SP Design Group
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Date June 9, 2017

RE: Bibb County Public Schools
Hartley Elementary – HVAC Renovation

Addendum #1

PROJECT MANUAL:

Specification

Section # - Section Name

1. 15950 – See attached and replace this section complete

DRAWINGS:

Replace the following sheets dated revised May 10, 2017

Sheet #

1. M001
2. M101
3. M201
4. M203

End of Addendum #1

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SECTION 15950
BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 1 Specification Sections, apply to this Section.

1.02 DESCRIPTION:

A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and a web-based operator interface.

B. Hartley Elementary is comprised of two main buildings: B2010 built in 1968, and B2020 built in 2002.

C. Hartley Elementary has an existing obsolete front end in place (an older Novar panel). Provide new controllers, accessories, sensors, wiring, etc. to control the mechanical equipment as specified herein for both buildings.

D. System software shall be based on a server/thin client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the owner's local area network, and (at the owner's discretion) over the Internet.

E. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. Web browser shall be used to access graphics, point displays, and trends, configure trends, configure points and controllers, or to download programming into the controllers. Control system should support several web based browsers, including Microsoft Internet Explorer, Google Chrome, Mozilla Firefox and Apple Safari.

F. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication among control modules. I/O points, schedules, setpoints, trends and alarms specified in “Sequence of Operations for HVAC Controls” shall be BACnet objects.

1.03 APPROVED CONTROL SYSTEM MANUFACTURERS:

A. Carrier iVu, Novar TL-1/Alerton, or Honeywell

1. The Contractor shall use only operator workstation software, controller software, custom application programming language, and controllers from the corresponding manufacturer and product line unless Owner approves use of multiple manufacturers.
2. Other products specified herein (such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

1.04 QUALITY ASSURANCE:

A. Installer and Manufacturer Qualifications:

1. Installer shall have an established working relationship with Control System Manufacturer.
2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

B. Codes and Standards: Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:
1. National Electric Code (NEC).
2. International Building Code (IBC).
3. Section 719 Ducts and Air Transfer Openings.
4. International Mechanical Code (IMC).
5. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems.

1.05 SYSTEM PERFORMANCE:

A. Performance Standards: System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems):
1. Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 sec.
2. Graphic Refresh: A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
3. Configuration and Tuning Screens: Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
4. Object Command: Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
5. Alarm Response Time: An object that goes into alarm shall be annunciated at the workstation within 45 sec.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
7. Performance: Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation: Each workstation on the network shall receive alarms within 5 sec of other workstations.
9. Reporting Accuracy: System shall report values with minimum end-to-end accuracy listed in Table 1.
10. Table 1 Reporting Accuracy / Table 2 Control Stability and Accuracy:

Measured Variable	Reported Accuracy
Space Temperature	±0.5ºC (±1ºF)
Ducted Air	±1ºF
Outside Air	±2ºF
Dew Point	±3ºF
Delta-T	±0.25ºF
Relative Humidity	±5% RH
Electrical	±1% of reading (see Note 3)

Note 3: Not including utility-supplied meters.

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.2 in. w.g.) ±0.01 in. w.g.	0–6 in. w.g.) -0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±2.0ºF	
Duct Temperature	±3ºF	
Humidity	±5% RH	

1.06 SUBMITTALS:

A. Product Data and Shop Drawings: Meet requirements of Section 15011 Mechanical Submittals on Shop Drawings, Product Data, and Samples. In addition, the contractor shall provide shop drawings or other submittals on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2006 (or newer) compatible files on flash drive or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and three 11" x 17" prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut-sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided within 12 weeks of contract award. Provide the following:

1. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
2. Network riser diagrams of wiring between central control unit and control panels.
3. Riser diagrams showing control network layout, communication protocol, and wire types.
4. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
5. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.

6. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
7. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
8. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
9. Provide a point list for each control system. List I/O points and software points for each type of equipment. Indicate alarmed and trended points.

B. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training.

1.07 WARRANTY:

A. Warrant work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
3. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
5. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

PART 2 – PRODUCTS

2.01 MATERIALS:

A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.02 COMMUNICATION:

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

B. Install new wiring and network devices as required to provide a complete and workable control network.

C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

D. Internetwork operator interface and value passing shall be transparent to internetwork architecture. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified herein. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

2.03 OPERATOR INTERFACE:

A. The Operator Workstation or server shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.

B. Operator Interface: Web server shall reside on high-speed network with building controllers.

C. Communication: Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

1. System Diagnostics: The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
2. Alarm Processing: System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93 (Sequences of Operation). Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
3. Alarm Messages: Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms.
4. Alarm Reactions: Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
5. Alarm and Event Log: Operators shall be able to view all system alarms and

changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.

6. Trend Logs: The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 23 09 93 (Sequences of Operation). Trends shall be BACnet trend objects.
7. Object and Property Status and Control: Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
8. Reports and Logs: Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
9. Standard Reports: Furnish the following standard system reports:
    a. Objects: System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
    b. Alarm Summary: Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
    c. Logs: System shall log the following to a database or text file and shall retain data for an adjustable period:
        (1) Alarm History.
        (2) Trend Data. Operator shall be able to select trends to be logged.
        (3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

2.04 CONTROLLER SOFTWARE:

A. Furnish the following applications for building and energy management. All software application shall reside and operate in the system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

B. Scheduling: Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:

1. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
3. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.

C. Demand Limiting:

1. The demand-limiting program shall monitor building power consumption from a

building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.

2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Part 4 (Sequences of Operation). When demand drops below adjustable levels, system shall restore loads as specified.

D. Maintenance Management: The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Part 4 (Sequences of Operation).

E. PID Control: System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.

2.05 CONTROLLERS:

A. BACnet:

1. Building Controllers (BCs): Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
2. Advanced Application Controllers (AACs): Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
3. Application Specific Controllers (ASCs): Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Sensors (SSs): Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
5. BACnet Communication:
   a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
   b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
   c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
   d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
   e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
   f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall

reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

B. Communication:

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation. Each piece of equipment specified in Sequence of Operations shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.

C. Environment: Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -20°F to 140°F.
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation 32°F to 120°F.

D. Real-Time Clock: Controllers that perform scheduling shall have a real-time clock.

E. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

F. Memory:

1. Controller memory shall support operating system, database, and programming requirements.
2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

G. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft.).

H. Transformer: ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.06 AUXILIARY CONTROL DEVICES:

A. Motorized Control Dampers, unless otherwise specified elsewhere, shall be as follows:

1. Type: Control dampers shall be the parallel or opposed-blade type as specified below or as scheduled on drawings.
2. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
3. Other modulating dampers shall be opposed-blade.
4. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.

B. Temperature Sensors:

1. Type: Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
2. Duct Sensors: Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 5 ft. in length per 10 ft^2 of duct cross-section.
3. Immersion Sensors: Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
4. Space Sensors: Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.
5. Differential Sensors: Provide matched sensors for differential temperature measurement.

C. Humidity Sensors:

1. Duct and room sensors shall have a sensing range of 20%–80%.
2. Duct sensors shall have a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 20%–95% RH and shall be suitable for ambient conditions of -40°F to 170°F.
4. Humidity sensors shall not drift more than 1% of full scale annually.

D. Relays:

1. Control Relays: Control relays shall be plug-in type, UL listed, and shall have dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time Delay Relays: Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

E. Voltage Transmitters:

1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4–20 mA output with zero and span adjustment.
2. Adjustable full-scale unit ranges shall be 100–130 Vac, 200–250 Vac, 250–330 Vac, and 400–600 Vac. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

F. Voltage Transformers:

1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 40°F–130°F and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

G. Power Monitors:

1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
2. 1.0% full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120–600 V, and auto range select.
3. Under voltage/phase monitor circuitry.
4. NEMA 1 enclosure.
5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0–0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.

H. Current Switches:

1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

I. Pressure Transducers:

1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

J. Local Control Panels:

1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.07 WIRING AND RACEWAYS:

A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 16.

B. Insulated wire shall use copper conductors and shall be UL listed for 200°F minimum service.

2.08 FIBER OPTIC CABLE SYSTEM:

A. Optical Cable: Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.

B. Connectors: Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

B. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

3.02 PROTECTION:

A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.

B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.03 COORDINATION:

A. Site:

1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance:

1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
2. The contractor shall provide training in the use of these tools. This training will be

planned for a minimum of 4 hours.

3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 units are balanced.
4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

C. Life Safety:

1. Duct smoke detectors required for air handler shutdown are provided under Division 16. Interlock smoke detectors to air handlers for shutdown as specified in Sequences of Operation.
2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 15. Interlock smoke dampers to air handlers as specified in Sequences of Operation.
3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 15. Fire and smoke damper control is provided under Division 16.

D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified in Communication.
2. Each supplier of a controls product is responsible for the configuration, programming, start up, and testing of that product to meet the Sequences of Operation.
3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.04 GENERAL WORKMANSHIP:

A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.05 FIELD QUALITY CONTROL:

A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Codes and Standards.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.06 WIRING:

A. All control and interlock wiring shall comply with national and local electrical codes, and Division 16 of this specification. Where the requirements of this section differ from Division 16, the requirements of this section shall take precedence.

B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.

C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.

E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 10ft.

F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

G. Do not install wiring in raceway containing tubing.

H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 10 ft intervals.

I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.

K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.

M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

O. Size of raceway and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

P. Include one pull string in each raceway 1 in. or larger.

Q. Use color-coded conductors throughout with conductors of different colors.

R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 in. from high-temperature equipment (e.g. steam pipes or flues).

T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

U. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.

V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.

W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, liquid-tight, flexible metal raceways shall be used.

Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.07 COMMUNICATION WIRING:

A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to manufacturer's instructions.

G. All runs of communication wiring shall be unspliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. All communication wiring shall be labeled to indicate origination and destination data.

J. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

K. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:

1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 30 pF per foot.
2. The maximum length of an MS/TP segment is 4000 ft with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
4. An MS/TP EIA-485 network shall have no T connections.

3.08 FIBER OPTIC CABLE:

A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.

B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.09 INSTALLATION OF SENSORS:

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.

D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.

E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 ft of

sensing element for each 1 ft^2 of coil area.

G. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

3.10 ACTUATORS:

A. General: Mount and link control damper actuators according to manufacturer's instructions.

1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide all mounting hardware and linkages for actuator installation.

B. Electric/Electronic:

1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.

3.11 WARNING LABELS:

A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows.

C A U T I O N
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

B. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows.

C A U T I O N
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.12 IDENTIFICATION OF HARDWARE AND WIRING:

A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 2 in. of termination with control system address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum ½ in. letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.

E. Identify room sensors related to terminal boxes or valves with nameplates.

F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

3.13 CONTROLLERS:

A. Provide a separate controller for each HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in Sequences of Operation.

3.14 PROGRAMMING:

A. Provide sufficient internal memory for the specified sequences of operation and trend logging.

B. Point Naming: Name points as shown on the equipment points list provided with each sequence of operation. See Sequences of Operation. If character limitations or space restrictions make it advisable to shorten the name, abbreviations may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.

C. Software Programming: Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

1. Text-based:
    a. Must provide actions for all possible situations
    b. Must be modular and structured
    c. Must be commented
    d. Graphic-based:
    e. Must provide actions for all possible situations
    f. Must be documented
2. Parameter-based:
    a. Must provide actions for all possible situations
    b. Must be documented.

D. Operator Interface:

1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of

the building. This includes each, air handler, split system, wall hung heat pump, exhaust fan and ceiling heater. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points.

2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.15 CONTROL SYSTEM CHECKOUT AND TESTING:

A. Startup Testing: All testing listed shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.

1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:
   a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
   b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
   c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE:

A. Demonstration:

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that

the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.

3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
    a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
    b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
    c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
    d. Interface to the building fire alarm system.
    e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system

as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.17 CLEANING:

A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.18 TRAINING:

A. Provide training for a designated staff of Owner’s representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

B. Classroom training shall be done using a network of working controllers representative of installed hardware.

3.19 DUCT SMOKE DETECTION:

A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."

B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.20 CONTROLS COMMUNICATION PROTOCOL:

A. General: The electronic controls packaged with this equipment shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control setpoints as shown in the points list, sequences of operation, and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in ANSI/ASHRAE Standard 135 (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Clause 15.5 of Standard 135.

B. Distributed Processing: The controller shall be capable of stand-alone operation and shall continue to provide control functions if the network connection is lost.

C. I/O Capacity: The controller shall contain sufficient I/ O capacity to control the target system.

D. The Controller shall have a physical connection for a laptop computer or a portable operator's tool.

E. Environment: The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°F to 140°F.
2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 32°F to 120°F.

F. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

G. Memory: The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 30 days.

H. Power: Controller shall be able to operate at 90% to 110% of nominal voltage rating.

I. Transformer: Power supply for the Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

3.21 START-UP AND CHECKOUT PROCEDURES:

A. Start up, check out, and test all hardware and software and verify communication between all components.

1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
2. Verify that all analog and binary input/output points read properly.
3. Verify alarms and interlocks.
4. Verify operation of the integrated system.

PART 4 - SEQUENCE OF OPERATION

4.01 Wall Hung Heat Pumps

A. Wall Hung Heat Pump units shall be enabled/disabled by the BAS, based on a time scheduled as directed by the owner.

B. Once the units are enabled, they should operate under their internal controls to maintain temperature and humidity setpoints. Temperature setpoints shall be controlled by the BAS.

C. Occupied Mode: The supply fan shall run continuously with a BAS master setpoint of 75°F cooling and 69°F heating.

D. Unoccupied Mode (night setback): The supply fan shall run intermittently and maintain 85°F (adj.) space cooling setpoint and 55°F (adj.) space heating setpoint.

E. High Zone Temp Alarm: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).

F. Low Zone Temp Alarm: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

G. Zone Setpoint Adjust: The occupant shall be able to adjust the BAS master setpoint by + or - 2°F.

H. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. The mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

I. Minimum Outside Air Ventilation - Fixed Percentage: The outside air dampers shall maintain a minimum position (adj.) during building occupied hours and be closed during unoccupied hours.

J. Energy Recovery Ventilator – The energy wheel shall run continuously when the unit is operating.

K. Dehumidification: The wall mounted humidistat shall maintain 60% RH (adj) Space humidity. If the space relative humidity rises above set point, the unit shall energize the hot gas solenoid valve, and the cooling shall be on, until the space humidity falls below setpoint. Dehumidification shall be enabled whenever the supply fan status is on. Cooling mode will override the humidity mode.

	Hardware Points				**Software Points**						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sch.**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	x								x		x
Zone Setpoint Adjust	x										x
Space Humidity	x								x		x
Supply Air Smoke Detector			x						x	x	x
Dehumidification Setpoint					x				x		x
Schedule								x			
Heating Setpoint									x		x
Cooling Setpoint									x		x

4.02 Gas Split System Unit Controls Sequence

A. Occupied Mode: The supply fan shall run continuously with a BAS master setpoint of 75°F cooling and 69°F heating.

B. Unoccupied Mode (night setback): The supply fan shall run intermittently and maintain 85°F (adj.) space cooling setpoint and 55°F (adj.) space heating setpoint.

C. High Zone Temp Alarm: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).

D. Low Zone Temp Alarm: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

E. Zone Setpoint Adjust: The occupant shall be able to adjust the BAS master setpoint by + or - 2°F.

F. Zone Optimal Start: The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

G. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

H. Emergency Shutdown: The unit shall shut down and generate an alarm upon receiving an emergency shutdown signal.

I. Supply Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.

J. Alarms shall be provided as follows:

1. Supply Fan Failure: Commanded on, but the status is off.
2. Supply Fan in Hand: Commanded off, but the status is on.
3. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

K. Cooling (AHU-1 ONLY): The controller shall measure the zone temperature and energize the cooling to maintain its cooling setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between starts, and each start shall have a user definable (adj.) minimum runtime. Cooling shall be enabled whenever outside air temperature is greater than 45°F (adj.) and the economizer is disabled or fully open and the zone temperature is above cooling setpoint and the supply fan status is on and the heating is not active.

L. Cooling Stages (AHU-2 ONLY): The controller shall measure the zone temperature and stage the cooling to maintain its cooling setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime. Cooling shall be enabled whenever outside air temperature is greater than 45°F (adj.) and the economizer is disabled or fully open and the zone temperature is above cooling setpoint and the supply fan status is on and the heating is not active.

M. Gas Heating (AHU-1 ONLY): The controller shall measure the zone temperature and energize the heating to maintain its heating setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between starts, and each start shall have a user definable (adj.) minimum runtime. Heating shall be enabled whenever outside air temperature is less than 65°F (adj.) and the zone temperature is below heating setpoint and the supply fan status is on and the cooling is not active.

N. Gas Heating Stages (Duct Heater for AHU-2 ONLY): The controller shall measure the zone temperature and stage the heating to maintain its heating setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime. Heating shall be enabled whenever outside air temperature is less than 65°F (adj.) and the zone temperature is below heating setpoint and the supply fan status is on and the cooling is not active.

O. Economizer: The controller shall measure the zone temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the zone cooling setpoint. The outside air dampers shall maintain a minimum adjustable position of 10% (adj.) open whenever occupied. The economizer shall be enabled whenever outside air temperature is less than 55°F (adj.) and the outside air temperature is less than the return air temperature and the supply fan status is on. The economizer shall close whenever mixed air temperature drops from 45°F to 40°F (adj.) or on loss of supply fan status.

P. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available, the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

Q. Minimum Outside Air Ventilation - Fixed Percentage: The outside air dampers shall maintain a minimum position (adj.) during building occupied hours and be closed during unoccupied hours.

R. Dehumidification (AHU-2 ONLY): The controller shall measure the Space humidity and sequence to maintain space humidity by energizing the hot gas solenoid valve whenever the humidity in the space is above an adjustable setpoint 60% rh (adj.). Dehumidification shall be enabled whenever the supply fan status is on. Cooling mode will override the humidity mode.

S. Supply Air Temperature: The controller shall monitor the supply air temperature. Alarms shall be provided for High Supply Air Temp (If the supply air temperature is greater than 125°F (adj.)) and Low Supply Air Temp (If the supply air temperature is less than 35°F (adj.)).

	Hardware Points				**Software Points**						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sch.**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	x								x		x
Zone Setpoint Adjust	x										x
Space Humidity	x								x		x
Return Air Temp	x								x		x
Supply Air Temp	x								x		x
Mixed Air Dampers		x							x		x
Zone Override			x						x		x
Supply Air Smoke Detector			x						x	x	x
Supply Fan Status			x						x		x
Supply Fan Start/Stop				x					x		x
Cooling Stage 1				x					x		x
Cooling Stage 2				x					x		x
Heating Stage 1				x					x		x
Economizer Zone Temp Setpoint					x				x		x

	Hardware Points				Software Points						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sch.**	**Trend**	**Alarm**	**Show On Graphic**
Dehumidification Setpoint					x				x		x
Environmental Index					x				x		
Percent of Time Satisfied					x				x		
Emergency Shutdown						x				x	x
Schedule								x			
Heating Setpoint									x		x
Cooling Setpoint									x		x
High Zone Temp										x	
Low Zone Temp										x	
Supply Fan Failure										x	
Supply Fan in Hand										x	
Supply Fan Runtime Exceeded										x	
Compressor Runtime Exceeded										x	
Final Filter Change Required										x	x
High Mixed Air Temp										x	
Low Mixed Air Temp										x	
High Return Air Humidity										x	
Low Return Air Humidity										x	
High Return Air Temp										x	
Low Return Air Temp										x	
High Supply Air Temp										x	
Low Supply Air Temp										x	

4.03 Split System Heat Pumps

A. Split System Heat Pump units shall be enabled/disabled by the BAS, based on a time scheduled as directed by the owner.

B. Once the units are enabled, , they should operate under their internal controls to maintain temperature and humidity setpoints. Temperature setpoints shall be controlled by the BAS.

C. Occupied Mode: The supply fan shall run continuously with a BAS master setpoint of 75°F cooling and 69°F heating.

D. Unoccupied Mode (night setback): The supply fan shall run intermittently and maintain

85°F (adj.) space cooling setpoint and 55°F (adj.) space heating setpoint.

E. High Zone Temp Alarm: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).

F. Low Zone Temp Alarm: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

G. Zone Setpoint Adjust: The occupant shall be able to adjust the BAS master setpoint by + or - 2°F.

H. Dehumidification (FCU/HP-1 through FCU/HP-5 ONLY): The wall mounted humidistat shall maintain 60% RH (adj) Space humidity. If the space relative humidity rises above set point, the unit shall energize the hot gas solenoid valve, and the cooling shall be on, until the space humidity falls below setpoint. Dehumidification shall be enabled whenever the supply fan status is on. Cooling mode will override the humidity mode.

	Hardware Points				**Software Points**						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sch.**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	x								x		x
Zone Setpoint Adjust	x										x
Space Humidity	x								x		x
Dehumidification Setpoint					x				x		x
Schedule								x			
Heating Setpoint									x		x
Cooling Setpoint									x		x

4.04 Electric Ceiling Heater

A. The unit will be provided a start stop contact closure for enable and disable of the Unit heater based on occupancy mode and outdoor air temperature lock out.

	Hardware Points				**Software Points**						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sch.**	**Trend**	**Alarm**	**Show On Graphic**
Enable				x				x			

4.05 Exhaust Fans ON/OFF

A. Occupied Mode: The exhaust fan shall run continuously during Occupied Mode.

B. Unoccupied Mode: The exhaust fan shall be “off.”

C. The controller shall monitor the fan status.

D. Alarms shall be provided as follows:

1. Fan Failure: Commanded on, but the status is off.
2. Fan in Hand: Commanded off, but the status is on.
3. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

	Hardware Points				**Software Points**						
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Loop**	**Sch.**	**Trend**	**Alarm**	**Show On Graphic**
Fan Status			x						x		x
Fan Start/Stop				x					x		x
Fan Failure										x	
Fan in Hand										x	
Fan Runtime Exceeded										x	

END OF SECTION

MECHANICAL LEGEND

LINE WEIGHTS	
	EXISTING TO REMAIN
	TO BE DEMOLISHED
	NEW WORK

SYMBOLS	
D	CONDENSATE DRAIN PIPING
R	REFRIGERANT PIPING
	DROPPING OR RISING PIPE
	PIPE TO OR FROM ABOVE
24x12	RECTANGULAR DUCT SIZE: FIRST DIMENSION IS SIDE DRAWN
	SPIRAL ROUND DOUBLE WALL DUCT
	ROUND DUCTWORK OR FLUE PIPING
	RECTANGULAR TO ROUND DUCT TRANSITION
	FLEXIBLE ROUND DUCT
	FLEXIBLE DUCT CONNECTION
	ADJUSTABLE DEFLECTOR VANES AT BRANCH DUCT
	SQUARE DUCT ELBOW WITH TURNING VANES
MVD	MANUAL VOLUME DAMPER
FD	FIRE DAMPER IN DUCT THROUGH WALL
FSD	FIRE/SMOKE DAMPER IN DUCT THROUGH WALL
AVD	AUTOMATIC (MOTORIZED) CONTROL DAMPER
	ONE INCH THICK DUCT LINER
30/12	SPLITTER DAMPER WITH SPLIT DIMENSIONS SHOWN
	VERTICAL OFFSET: ARROW INDICATES RISE
FD	FIRE DAMPER IN DUCT THROUGH FLOOR SLAB
RFD	RADIANT FIRE DAMPER AT CEILING
	EQUIPMENT ON ROOF ABOVE
T	WALL MOUNTED THERMOSTAT OR TEMPERATURE SENSOR
H	WALL MOUNTED HUMIDISTAT OR HUMIDITY SENSOR
S	WALL MOUNTED FAN SWITCH
	WALL MOUNTED TIME CLOCK
	DOOR GRILLE
U.C.	UNDERCUT DOOR 3/4"
	CONCRETE PAD
	POINT OF CONNECTION OR LIMIT OF SCOPE OF WORK
₵	CUBIC FEET PER MINUTE AIRFLOW

ABBREVIATIONS	
AFF	ABOVE FINISHED FLOOR
APPROX	APPROXIMATE
BAS	BUILDING AUTOMATION SYSTEM
CFM	CUBIC FEET PER MINUTE
DIA	DIAMETER
db	DRY BULB
DUAL TEMP	DUAL TEMPERATURE
DX	DIRECT EXPANSION
EER	ENERGY EFFICIENCY RATING
EAT	ENTERING AIR TEMPERATURE
Edb	ENTERING DRY BULB
ESP	EXTERNAL STATIC PRESSURE
EVAP	EVAPORATOR
Ewb	ENTERING WET BULB
FPM	FEET PER MINUTE
FT	FEET
H	HEIGHT
HP	HORSE POWER
IN	INCHES
IN. WG	INCHES WATER GAUGE
kW	KILOWATTS
LAT	LEAVING AIR TEMPERATURE
Ldb	LEAVING DRY BULB
Lwb	LEAVING WET BULB
MAX	MAXIMUM
MBH	THOUSAND BTU PER HOUR
MIN	MINIMUM
OA	OUTDOOR AIR
PD	PRESSURE DROP
PSIG	POUNDS PER SQUARE INCH GAUGE
RPM	REVOLUTIONS PER MINUTE
SEER	SEASONAL ENERGY EFFICIENCY RATING
SQ. FT.	SQUARE FEET
TEMP	TEMPERATURE
TYP	TYPICAL
VFD	VARIABLE FREQUENCY DRIVE
W	WIDTH
wb	WET BULB
°F	DEGREES FAHRENHEIT
Δ t	TEMPERATURE DIFFERENCE

WALL HUNG HEAT PUMP SCHEDULE

MARK	BARD MODEL No.	SUPPLY CFM	OA CFM FROM ERV	TOTAL COOLING MBH	SENSIBLE COOLING MBH	HEAT OUTPUT MBH	ELEC HEAT kW	NOTES
WHHP-1	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-2	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-3	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-4	T36S1DB09R	1100	200	33.8	26.2	33.0	6.0	1;2;3;4;5;6;7;8;9
WHHP-5	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-6	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-7	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-8	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-9	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-10	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-11	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-12	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-13	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-14	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-15	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9
WHHP-16	T30S1DB06R	900	200	28.0	21.2	27.8	6.0	1;2;3;4;5;6;7;8;9

1. COOLING CAPACITIES BASED ON AIR ENTERING EVAPORATOR AT 80° Fdb, 67° Fwb AND 95° F AMBIENT AIR TEMPERATURE
2. HEAT PUMP HEATING CAPACITY AT 47° F
3. PROVIDE HOT GAS REHEAT DEHUMIDIFICATION
4. PROVIDE AUXILIARY ELECTRIC HEATER OF CAPACITY SCHEDULED
5. PROVIDE REMOTE WALL MOUNTED THERMOSTAT
6. PROVIDE ENERGY RECOVER VENTILATOR WITH ROTARY CASSETTE
7. PROVIDE CARRIER I-VU CONTROLS COMPATIBLE WITH SCHOOL'S NEW EMS
8. INTEGRAL CIRCUIT BREAKER OR DISCONNECT
9. PROVIDE GLOBAL PLASMA SOLUTIONS AIR PURIFICATION UNIT MODEL GPS-FC-3-BAS AFTER FILTER AND BE FIRE COOLING COIL

GRILLE SCHEDULE

MARK	TITUS MODEL No.	FACE SIZE	NECK SIZE	SERVICE	FINISH	NOTES
A	TDC-AA	24x24	8"Ø	SUPPLY	WHITE	1;2;3;4
B	TDC-AA	24x24	10"Ø	SUPPLY	WHITE	1;2;3;4
C	TDC-AA	24x24	12"Ø	SUPPLY	WHITE	1;2;3;4
D	50F	24x24	- - -	RETURN	WHITE	7;8
E	300RS	32x14	30x12	SUPPLY	WHITE	3;5;6
F	300RS	24x10	22x8	SUPPLY	WHITE	3;5;6
G	350RS	50x34	48x32	RETURN	WHITE	3;5;6
H	350RS	24x42	22x40	RETURN	WHITE	3;5;6
J	TDC-AA	24x24	6"Ø	SUPPLY	WHITE	1;2;3;4
K	33RL	50x50	48x48	RETURN	WHITE	6;10
X	EXISTING					9

1. LOUVER FACE SUPPLY DIFFUSER
2. IN 24x24 PANEL FOR LAY-IN T-BAR CEILING
3. PROVIDE STEEL OPPOSED BLADE BALANCING DAMPER
4. ROUND NECK
5. RECTANGULAR NECK
6. FRONT BLADES PARALLEL TO THE SHORT DIMENSION
7. 1/2"x1/2"x1/2" ALUMINUM EGG-CRATE CEILING REGISTER
8. OPEN TO RETURN AIR PLENUM
9. BALANCE TO CFM SHOWN
10. HEAVY DUTY, 3/4" SPACING, SINGLE DEFLECTION RETURN GRILLE

GAS DUCT HEATER SCHEDULE

MARK	MODINE MODEL No.	MBH INPUT	AIR Δt °F	CFM	DUCT SIZE		WINTER CONDITIONS		NOTES
					W	H	EDB	LDB	
GDH-1	DFS-250	250,0	35,0	5250	48"	16"	60,0	95,0	1;2;3;4;5

1. FLANGED TYPE GAS DUCT HEATER WITH INTEGRAL CONTROL BOX
2. PROVIDE SEPARATED COMBUSTION KIT
3. PROVIDE AIR PROVING SWITCH, OVER-TEMPERATURE CUT-OUT AND CONTROL CONTACTOR
4. PROVIDE ELECTRONIC MODULATION CONTROLS
5. PROVIDE BMS COMPATIBLE GAS CONTROLS

DUCTLESS SPLIT SYSTEM SCHEDULE

MARK	INDOOR UNIT MITSUBISHI MODEL No.	OUTDOOR UNIT MITSUBISHI MODEL No.	EVAP CFM	TOTAL COOLING MBH	TOTAL HEATING MBH	SEER	NOTES
DSHSDSHM-1	MSZ-FE09NA	MUZ-FE09NA	343	9.0	10.3	20.5	1;2;3;4;5;6;7;8

1. COOLING CAPACITIES BASED ON AIR ENTERING EVAPORATOR AT 80° F db, 67° F wb AND 95° F AMBIENT AIR TEMPERATURE
2. HEATING CAPACITIES BASED ON REVERSE-CYCLE HEAT PUMP OPERATION AT 47 °F AMBIENT AIR TEMPERATURE
3. HIGH SIDEWALL INDOOR UNIT
4. SUPPLY AIRFLOW CFM BASED ON HIGH SPEED AND DRY COIL
5. PROVIDE CONDENSATE PUMP
6. PROVIDE LOW AMBIENT CONTROL
7. PROVIDE REMOTE WALL MOUNTED THERMOSTAT

FAN COIL UNIT SCHEDULE

MARK	MANUFACTURER	MODEL No.	TOTAL SUPPLY CFM	OA CFM	FAN MOTOR HP	E.S.P. IN. W.G.	COOLING		HEATING		NOTES
							TOTAL MBH	SENSIBLE MBH	HEAT PUMP MBH	AUXILIARY @ 208V/3Ø	
FCU-1	AAON	V3-BRB-8-0-141D-3B2	900	135	3/4	0,5	35,2	26,3	28,8	10,5	1;2;3
FCU-2	AAON	V3-ARB-8-0-141D-3B2	900	135	3/4	0,5	35,2	26,3	28,8	10,5	1;2;3
FCU-3	AAON	V3-ARB-8-0-141D-3B2	700	135	3/4	0,5	35,2	26,3	28,8	10,5	1;2;3
FCU-4	AAON	V3-BRB-8-0-141D-3B2	900	135	3/4	0,5	35,2	26,3	28,8	10,5	1;2;3
FCU-5	AAON	V3-ARB-8-0-141D-3B2	900	135	3/4	0,5	35,2	26,3	28,8	10,5	1;2;3
FCU-6	CARRIER	FX4D049	1600	135	3/4	0,5	48,9	40,2	48,9	7,5	1;3

1. VERTICAL CABINET FAN COIL UNIT WITH TOP DISCHARGE AND BOTTOM RETURN
2. PROVIDE HOT GAS REHEAT DEHUMIDIFICATION
3. PROVIDE GLOBAL PLASMA SOLUTIONS AIR PURIFICATION UNIT IN SUPPLY DUCT
5. PROVIDE I-Vu CONTROLS COMPATIBLE WITH SCHOOLS NEW EMS

HEAT PUMP UNIT SCHEDULE

MARK	MANUFACTURER	MODEL No.	TOTAL COOLING MBH	SENS. COOLING MBH	HEAT PUMP MBH	MIN SEER	NOTES
HP-1	AAON	CFA-003-A-A-8-DJ00H	35.2	26.3	28.8	14.0	1;2;3
HP-2	AAON	CFA-003-A-A-8-DJ00H	35.2	26.3	28.8	14.0	1;2;3
HP-3	AAON	CFA-003-A-A-8-DJ00H	35.2	26.3	28.8	14.0	1;2;3
HP-4	AAON	CFA-003-A-A-8-DJ00H	35.2	26.3	28.8	14.0	1;2;3
HP-5	AAON	CFA-003-A-A-8-DJ00H	35.2	26.3	28.8	14.0	1;2;3
HP-6	CARRIER	25HCD048	48.9	40.2	48.9	14.0	1;2;3

1. COOLING BASED ON 80°db/67°wb, 95° AMBIENT
2. HEATING BASED ON 17°db
3. PROVIDE 1/4" THICK NEOPRENE WAFFLE-PAD UNDER ALL SUPPORT POINTS

EXHAUST FAN SCHEDULE

MARK	GREENHECK MODEL No.	CFM	APPROX. ESP IN. WG	FAN RPM	MOTOR HP	MAX SONES	NOTES
EF-1	G-183-VG	2100	0.5	810	1/8	8.2	2;3;6
EF-2	G-75-VG	400	0,25	1550	1/6	4.9	2;3;6
EF-3	G-60-VG	125	0,25	1560	1/6	3.7	2;3;6
EF-4	SP-B0-VG	75	0,25	935	1/20	1.0	1;2;3;4;5
EF-5	G-97-VG	150	0,25	1000	1/4	3.9	2;3;6

1. CEILING MOUNTED FAN
2. DIRECT DRIVE
3. PROVIDE DISCONNECT SWITCH
4. PROVIDE INLET AND DISCHARGE DUCT CONNECTION FLANGES
5. PROVIDE SPRING RUBBER IN-SHEAR ISOLATORS
6. PROVIDE NEW ROOF CURB OR CURB ADAPTER IF REQUIRED

AIR HANDLING UNIT SCHEDULE

MARK	MANUFACTURER	MODEL No.	TOTAL SUPPLY CFM	OA CFM	TOTAL COOLING MBH	SENSIBLE COOLING MBH	APPROX ESP IN. WG	MOTOR HP	GAS HEAT INPUT MBH	NOTES
AHU-1	CARRIER	(2) 59SP2A080E17-16	2800	400	84.6	68.4	0.5	(2) 2.0	160	1;2;5;6;8
AHU-2	AAON	V3-DRB-8-0-162C-000	5250	1000	192.9	148.4	0,6	4.0	- -	1;2;3;4;7;8

1. VERTICAL UP FLOW UNIT WITH TOP DISCHARGE
2. COOLING CAPACITIES BASED ON AIR ENTERING EVAPORATOR AT 80° Fdb, 67° Fwb
3. PROVIDE DEHUMIDIFICATION CYCLE . SEE SPECIFICATIONS FOR DEHUMIDIFICATION CONTROL SEQUENCE
4. HEATING PROVIDED BY SEPARATED COMBUSTION DUCT HEATER
5. PROVIDE TWINNING KIT
6. PROVIDE GLOBAL PLASMA SOLUTIONS AIR PURIFICATION UNIT. , MODEL GPS-FC-3-BAS. MOUNT AFTER FILTER & BEFORE COOLING COIL
7. PROVIDE TWO (2) GLOBAL PLASMA SOLUTIONS AIR PURIFICATION UNITS, MODEL GPS-FC-3-BAS. MOUNT AFTER FILTER & BEFORE COOLING COIL
8. PROVIDE ENTHALPY ECONOMIZER

AHU CONDENSING UNIT SCHEDULE

MARK	MANUFACTURER	MODEL No.	TOTAL COOLING MBH	SENS. COOLING MBH	MIN EER	NOTES
AC-1	CARRIER	(2) 24ACC448	84.6	68.4	12.0	1;2
AC-2	AAON	CFA-018-C-A-8-DC00K	192.9	148.4	12.3	1;2

1. COOLING BASED ON 80°db/67°wb, 95° AMBIENT

ELECTRIC CEILING HEATER SCHEDULE

MARK	MARKEL-TPI MODEL No.	kW	HEAT OUTPUT MBH	AIR Δt °F	CFM	NOTES
ECH-1	F3483A1	3,0	10,236	22.0	600	1;2
ECH-2	F3483A1	3,0	10,236	22,0	600	1;2

1. ELECTRIC CEILING HEATER WITH INTEGRAL CONTROL BOX
2. PROVIDE MANUAL RESET

GENERAL DEMOLITION NOTES:

1. FIELD VERIFY EXISTING CONDITIONS, LOCATION OF EXISTING EQUIPMENT, DUCT AND PIPE ROUTES MAY DEVIATE SLIGHTLY FROM WHAT IS SHOWN ON THE DRAWINGS.
2. WHERE EQUIPMENT, DUCTS AND PIPES, CONTROL DEVICES, CONDUITS, CABLES AND WIRING ARE DISCONNECTED FOR THE REMOVAL OF EQUIPMENT, THEY SHALL BE RECONNECTED, TESTED AND MADE OPERATIONAL.
3. UNLESS OTHERWISE NOTED, ALL MATERIALS & EQUIPMENT SHOWN OR SPECIFIED TO BE REMOVED SHALL BE THE PROPERTY OF THE CONTRACTOR AND SHALL BE REMOVED FROM THE PROJECT SITE.
4. DO ANY AND ALL CUTTING AND PATCHING REQUIRED FOR THIS SCOPE OF WORK, RESTORING ALL SURFACES TO THEIR ORIGINAL CONDITION TO MATCH SURROUNDING FINISHES. ALTERATIONS TO ANY STRUCTURAL MEMBER, EITHER STEEL OR CONCRETE, SHALL REQUIRE THE APPROVAL OF THE OWNER.
5. REMOVE ALL SUPPORTING FACILITIES NO LONGER NEEDED OR MADE OBSOLETE BY THE NEW EQUIPMENT AND MATERIALS FURNISHED UNDER THIS CONTRACT. SUCH REMOVAL INCLUDES, BUT IS NOT LIMITED TO, SUPPORT BRACKETS AND ATTACHMENTS. ABANDONED PIPING SUPPORT BRACKETS AND ATTACHMENTS. REMOVAL OF PIPING SHALL INCLUDE ASSOCIATED VALVES. WELDED SUPPORTS SHALL BE REMOVED FLUSH WITH SURFACE. SURFACE SHALL BE GROUND SMOOTH, CLEANED PRIMED AND PAINTED TO MATCH SURROUNDING FINISH.
6. AFTER EXISTING PIPING AND DUCTWORK ARE REMOVED, PATCH THE EXISTING FLOOR OR WALL OPENINGS TO MATCH SURROUNDING SURFACES AND MAINTAIN THE FIRE RATING.
7. WHERE EQUIPMENT IS SHOWN TO BE REMOVED IT SHALL BE REMOVED COMPLETE WITH ASSOCIATED PIPING, CONTROLS AND ASSOCIATED CONDUITS AND WIRING.
8. "VERIFY" SHALL MEAN CHECK EXISTING AS-INSTALLED CONDITIONS AGAINST DRAWINGS AND SPECIFICATION AND ADJUST NEW WORK TO MATCH EXISTING, OBTAIN RULING FROM THE OWNER CONTRACTING OFFICER ON ANY ITEMS REQUIRING CLARIFICATION.
9. BEFORE REMOVAL OF ANY SERVICES SUCH AS PIPING, LABEL EACH EXISTING PIPE AT THE POINT OF RECONNECTION BETWEEN EXISTING AND NEW SERVICES TO ENSURE PROPER RECONNECTION WITHOUT CROSSOVERS.

GENERAL NOTES:

1. VERIFY ALL SIZES, MATERIALS, TEMPERATURES AND PRESSURES BEFORE ORDERING OR FABRICATION OF ANY MATERIALS.
2. MECHANICAL DRAWINGS DO NOT SPECIFY VOLTAGES OF MECHANICAL EQUIPMENT. REFER TO THE ELECTRICAL DRAWINGS FOR VOLTAGES AND MECHANICAL EQUIPMENT ELECTRICAL LOADS. VERIFY ELECTRICAL CHARACTERISTICS OF ALL MECHANICAL EQUIPMENT BEFORE ORDERING EQUIPMENT.
3. REFER TO EACH DRAWING FOR NOTES SPECIFIC TO THAT DRAWING SHEET.
4. ALL PENETRATIONS THROUGH EXISTING FIRE RATED WALLS, PARTITIONS AND FLOOR SLABS SHALL BE FIRE STOPPED TO MAINTAIN THE FIRE RATING OF OF THE EXISTING WALL, PARTITION OR FLOOR SLAB.
5. ALL FRESH AIR INTAKES SHALL BE MINIMUM 10 FT AWAY FROM ANY BUILDING GENERAL EXHAUST AND PLUMBING VENTS, AND MINIMUM 15 FT AWAY FROM FLUES AND GREASE EXHAUST.
6. WHEN ROOF MOUNTED MECHANICAL EQUIPMENT DEVIATES FROM THE BASIS OF DESIGN, COORDINATE ORIENTATION AND LOCATION OF THE OUTDOOR AIR INTAKE OF THE EQUIPMENT WITH EXHAUST FANS, PLUMBING VENTS AND GAS VENTS. ALLOW CLEARANCES AS INDICATED ABOVE.

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LOCAL FUNDS ONLY

BIBB BOE BID # 17-26

REVISION
MAY 10, 2017

HVAC RENOVATIONS TO
MATILDA HARTLEY ELEMENTARY
FOR THE BIBB COUNTY BOARD OF EDUCATION
BIBB COUNTY GEORGIA

PROJECT NO.
17-005

SHEET TITLE
MECHANICAL
LEGEND, DETAIL AND
GENERAL NOTES

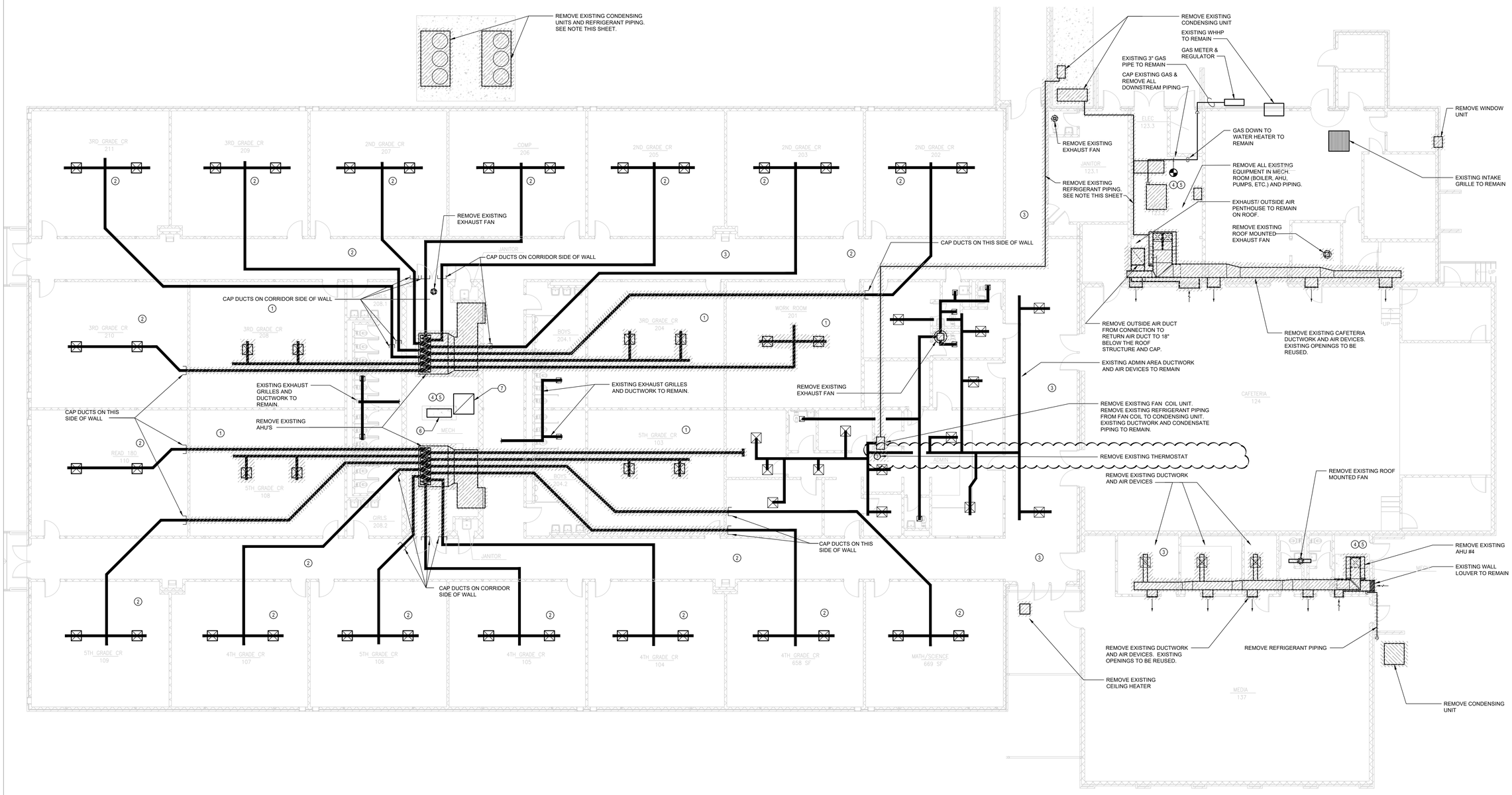
DATE
APRIL 18, 2017

DRAWN BY
SPJ

CHECKED BY
VMS

SHEET NUMBER
M001

SEE SHEET M102 FOR CONTINUATION



1 FLOOR PLAN - MECHANICAL DEMOLITION
SCALE: 1/8"=1'-0"

DEMOLITION NOTES:

1. REMOVE ALL EXISTING DUCTWORK IN CLASSROOMS 103, 108, 204, 208 AND WORKROOM 210 SERVED BY NEW FAN COIL UNITS
2. ALL EXISTING DUCTWORK IN CLASSROOMS SERVED BY NEW WALL HEAT PUMP UNITS, AND CORRIDORS TO BE ABANDONED IN PLACE.
3. ALL EXISTING HOT WATER PIPING OUTSIDE THE MECHANICAL ROOM TO BE ABANDONED IN PLACE. (NOT SHOWN)
4. REMOVE ALL EXISTING HOT WATER PIPING INSIDE MECHANICAL ROOMS (NOT SHOWN)
5. REMOVE ALL PNEUMATIC PIPING, COMPRESSORS, CONTROL PANELS (NOT SHOWN)
6. REMOVE EXISTING WATER COOLER AND ALL ASSOCIATED PIPING AND CONTROLS
7. EXISTING OUTDOOR AIR INTAKE TO REMAIN. REMOVE ALL OA DUCT 24" BELOW STRUCTURE. EXISTING OA INTAKE AND DUCT THRU ROOF TO REMAIN. CAP BOTTOM OF OA DUCT AIR TIGHT

NOTES:

BIBB COUNTY PERSONNEL WILL RECOVER REFRIGERANT R-22 PRIOR TO CONSTRUCTION. COORDINATE TIMING OF REFRIGERANT REMOVAL WITH START OF CONSTRUCTION.

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REVISION
MAY 10, 2017

HVAC RENOVATIONS
TO
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BIBB COUNTY GEORGIA

PROJECT NO.
17-005

SHEET TITLE
FLOOR PLAN
MECHANICAL DEMOLITION

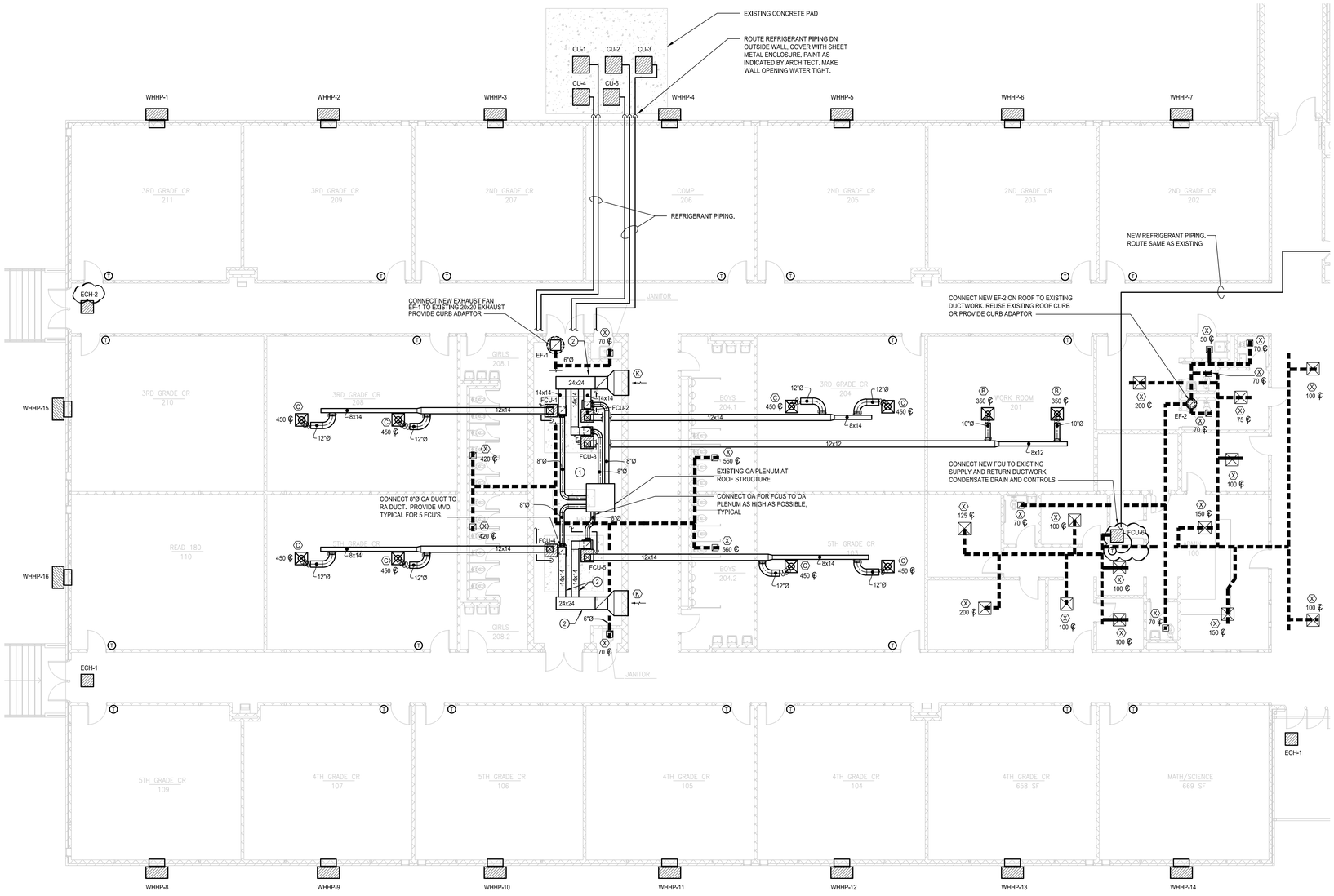
DATE
APRIL 18, 2017

DRAWN BY
SPJ

CHECKED BY
VMS

SHEET NUMBER
M101

SEE SHEET M203 FOR CONTINUATION



SEE SHEET M202 FOR CONTINUATION

1 FLOOR PLAN BUILDING 2010 - MECHANICAL RENOVATION
SCALE: 1/8"=1'-0"

FLOOR PLAN NOTES:

1. ROUTE NEW 3/4" TRAPPED CONDENSATE DRAINS TO EXISTING FLOOR DRAINS
2. INSTALL RETURN AIR DUCT AS HIGH AS POSSIBLE

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LOCAL FUNDS ONLY

BIBB BOE BID # 17-26

REVISION
MAY 10, 2017

HVAC RENOVATIONS TO
MATILDA HARTLEY ELEMENTARY
FOR THE BIBB COUNTY BOARD OF EDUCATION
BIBB COUNTY GEORGIA

PROJECT NO.
17-005

SHEET TITLE
MATILDA HARTLEY
FLOOR PLAN
BUILDING 2010 -
MECHANICAL
RENOVATIONS

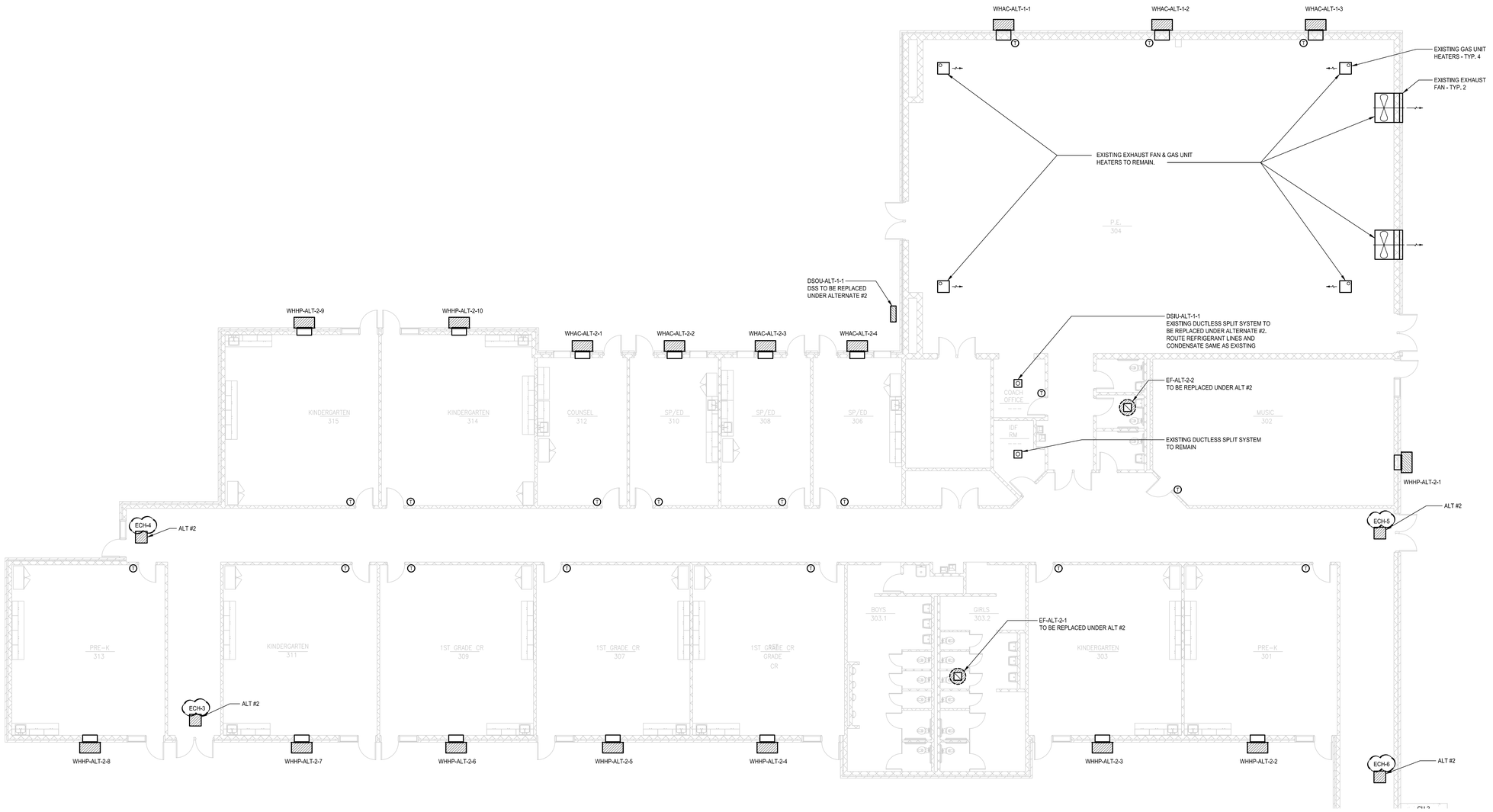
DATE
APRIL 18, 2017

DRAWN BY
SPJ

CHECKED BY
VMS

SHEET NUMBER
M201

J:\2017\17014 Ingram Pye-Hartley ES HVAC Renovations\0.3 Drawings\17014_M201-M203 Hartley NEW.dwg, 6/7/2017 8:53:03 AM



SEE SHEET M201 FOR CONTINUATION

1 FLOOR PLAN BUILDING 2020 - MECHANICAL RENOVATION - ALTERNATES #1 & #2

SCALE: 1/8"=1'-0"

NOTES:

ALTERNATE #1:
- INSTALL 3 NEW WALL AIR CONDITIONING UNITS, COOLING ONLY

ALTERNATE #2:
- INSTALL NEW WALL HEAT PUMP UNITS TO REPLACE EXISTING UNITS, AS SCHEDULED AND SHOWN ON PLAN.
- REPLACE EXISTING DUCTLESS SPLIT SYSTEM SERVING THE COACH'S OFFICE.
- REPLACE CEILING ELECTRIC HEATERS.

EXHAUST FAN SCHEDULE (ALT #2)

MARK	GREENHECK MODEL No.	CFM	APPROX. ESP IN. WG	FAN RPM	MOTOR HP	MAX SONES	NOTES
EF-ALT-2-1	G-103-VG	900	0.5	1450	1/6	8.0	2:3:6
EF-ALT-2-2	G-70-VG	225	0.25	1140	1/6	6.0	2:3:6

1. CEILING MOUNTED FAN
2. DIRECT DRIVE
3. PROVIDE DISCONNECT SWITCH
4. PROVIDE INLET AND DISCHARGE DUCT CONNECTION FLANGES
5. PROVIDE SPRING RUBBER IN-SHEAR ISOLATORS
6. PROVIDE NEW ROOF CURB OR CURB ADAPTER IF REQUIRED

ELECTRIC CEILING HEATER SCHEDULE (ALT #2)

MARK	MARKEL-TPI MODEL No.	kW	HEAT OUTPUT MBH	AIR Δt °F	CFM	NOTES
ECH-3	F3483A1	3.0	10.236	22.0	600	1:2
ECH-4	F3483A1	3.0	10.236	22.0	600	1:2
ECH-5	F3483A1	3.0	10.236	22.0	600	1:2
ECH-6	F3483A1	3.0	10.236	22.0	600	1:2

1. ELECTRIC CEILING HEATER WITH INTEGRAL CONTROL BOX
2. PROVIDE MANUAL RESET

DUCTLESS SPLIT SYSTEM SCHEDULE (ALT #2)

MARK	INDOOR UNIT MITSUBISHI MODEL No.	OUTDOOR UNIT MITSUBISHI MODEL No.	EVAP CFM	TOTAL COOLING MBH	TOTAL HEATING MBH	SEER	NOTES
DSIU/DSOU-ALT-1-1	MSZ-FE09NA	MUZ-FE09NA	343	9.0	10.9	26.0	1:2:3:4:5:6:7:8

1. COOLING CAPACITIES BASED ON AIR ENTERING EVAPORATOR AT 80 °F db, 67 °F wb AND 95 °F AMBIENT AIR TEMPERATURE
2. HEATING CAPACITIES BASED ON REVERSE-CYCLE HEAT PUMP OPERATION AT 47 °F AMBIENT AIR TEMPERATURE
3. HIGH SIDEWALL INDOOR UNIT
4. SUPPLY AIRFLOW CFM BASED ON HIGH SPEED AND DRY COIL
5. PROVIDE CONDENSATE PUMP
6. PROVIDE LOW AMBIENT CONTROL
7. PROVIDE REMOTE WALL MOUNTED THERMOSTAT
8. PROVIDE TWO EQUIPMENT SUPPORT RAILS UNDER CONDENSING UNIT

WALL HUNG AC/HEAT PUMP SCHEDULE (ALTERNATES #1 & #2)

MARK	BARD MODEL No.	SUPPLY CFM	OA CFM FROM ERV	TOTAL COOLING MBH	SENSIBLE COOLING MBH	HEAT OUTPUT MBH	ELEC HEAT kW	NOTES	
WHAC-ALT-1–1	W60AADB15R	1800	350	59.0	43.2	--	--	1;3;5;6;7;8;9	ALT #1
WHAC-ALT-1–2	W60AADB15R	1800	350	59.0	43.2	--	--	1;3;5;6;7;8;9	ALT #1
WHAC-ALT-1–3	W60AADB15R	1800	350	59.0	43.2	--	--	1;3;5;6;7;8;9	ALT #1
WHHP-ALT-2–1	T42S1DB09R	1250	270	39.5	29.7	37.3	9.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–2	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–3	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–4	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–5	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–6	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–7	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–8	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–9	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHHP-ALT-2–10	T24H1DB06R	800	200	22.4	18.4	22.2	6.0	1;2;3;4;5;6;7;8;9	ALT #2
WHAC-ALT-2–1	W12AAAA05	475	75	12.0	9.2	--	5.0	1;4;5;7;8;9	ALT #2
WHAC-ALT-2–2	W12AAAA05	475	75	12.0	9.2	--	5.0	1;4;5;7;8;9	ALT #2
WHAC-ALT-2–3	W12AAAA05	475	75	12.0	9.2	--	5.0	1;4;5;7;8;9	ALT #2
WHAC-ALT-2–4	W12AAAA05	475	75	12.0	9.2	--	5.0	1;4;5;7;8;9	ALT #2

1. COOLING CAPACITIES BASED ON AIR ENTERING EVAPORATOR AT 80° Fdb, 67° Fwb AND 95° F AMBIENT AIR TEMPERATURE
2. HEAT PUMP HEATING CAPACITY AT 47° F
3. PROVIDE HOT GAS REHEAT DEHUMIDIFICATION
4. PROVIDE AUXILIARY ELECTRIC HEATER OF CAPACITY SCHEDULED
5. PROVIDE REMOTE WALL MOUNTED TEMPERATURE SENSOR
6. PROVIDE ENERGY RECOVER VENTILATOR WITH ROTARY CASSETTE
7. PROVIDE CARRIER I-VU CONTROLS COMPATIBLE WITH SCHOOL'S EXISTING EMS
8. PROVIDE INTEGRAL CIRCUIT BREAKER OR DISCONNECT
9.PROVIDE GLOBAL PLASMA SOLUTIONS MODEL GPS-FC-3-BAS, MOUNT AFTER FILTER AND BEFORE COOLING COIL

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LOCAL FUNDS ONLY

BIBB BOE BID # 17-26

REVISION

MAY 10, 2017

HVAC RENOVATIONS TO
MATILDA HARTLEY ELEMENTARY
FOR THE BIBB COUNTY BOARD OF EDUCATION
BIBB COUNTY GEORGIA

PROJECT NO.
17-005

SHEET TITLE
MATILDA HARTLEY
FLOOR PLAN
BUILDING 2020 -
ALTERNATE #1 &
ALTERNATE #2

DATE
APRIL 18, 2017

DRAWN BY
SPJ

CHECKED BY
VMS

SHEET NUMBER
M203