- 22.1 The TCC shall provide a new room thermostat to monitor the room temperature. The existing controls are to remain.

HARDWIRE	Binary Status	Analog Point	Start/ Stop	Alarm	Trend
Space Temperature		X	X	X	X

END OF SECTION.