DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

23 00 00 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

A. All equipment shall be furnished with the manufacturer’s installation directions and operating and maintenance instructions.

B. Provide positive ventilation in equipment rooms to prevent damage from heat and humidity.

C. Design conditions shall conform to ASHRAE/IESNA 90.1, codified version.

D. Outside air intakes should be located so they will not be contaminated by fume hood exhaust, building exhausts, vents or motor exhausts.

E. Do not use electric heating coils or electric heat without Owner approval.

F. In general, systems shall provide heating and cooling year-round to accommodate the desired occupancy.
   
   1. Proposed systems require life cycle costing and compliance with the ASHRAE/IESNA 90.1, codified version.

   a) The impact of central system zoning needs consideration. The cost analysis must include the operational costs as the building is operated and not be based on square footage costs alone. Zoning of the systems by occupant function, and the ability to shut down areas occupied only during regular university hours is strongly encouraged.

   b) The impact of the mechanical selection should include the maintenance costing as well as the energy cost impact.

   2. Wherever possible, the sources of energy should be from the central heating plant.

   a) The source of heat should be steam in all cases.

   b) The source of humidification should be steam, unless the economies of operation dictate the use of another method (i.e., evaporative).

3. When radiation systems are supplied, they must not be “string” type radiation. Each piece should be connected to the supply and return independently.

23 00 01 – MECHANICAL ROOM PLANNING AND EQUIPMENT ACCESS

GENERAL

This section provides general standards for overall planning and design of Mechanical Rooms to assure that the mechanical rooms are adequately sized and equipment located to facilitate safe maintenance, operations and equipment replacement over a
100 year life of a typical building. Other sections contain specific standards for each system per CSI specification format.

DESIGN GUIDELINES

A. Design General

1. Access to mechanical equipment is critical to the operations and maintenance of the equipment. Safety of maintenance staff shall be considered in room and equipment layout. Maintenance will be performed for the expected equipment life of 30 to 50 years. It is likely that the equipment will be replaced before the building is replaced. Therefore adequate consideration must be given to getting replacement equipment in and out of the mechanical room.

B. Mechanical Room Planning

1. During program planning, and study phase, an allowance of 10% of the gross square foot area shall be set aside for mechanical space. This may be adjusted during subsequent phases of a project but, in no case shall be less than that required for any piece of equipment, as shown on the sample plan.

2. The room size and equipment layout shall be reviewed by the architect to assure compliance with ICC. Egress paths around the equipment shall be reviewed and changed if necessary to comply with egress requirements.

3. Mechanical rooms shall be serviced by standard stairs or elevators large enough to accommodate routine maintenance parts such as motors and filters. Equipment rooms shall not be accessed by “ships ladders”.

4. Doors to mechanical equipment rooms shall be 7’6” x 6’0” with corridors and access that do not limit the use of these doors. Access through another space is not acceptable. Exterior removable panels and louvers shall be provided for access for the replacement of large equipment that cannot be brought in pieces.

5. Mechanical rooms below grade shall be provided with an areaway large enough to replace the largest piece of equipment in the mechanical room.

6. Air intakes shall not be placed in areaways below grade and, unless approved by the PM, shall be at least 16 feet above grade to the bottom of the intake unless it is on the roof.
7. Roof top penthouses shall be provided with exterior doors, so located that they access a flat part of the roof. The float roof structure outside of the penthouse shall be capable of supporting the heaviest piece of equipment in the penthouse.

8. All penetrations for piping, duct of access shall be provided with the fire rating called or on the architectural plans.

9. Ductwork in mechanical rooms shall be designed to provide maximum headroom and provide straight runs for efficient operation of fans.

10. All equipment shall be drawn to scale using the design basis equipment. The drawings shall show all ducts, piping and accessories that would affect maintenance access.

11. Composite drawings of mechanical, electrical, plumbing, fire protection, controls, and other major components that will need maintenance clearances shall be prepared to show the general arrangement of equipment to assure the intent of these guidelines are met.

12. All equipment should be floor mounted within the mechanical room. If it is necessary to elevate equipment ABOVE 72", PERMANENT SERVICE PLATFORMS SHALL BE PROVIDED WITH STAIRS/LADDER ACCESS.

13. Mechanical rooms shall not be used as part of the return air path.

14. Floor drains shall be located next to each major piece of equipment which may need to be drained. Permanent drain lines from air compressors, air handing units, etc. shall not run across open floor space.

15. A condensate piping shall be routed from each piece of equipment that utilizes steam. Condensate shall drain by gravity from all equipment using steam. Piping shall terminate at the main condensate pump. In no case shall a F&T trap be used to lift condensate.

16. Piping shall be routed below any ductwork. Piping shall be routed a minimum of 7 ft above the floor.

17. Electrical service.
17.1 Provide GFCI receptacles at regular spacing throughout the mechanical room where additional task lighting or service equipment such as shop vacuums, welders may be required. Maximum spacing shall be 30 ft.

17.2 Provide one welding outlet per mechanical room.

17.3 Provide one receptacle and minimum of one light fixture on e-power by the main switchgear.

18. Water Service. Provide a hose bib in the mechanical rooms within 20’ of each air handler to facilitate air handling unit cleaning. Provide a freeze-proof hose bib near condensing units at exterior locations.

C. Personnel and Equipment Traffic

1. There shall be adequate access paths in and around the mechanical room to allow for maintenance to bring in repair equipment, temporary equipment, electrical safety and also future equipment replacement.

2. There shall be adequate lighting throughout the mechanical room to facilitate maintenance work.
FIGURE 1 - SAMPLE MECHANICAL ROOM LAYOUT
23 05 00 – COMMON WORK RESULTS FOR HVAC

23 05 09 – TESTING, ADJUSTING, AND BALANCING

Contact UNI for instruction on whether UNI will issue separate purchase order or include in contract. If separate purchase order is issued, the Design Professional shall provide plans and specifications to use in obtaining quotes.

23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC

The Design Professional is solely responsible for the design of the HVAC control systems. During the design process, the Design Professional shall review control strategies with the Owner. Siemens will develop control drawings to be included in the bidding documents. Siemens is the only approved BAS vendor.

For projects with a construction budget under $100,000, the installation of the controls systems shall be included in the contractor's bid.

For projects with a construction budget over $100,000, Siemens will provide the Owner with the price of their bid. The Siemens bid, once approved by Owner, shall be included as an allowance in the bidding documents as part of the addenda. All installation work shall be as per the following matrix. This matrix shall be included in the bidding documents.

Electrical Contractor – EC
Mechanical Contractor – MC
Sheet Metal Contractor – SMC
Manufacturer – MF

<table>
<thead>
<tr>
<th>Item</th>
<th>Provided By</th>
<th>Installed By</th>
<th>Wired By</th>
<th>Controls Provided By</th>
<th>Notes</th>
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<td>SMC</td>
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Ensure pneumatic lines for controls include an independent support system and not in contact with any sharp or rough edges/materials.

All pneumatic lines are to be plugged with ¼ inch brass double barbed fittings.

Standard guide specifications are available from the University. Control wiring is to be included in Division 17 specifications.

23 09 13 – INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

23 09 13.13 – ACTUATORS AND OPERATORS

PART 1 – PRODUCTS

1.1 General

A. Electric actuation is preferred for major systems such as heat exchangers, air handlers, chilled water systems, etc. except as noted/specified otherwise.

1.2 ACCEPTABLE MANUFACTURER / SUPPLIER

Siemens Industry, Inc.

PART 2 – DEVICES

2.1 Valve Actuators – Electronic

A. Reheat and/or Baseboard Radiation Service
1. 24 VAC, 3 – position (floating) control, fail-in-place. Basis of design is Siemens SSC81-U.

B. Major System Service

1. 24 VAC, proportional control, spring return.
   a) Basis of design for ¾-inch stroke: SKD62UA or SKB62UA as required by close-off.
   b) Basis of design for 1½-inch stroke: SKC62UA.

2.2 Valve Actuators – Electronic

A. Electronic actuation shall be used for reheat or baseboard radiation service in direct-digital control applications.

B. Hot and Chilled Water Service

1. Basis of design for ¾-inch stroke: Siemens Electronic Valve Actuator as required by application and valve size.

2. Basis of design for 1½-inch stroke: Siemens Electronic Valve Actuator as required by application and valve size.

C. Steam Service

1. Basis of design for ¾-inch stroke: Siemens High Temperature Electronic Valve Actuator as required for application and valve size.

2. Basis of design for 1½-inch stroke: Siemens Electronic Valve Actuator as required for the application and valve size.

2.3 Damper Actuators - Electronic

A. Actuators shall employ brushless motor technology with stall protection. They shall be bi-directional with all-metal housing and manual override. Independently adjustable dual auxiliary switches and heated auxiliary enclosures shall be optionally available. Actuators shall possess sufficient torque to provide smooth modulating or two-position action and proper close-off as specified at the velocity and pressure conditions to which the damper will be subjected.

1. Actuators for terminal box control applications shall be 24 VAC, 3-position (floating) control, fail-in-place.

2. Actuators for major system service shall be 24 VAC proportional control or two-position control as specified with fail-safe spring return.
3. Actuators shall include the necessary and proper mounting and connection hardware for mounting and connection to a standard \( \frac{1}{2} \)-inch damper shaft, and shall be capable of direct connection without the need for connection linkages.

4. Actuators having more than 100 in-lbs. of available torque output shall have a self-centering damper shaft clamp that will accept a 1-inch shaft directly, without the need for auxiliary adapters. The self-centering clamp shall guarantee concentric alignment of the actuator’s output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed “v”-shaped toothed cradles, each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft.

5. Actuators shall be designed and manufactured using ISO 9001 registered procedures, and shall be listed under Standards UL873 and CSA22.2 No. 24-93 I.

6. Basis of design: Siemens OpenAir™ Direct-coupled Electronic Damper Actuators with torque selected according to application.

23 09 13.23 – SENSORS AND TRANSMITTERS

PART 1 – GENERAL

1.1 ACCEPTABLE MANUFACTURER / SUPPLIER

Siemens Industry, Inc.

PART 2 – PRODUCTS

2.1 Temperature Sensors

A. Room sensors for terminal box applications

1. Sensors shall monitor room temperatures between 55° F and 95° F.

2. Sensing element shall be 100K-ohm NTC thermistor.

3. Calibration point: 100,000 ohms @ 77° F.

4. Accuracy at calibration point: ±0.5° F.

5. Setpoint adjustment, day/night override button and temperature display shall be optionally available.

6. If specified, setpoint and temperature display range shall be 55° F - 95° F.

7. Output signal: changing resistance

B. Room sensors for monitoring only applications
1. Range for field panel termination: -40°F - +240°F nominal.
2. Range for terminal box/remote termination: -40°F - 257°F nominal.
3. Element for field panel termination: 1000-ohm platinum, two-wire
4. Element for terminal box/remote termination: 100K-ohm NTC thermistor, two-wire
5. Calibration point – 1000-ohm: 1000 ohms @ 32°F.
6. Calibration point – 100K-ohm: 100,000 ohms @ 77°F.
7. Accuracy at calibration point: ±0.5°F.
8. Output signal: changing resistance

C. Liquid Immersion temperature sensors
   1. Range shall be -40°F - +240°F nominal.
   2. Sensing element: 1000-ohm platinum, two wire
   3. Calibration point: 1000 ohms @ 32°F.
   4. Accuracy at calibration point: ±0.5°F.
   5. Output signal: changing resistance
   6. Sensors shall be supplied with 2.5-inch stainless steel well, threaded ½-inch NPT male unless specified otherwise elsewhere.

D. Duct temperature sensors – averaging type
   1. Range shall be -40°F - +240°F nominal.
   2. Sensing element: 1000-ohm platinum, two wire
   3. Calibration point: 1000 ohms @ 32°F.
   4. Accuracy at calibration point: ±0.5°F.
   5. Output signal: changing resistance
   6. Element length shall be 1.5 feet, 2 feet, or 4 feet if rigid, 25 feet if flexible, as required/where specified.

E. Duct temperature sensors – single point type
   1. Range shall be -40°F - +240°F nominal.
2. Sensing element: 1000-ohm platinum, two wire

3. Calibration point: 1000 ohms @ 32° F.

4. Accuracy at calibration point: ±0.5° F.

5. Output signal: changing resistance

6. Sensor shaft length shall be 12 inches minimum, with insertion depth adjustable at mounting bracket.

F. Outdoor air temperature sensors

1. Range shall be -40° F - +240° F nominal.

2. Sensing element: 1000-ohm platinum, two wire

3. Calibration point: 1000 ohms @ 32° F.

4. Accuracy at calibration point: ±0.5° F.

5. Output signal: changing resistance

6. Sensor shall be installed away from any intake and/or exhaust airstreams, under a sunshield.

2.2 Pressure Sensors

A. Fluid pressure sensors

1. Range: 0-30 psig
   0-60 psig
   0-100 psig
   0-250 psig

2. Sensing element: ceramic strain gage

3. Output signal: 4 – 20mA DC

4. Calibration adjustments: zero and span

5. Accuracy: ± 0.2% of span

6. Linearity: ± 0.1% of span

7. Hysteresis: ± 0.05% of span

B. Liquid Differential Pressure Sensors
1. Range: 0-25 psid
   0-50 psid
   0-60 psid
   0-100 psid

2. Sensing element: ceramic strain gage
3. Output signal: 4 – 20mA DC
4. Calibration adjustments: zero and span
5. Accuracy: ± 0.2% of span
6. Linearity: ± 0.1% of span
7. Hysteresis: ± 0.05% of span
8. Basis of design: Setra 230

C. Duct and Building Static Pressure Sensors

1. Range: 0 - ±0.10 inches WC
   0 - ±0.25 inches WC
   0 - ±1.00 inches WC
   0 - ±2.50 inches WC
   0 – 1.0 inches WC
   0 – 2.0 inches WC
   0 – 5.0 inches WC
   0 – 10.0 inches WC

2. Sensing element: ceramic strain gage
3. Output signal: 4 – 20mA DC
4. Calibration adjustments: zero and span
5. Accuracy: ± 0.2% of span
6. Linearity: ± 0.1% of span
7. Hysteresis: ± 0.05% of span
8. Basis of design: Setra 264

D. Differential Pressure Switches (Status Applications)

1. Liquid applications

   A. Range: 8 – 70 psig
B. Differential: 3 psig
C. Maximum differential pressure: 200 psig
D. Maximum working pressure: 325 psig
E. Basis of design: Penn P74

2. Airflow applications
   A. Range: 0.5 – 1.0 inches WC
      1.0 – 12.0 inches WC
   B. Basis of design: Siemens Building Technologies SW141

2.3 Humidity Sensors
   A. Range: 0 – 100% RH
   B. Sensing element: bulk polymer; element shall be field replaceable
   C. Accuracy: ±2.0% @ 77°F
   D. Output signal: 4 – 20mA DC

2.4 Insertion Flow Meters
   A. Range: as required/specifed
   B. Sensing method: turbine wheel
   C. Accuracy: ±2% of actual reading
   D. Output signal: 4 – 20mA DC
   E. Maximum operating pressure: 400 psig
   F. Shall be bi-directional where required/specifed
   G. Basis of design: Data Industrial Insertion Turbine

2.6 Current Sensing Relays
   A. Relays shall be solid-state, adjustable, current operated type
   B. Relays shall change switch contact state in response to an adjustable setpoint value of current in the monitored AC circuit.
   C. Relay switch point shall be adjusted so that the relay responds to motor operation under load as an “on” state and so that the relay responds to an unloaded motor as
an “off” state. A motor with a broken belt or coupling is considered an unloaded motor.

D. Basis of design for constant speed applications: Veris HawkEye H608 or H908

E. Basis of design for variable speed (VFD) applications: Veris HawkEye H904

2.7 Air Flow Measurement Stations

A. Duct Locations

1. Each insertion station shall contain an array of velocity sensing elements and straightening vanes.

2. The velocity sensing elements shall be of the RTD or thermistor type. The sensing elements shall be distributed across the duct cross section in a quality to provide accurate readings.

3. The resistance to airflow through the airflow measurement station shall not exceed 0.08 inches water gage at airflow of 2,000 fpm.

4. Station construction shall be suitable for operation at airflow of up to 5,000 fpm over a temperature range of -40 to 120 degrees F and accuracy shall be plus or minus 3 percent over a range of 125 to 2,500 fpm scaled to air volume.

5. Each transmitter shall produce a linear, temperature compensated output corresponding to the required velocity measurement.

6. Outdoor air stations shall consist of a load cell and associated electronics measuring pressure drop across a ¼” mesh galvanized steel screen.

7. Output shall be 4 – 20mA DC scaled in feet per minute (fpm) with range appropriate to the velocity in the duct, or alternatively in cubic feet per minute (cfm) if such output is available at the transmitter.

8. Basis of design: Ebtron Gold Series

B. Fan Inlet Locations

1. Station shall contain parallel air straightener, total and static pressure sensing manifolds, internal piping and external pressure transmission ports with flexible tubing and quick-connect fittings.

2. Station shall be fabricated of galvanized steel and sized for the fan inlet in which it is mounted.

3. Maximum pressure loss through station shall be 0.08 inches WC at 1500 fpm.

4. Accuracy shall be 2%. 
5. Identify by model number, size, area, and specified airflow capacity.

2.8 Low Temperature Detection Thermostats (LTDT) (Freezestats)

1. LTDT shall be four-wire, two-circuit type
2. Setpoint shall be 15°F to 55°F, adjustable
3. Provide manual reset
4. LTDT shall be installed as indicated on the plans and shall provide protection for the coil such that one linear foot of element provides protection for one square foot of coil face area.
5. LTDT shall stop associated fans and return automatic dampers to their normal position upon detection of low temperature.

23 09 13.33 CONTROL VALVES

PART 1 – GENERAL

1.1 ACCEPTABLE MANUFACTURER / SUPPLIER

Siemens Industry, Inc.

1.2 Related Section

A. 23 09 13.13 Actuators and Operators

PART 2 – PRODUCTS

2.1 Valves 2-inch and smaller

A. Proportional (modulating) Service

1. Rangeability shall be 100:1 at a minimum
2. ANSI Class 250, globe pattern body with screwed ends;
3. Body material shall be bronze
4. Body trim shall be stainless steel
5. Stem shall be polished stainless steel
6. Packing for steam service shall be high temperature type
7. Controlled medium: steam, water, glycol solutions to 50%
8. Flow characteristic – liquid: modified equal percentage

10. Control action: normally open, normally closed or three-way mixing as required/specified

11. For liquid service, valves shall be provided with characterized throttling plugs and shall be sized for minimum 25% of system pressure drop or 5 psig, whichever is less.

B. Two-position Service

1. ANSI Class 250 body, screwed ends; shall be line size unless otherwise specified

2. Globe pattern or ball pattern, as required/specified

3. Body trim shall be stainless steel

4. Stem (or ball) shall be polished stainless steel

5. **Packing for steam service shall be high temperature type**

6. Control action: normally open or closed as required/specified

7. Controlled medium: steam, water, glycol solutions to 50%

2.2 Valves 2.5-inch and larger

A. Proportional (modulating) Service

1. Rangeability shall me 100:1 at a minimum

2. ANSI Class 250, globe pattern body with flanged ends

3. Body material shall be cast iron

4. Body trim shall be stainless steel

5. Stem shall be polished stainless steel

6. **Packing for steam service shall be high temperature type**

7. Controlled medium: steam, water, glycol solutions to 50%

8. Flow characteristic – liquid: modified equal percentage

10. Control action: normally open, normally closed or three-way mixing as required/specifed

11. For liquid service, valves shall be provided with characterized throttling plugs and shall be sized for minimum 25% of system pressure drop or 5 psig, whichever is less.

B. Two-position Service

1. ANSI Class 250 body, flanged ends; shall be line size unless otherwise specified

2. Globe pattern unless otherwise specified

3. Butterfly pattern shall be used only on valve sizes larger than 6-inch.

4. Body trim shall be stainless steel

5. Stem shall be polished stainless steel

6. **Packing for steam service shall be high temperature type**

7. Control action: normally open or closed as required/specifed

8. Controlled medium: steam, water, glycol solutions to 50%

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**23 09 13.43 - CONTROL DAMPERS**

**PART 1 – GENERAL**

1.1 All dampers shall be low leakage with airfoil type blades

1.2 Related Section

   A. 23 09 13.13 Actuators and Operators

**PART 2 – PRODUCTS**

2.1 ACCEPTABLE MANUFACTURERS

   T. A. Morrison (TAMCO) (1500 series), Arrow AFD, Ruskin CD-50

2.2 Construction

   A. Frames shall be extruded aluminum hat channels with minimum 0.125-inch thickness.

   B. Blades shall be extruded aluminum with maximum 6-inch blade width
C. Hardware shall consist of molded synthetic or sealed ball bearings (as required/specified), zinc plated steel axles, linkage brackets, connecting rods and mounting bolts.

D. Seals shall consist of silicone or flexible metal compression type at frame ends, and silicone or extruded vinyl inflatable type at blade edges.

2.3 Leakage

A. Leakage shall not be more than 6 cfm per square foot of damper area, measured at a minimum differential pressure of 4 inches WC with an applied torque of 50 inch-pounds.

2.4 Operating Limits

A. Temperature range: -25°F to 200°F

B. Differential pressure: 6 inches WC

C. Velocity: up to 4000 fpm

2.5 Selection

A. Opposed blade type shall be used in proportional service

B. Parallel blade type may be used for two-position service, and may be used in mixed air applications to promote improved air mixing.

C. Sizing

1. Sizes shall be as indicated on the drawings.

2. Sizes differing from those indicated on the drawings may be provided if improved performance can be demonstrated by calculations.

3. Multiple sections may be provided to achieve required size.

4. When multiple sections are provided, individual sections shall in no case be larger than 6 by 6 feet.

23 09 23 – DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Building Automation System (BAS) manufacturer, Siemens Industry, Inc., shall furnish and install a fully integrated building automation system,
incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified. The BAS System will be Siemens Apogee.

Provide open communications system. The system shall be an open architecture with the capabilities to support a multi-vendor environment. To accomplish this effectively, system shall be capable of utilizing standard protocols as follows as well as be able to integrate third-party systems via existing vendor protocols. System shall be capable of BACnet communication according to ASHRAE standard ANSI/ASHRAE/ISO 135-2004. System shall be capable of OPC server communications according to OPC Data Access 2.0 and Alarms and Events 1.0. The system shall not be limited to only use open communication protocols, but also be able to integrate a wide variety of third-party devices and applications via existing vendor protocols and through the latest software standards.

The system shall provide for seamless read and write access by the main Siemens Industry, Inc. Apogee Building Automation System campus network. This shall include, but not be limited to, monitoring and reporting point data (particularly fire and/or security alarms), commanding points, modifying system set points and scheduling equipment through the existing Apogee network workstations.

The intent is to allow information about the system provided in this contract to be sent to existing workstations accessing the Apogee system. The user shall have a single seat interface on the existing Siemens system from which to perform daily operation of the system provided in this contract.

B. The installation of the building automation system shall be performed by the Electrical Contractor under the general supervision of the BAS manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing contractor shall certify, in writing, that the equipment manufacturer's personnel have prepared the shop drawings and that the equipment manufacturer's personnel have supervised the installation. In addition, the equipment manufacturer shall certify, in writing, that their company prepared the shop drawings and that all temperature control equipment was installed under their general supervision.

C. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.

D. All wiring shall be done in accordance with all local and national codes.

1. 2 WORK BY OTHERS

A. **Mechanical Constructor** shall install the following:

1. Control valves.
2. Devices mounted in piping.
3. Terminal air box controllers (physical installation only, if not factory installed)
4. Control dampers.
5. Be responsible for any needed pneumatic demo.
6. Other devices that must be physically connected to piping or ductwork.

B. **Electrical Constructor** shall provide:

1. Provide power to power connections on control panels, including disconnects and required electrical devices.
2. Provide interlock wiring between electrically operated equipment units and between equipment and field installed control devices as indicated on the Electrical and/or Building Automation drawings.

C. Products furnished but not installed under this section:

1. Section 23 09 13 Instrumentation and Control Devices for HVAC:
   a. 23 09 13.13 and 23 09 13.33 Actuators and Control Valves
   b. 23 09 13.23 Sensors and Transmitters - Flow Switches
   c. 23 09 13.23 Sensors and Transmitters – Temp Sensors
   d. 23 09 13.23 Sensors and Transmitters – Flow Meters
2. Section 23 09 13 Instrumentation and Control Devices for HVAC:
   a. 23 09 13.13 and 23 09 13.33 Actuators and Dampers
   b. 23 09 13.23 Sensors and Transmitters - Air-flow Stations
   c. 23 09 13.13 Actuators and Operators - Terminal Unit Actuators

D. The Electrical Constructor or BAS Electrical Installer shall be present for the verification of the Building Automation System wiring, commissioning and operational checkout. The Electrical Constructor or BAS Electrical Installer shall provide an electrician to assist the BAS personnel during point-to-point checkout of the BAS. The Electrical Contractor or BAS Electrical Installer shall assist with all troubleshooting of the BAS on an as-needed basis.

E. The Mechanical Constructor shall be present for the verification of the Building Automation System control damper and control valve point-to-point checkout, control air piping pressure test, commissioning and operational checkout.

F. Completed work shall demonstrate compatibility with both the current and next generation of the Campus Building Automation System without bridges, routers, gateways or protocol converters. Provide for connection to the existing Building Automation System.

### 1.3 RELATED WORK

A. Division AA AA AA General and Special Conditions
B. Division XX XX XX Mechanical
C. Division 26 and/or 27 Electrical, including Low Voltage

1.4 QUALITY ASSURANCE

A. The BAS system shall be designed, commissioned and serviced by manufacturer-employed, factory-trained personnel. Manufacturer shall have an in-place branch office support facility within 120 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. **Distributors or licensed installing Constructors are not acceptable.**

The manufacturer/supplier shall provide an experienced project manager for this work, responsible for general supervision of the installation, start up and commissioning of the BAS.

The BAS supplier shall be regularly engaged in the manufacturing, installation and maintenance of BAS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. The BAS supplier shall have a service organization consisting of competent factory-trained personnel, maintained for a period of not less than ten years and shall provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of building automation systems and shall be the manufacturer's latest standard design that complies with the specification requirements.

C. All BAS peer-to-peer Automation Level Network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 916 category PAZX, Standard UL 864, categories UDTZ, and QVAX and be so listed at the time of bid.

D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

E. The manufacturer of the Building Automation System shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-14001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.
F. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing peer-to-peer Automation Level Network controllers / field panels to the current level of technology and to execute said upgrade in increments of one panel at a time without the need to upgrade all controllers on the network. Compatibility shall also be defined as the ability to extend a previously installed network with new peer-to-peer Automation Level Network controllers / field panels. Compatibility shall be further defined as the ability for any existing peer-to-peer Automation Level Network controller/field panel to be connected to, and directly communicate with, new peer-to-peer Automation Level Network controllers / field panels without bridges, routers or protocol converters.

Information on this documented history shall be included in the technical proposal called for in Section 1.7 of this specification.

1.5 SUBMITTALS

A. Submit (8, or as required) complete sets of documentation in the following phased delivery schedule:

1. Valve and damper schedules
2. Equipment data cut sheets
3. System schematics, including:
   - sequence of operations
   - point names (furnished by Owner)
   - point addresses
   - interface wiring diagrams
   - panel layouts
   - system riser diagrams
4. Auto-CAD or Revit compatible as-built drawings

B. Upon project completion, submit operation and maintenance manuals, consisting of the following:

- Index sheet, listing contents in alphabetical order.
- Manufacturer's equipment parts list of all functional components of the system.
- Auto-CAD or Revit disk of system schematics, including wiring diagrams.
- System schematics, including sequence of operations.
- As-Built interconnection wiring diagrams.
- Trunk cable schematic showing remote electronic panel locations and all trunk data.
• List of connected data points, including panels to which they are connected and input device (e.g., temperature sensors, ionization detectors, etc.)
• Conduit routing diagrams

1.6 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the BAS system for a period of two (2) years after first beneficial use.

B. The adjustment, required testing, and repair of the system includes all computer equipment (if furnished), DDC Controllers, HVAC & Mechanical Equipment Controllers, Application Specific Controllers, transmission equipment and all sensors and control devices.

C. The on-line support services shall allow the local BAS supplier to dial out over telephone lines to monitor and control the facility's building automation system if this service is requested by the Owner. If so requested/specified, this remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, or if so requested by the Owner, the BAS manufacturer / supplier shall dispatch the appropriate personnel to the job site to resolve the problem within 4 hours of the time that the problem is reported.

1.7 TECHNICAL PROPOSAL

A. A technical proposal shall be prepared in accordance with these specifications. Four (4) copies of the proposal, each one bound in a three-ring binder, shall be submitted to the Owner within twenty-one (21) days after receipt of bids. Proposals that are unbound, loose in a file folder, stapled, stapled in a manila file folder, etc., will not be acceptable. The technical proposal shall include the following data / information as a minimum. The order of listing here is not intended to indicate, nor should it be construed to indicate, the relative importance of the data / information. The Owner and Engineer shall review this technical proposal for system completeness and compatibility with the Owner's existing installations.

1. Information on organizational capability to handle this project (management, personnel, manufacturing, single source responsibility, etc.)
2. Information on training program to demonstrate specification compliance.

3. System Configuration as Proposed:
   a) Description of system architecture, including a schematic layout with location and type (model number) and designation (DDC Controller or HVAC & Mechanical Equipment Controller) of all controllers / panels.
   b) Description of system operation, functions and control techniques.
   c) Information on system and field panel modularity.
   d) Provisions against obsolescence due to technological advancement.
   e) Hardware and software data sheets on any interfaces to third-party systems (e.g., chillers, fire alarm systems, etc.).

4. Technical data to support the information on the hardware configuration.

5. Detailed description of all operating, command, application and energy management software provided for this project.

6. **A signed certificate stating that the BAS supplier has read and understood the performance and functional requirements, and that the technical proposal will comply with all parts of the specification.**

7. Other requirements for inclusion in the technical proposal located elsewhere in this specification, [Section 1.4 F](#) in particular.

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**PART 2 - PRODUCTS**

2.1 ACCEPTABLE MANUFACTURER

Siemens Industry, Inc.

2.2 NETWORKING COMMUNICATIONS

A. The design of the BAS shall network operator workstations, stand-alone DDC Controllers and stand-alone HVAC & Mechanical Equipment Controllers. The network architecture shall consist of multiple levels for communication efficiency. An existing campus-wide Ethernet network based on TCP/IP protocol (Management Level Network), high performance dedicated peer-to-peer Automation Level Network(s) and DDC Controller / HVAC & Mechanical Equipment Controller floor level local area networks with access being totally transparent to the user when accessing data or when developing, editing, and implementing control programs.
B. The design of the BAS shall allow the co-existence of new DDC Controllers and HVAC & Mechanical Equipment Controllers with existing DDC Controllers and HVAC & Mechanical Equipment Controllers on the same peer-to-peer Automation Level Network without the use of gateways, routers, or protocol converters.

1. System shall provide for **seamless read and write access** by the existing main Siemens Building Technologies (SBT) campus network. This shall include but not be limited to monitoring and reporting point data (particularly fire and/or security alarms), commanding points, modifying system set points and scheduling equipment through the existing Siemens Apogee network workstations. The intent of this section is to provide for daily operator functions to be completed from a single seat interface on the existing SBT network.

C. Dedicated Peer-to-Peer Automation Level Network:

1. All operator devices shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer Automation Level Network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.

2. The peer-to-peer Automation Level Network shall support a minimum of 100 DDC Controllers and HVAC & Mechanical Equipment Controllers and/or PC workstations.

3. Each PC workstation shall be capable of supporting a minimum of 4 peer-to-peer Automation Level Networks hardwired or dial-up.

4. The system shall support integration of third-party systems (e.g., fire alarm, security, lighting, PLC, chiller, boiler) via panel-mounted open protocol processors. This processor shall exchange data between the two systems for interprocess control. All exchanged points shall have full system functionality as specified herein for hardwired points.

5. Controllers must be capable of integration with open standards including Modbus, BACnet, and Lonworks as well as with third-party devices via existing vendor protocols.

2.3 CONTROLLER FLOOR LEVEL NETWORKS:

A. This level of communication shall support a family of Application Specific Controllers and shall communicate with the peer-to-peer Automation Level Network through DDC Controllers and/or HVAC & Mechanical Equipment Controllers for transmission of global data.

2.4 DDC CONTROLLERS AND HVAC & MECHANICAL EQUIPMENT CONTROLLERS

A. The DDC Controllers and HVAC & Mechanical Equipment Controllers shall reside on the Automation Level Network(s).
B. DDC Controllers and HVAC & Mechanical Equipment Controllers shall use the same programming language and/or tools. The programming language shall be text-based, similar to BASIC. DDC Controllers and HVAC & Mechanical Equipment Controllers that require different programming languages or tools for each type of controller are not acceptable. Graphical programming languages or tools are not acceptable.

C. DDC Controllers and HVAC & Mechanical Equipment Controllers that do not meet the functions specified in Section 2.4.1 and Section 2.5 for DDC Controllers or Section 2.4.2 and Section 2.5 for HVAC & Mechanical Equipment Controllers are not acceptable.

2.4.1 DDC CONTROLLERS

A. DDC Controllers shall be, at a minimum, 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three (3) Floor Level Application Specific Controller Device Networks. Basis of design is Siemens Apogee PXC Modular Controller.

B. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:

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

C. Each DDC Controller shall support firmware upgrades without the need to replace hardware.

D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

E. DDC Controllers shall provide for RS-232C serial data communication for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator’s terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
F. The operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board operator override switches. These shall be hand/off/auto switches for digital control type points and gradual switches for analog control type points.

1. Switches shall be mounted within the DDC Controller’s key-accessed enclosure to prevent unauthorized overrides.

2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

(** Note: Provide I/O schedule for points needing manual override **) 

G. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.

H. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

H. Isolation shall be provided at all peer-to-peer Automation Level Network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

1. RF-Conducted Immunity (RFCl) per ENV 50141 (IEC 1000-4-6) at 3 V

2. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact

3. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power

4. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)

5. Isolation shall be provided at all peer-to-peer panels' AC input terminals to suppress induced voltage transients consistent with:


   b. UL 864 Supply Line Transients

   c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

J. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software.
Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 20 days.

1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.

2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

K. Provide separate DDC Controller(s) for each AHU or HVAC system (or group of systems) as indicated in Section 3.2. It is intended that each system or group of systems (as indicated in Section 3.2) be provided with its own point resident DDC Controller.

L. Existing DDC controller(s) may be reused if applicable. If they are NOT REUSED, they shall be salvaged and retained by the Owner. Carefully remove and transmit intact to Owner’s designated personnel for storage. If panels are reused, reuse point modules wherever possible, install replacements as required.

2.4.2 HVAC & MECHANICAL EQUIPMENT CONTROLLERS

A. HVAC & Mechanical Equipment Controllers shall be, at a minimum, 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with enclosed processors. Basis of design shall be Siemens Apogee Modular Controller (PXM) or Compact Controller (PXC).

B. Each HVAC & Mechanical Controller shall have sufficient memory to support its own operating system and databases, including:

1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level of alarm specified for each alarmable point in the system.
4. Historical/trend data for points specified
5. Maintenance support applications
6. Custom processes
7. Operator I/O
8. Remote communications

C. HVAC & Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator’s terminals.

D. HVAC & Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
E. Each HVAC & Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC & Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

F. The operator shall have, if required / specified, the ability to manually override automatic or centrally executed commands at the HVAC & Mechanical Equipment Controller via local, point discrete, on-board operator override switches. These shall be hand/off/auto switches for digital control type points and gradual switches for analog control type points.

1. Switches shall be mounted either within the HVAC & Mechanical Equipment Controller’s key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.

2. HVAC & Mechanical Equipment Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. HVAC & Mechanical Equipment Controllers shall also collect override activity information for reports.

(** Note: Provide I/O schedule for points needing manual override **) 

G. Isolation shall be provided at all peer-to-peer Automation Level Network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

1. RF-Conducted Immunity (RFCl) per ENV 50141 (IEC 1000-4-6) at 3 V

2. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact

3. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power

4. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)

5. Isolation shall be provided at all peer-to-peer panels’ AC input terminals to suppress induced voltage transients consistent with:

   a) IEEE Standard 587-1980

   b) UL 864 Supply Line Transients

   c) Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

H. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC & Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all
critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.

1. Upon restoration of normal power, the HVAC & Mechanical Equipment Controller shall automatically resume full operation without manual intervention.

2. Should HVAC & Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC & Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in (if so specified) or from a network workstation PC.

3. Provide a separate HVAC & Mechanical Equipment Controller for each AHU or other HVAC system (or group of systems) as indicated in Section 3.2. It is intended that each system or group of systems (as indicated in Section 3.2) be provided with its own point resident HVAC & Mechanical Equipment Controller.

2.5 DDC CONTROLLER AND HVAC & MECHANICAL EQUIPMENT CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and HVAC & Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.

2. All points shall be identified by up to 30-character point name and 15-character point descriptor. The same names shall be used at the PC workstation. These names and their associated addresses shall be unique in the entire system, and not merely in the controller or in a point grouping.

3. All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state, e.g. SUMMER / WINTER).

B. Control Software Description:

1. The DDC Controllers and HVAC & Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:
   
   a) Two-position control
   b) Proportional control
   c) Proportional plus integral control
   d) Proportional plus integral plus derivative control
e) Automatic tuning of P only, PI and PID control loops
f) Model-free adaptive control - multiple or single output

C. DDC Controllers and HVAC & Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.

1. Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
   a) The SSTO program shall operate in both the heating and cooling seasons.
      1) It shall be possible to apply the SSTO program to individual fan systems.
      2) The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
   b) The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.

2. Event Scheduling: Provide a comprehensive menu driven program to automatically command designated points or groups of points according to a stored time.
   a) It shall be possible to individually command a point or group of points.
   b) For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
   c) The operator shall be able to define the following information:
      1. Time, day, month and year
      2. Commands such as on, off, change of setpoint, etc.
      3. Time delays between successive commands.
   d) It shall be possible to schedule events up to one (1) year in advance.
1. Scheduling shall be calendar based.

2. Holidays shall allow for different schedules.

3. There shall be provisions for manual overriding of each schedule by an appropriately authorized operator.

3. Economizer

a) The Energy Management Control Software (EMCS) will control the position of air handling unit outdoor air, return air and relief air dampers. If outdoor air dry bulb temperature falls below changeover setpoint, or if outdoor air enthalpy falls below enthalpy changeover setpoint (whichever method is specified), the EMCS will modulate the dampers toward 100% outdoor air as necessary to maintain mixed air temperature. Above the changeover setpoint the EMCS will position the dampers for minimum outdoor air.

b) The operator shall be able to override the economizer cycle and return to mixed air operation at any time.

4. Temperature-compensated duty cycling

a) The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.

b) The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

5. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

6. Night/unoccupied setback control: The system shall provide the ability to automatically adjust setpoints for night/unoccupied control.

7. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.

a) PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.

b) PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.

c) If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
d) Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.

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

1. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers and HVAC & Mechanical Equipment Controllers on the peer-to-peer Automation Level Network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers and HVAC & Mechanical Equipment Controllers on the network. The database shall support 30 character, English language point names, structured for searching and logs.

2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

3. DDC Controllers and HVAC & Mechanical Equipment Controllers shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.

4. DDC Controller and HVAC & Mechanical Equipment Controller processes shall be capable of comment lines for sequence of operation explanation.

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

1. All alarm or point change reports shall include the point’s 30-character English language description and the time and date of occurrence.

2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller and HVAC & Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms.
during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after-hours destinations) or based on priority.

4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200-character alarm message to more fully describe the alarm condition or to direct operator response.

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

F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary. The entire collection process shall be automated so that the data collection definition, amount of data to be collected, collection report and scheduling take the form of a wizard, or online assist utility, in order to complete this process within a short amount of time for a large group of points. Ability to produce a summary of changes in a log file.

1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers and HVAC & Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Time intervals of 1 minute to 7 days shall be provided. Each DDC Controller and HVAC & Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 1000 data samples per trended point. All trend data shall be available for transfer to a workstation without manual intervention.

   a) Time-interval based trending shall have the capability of synchronizing the trend sampling of discrete points. This allows for the comparison of values of several different points at the same moment in time.

   b) Trended points shall have the option of sampling data values based on the condition of a “trigger” point. (i.e., conditional trending). Options for sampling shall include: always sampling as defined, only sampling when the trended point is in the alarm condition, or not sampling.

2. DDC Controllers and HVAC & Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms and/or model-free adaptive control shall be provided for operator-selected control loops as identified in the point I/O summary.
a) Loop tuning shall be capable of being initiated either locally at the DDC Controllers and HVAC & Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

G. DDC Controllers and HVAC & Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.

H. The peer-to-peer Automation Level Network shall allow the DDC Controllers and HVAC & Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC Controllers and HVAC & Mechanical Equipment Controller or combination of controllers on the peer-to-peer Automation Level Network without dependence upon a central or intermediate processing device. DDC Controllers and HVAC & Mechanical Equipment Controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate-processing device. The peer-to-peer Automation Level Network shall also allow any DDC or HVAC & Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.

I. The peer-to-peer Automation Level Network shall allow the DDC Controllers and HVAC & Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each operator individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

1. Passwords shall have the option to be configured to expire within a selected timeframe (1-365 days).

   a) Configuring the password expiration shall also enable the functionality to lock-out a user account after three failed log-on attempts.

2.6 FLOOR LEVEL NETWORK APPLICATION SPECIFIC CONTROLLERS (ASCs)

A. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through Floor Level LAN Device Networks.
B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.

C. Application Specific Controller Applications:

1. Provide for control of each piece of equipment as specified, including, but not limited to, the following:
   a) Variable Air Volume (VAV) boxes
   b) Constant Air Volume (CAV) boxes
   c) Dual Duct Terminal Boxes
   d) Unit Conditioners
   e) Heat Pumps
   f) Unit Ventilators
   g) Room Flow Tracking / Pressurization
      1) Containment in laboratory rooms shall be maintained by controlling the quantity of air exhausted from and supplied to the room.
      2) A controller and its associated sensors shall measure and control the quantity of air flowing into and out of the room through flow measuring devices in the supply air and exhaust air terminals.
      3) The controller shall have an operating range that will maintain a differential between supplied and exhausted air sufficient to maintain the specified containment in the space.
   h) Laboratory Room
      1) Controllers shall be BAS supplier’s OEM products. Controllers shall reside on the BAS floor level network. Third-party controllers are not acceptable.
      2) Laboratory rooms, and the fume hood(s) and general exhaust terminal(s) in those rooms shall be controlled to allow for a variable flow of conditioned air into the room and exhaust through the hood while maintaining a safe velocity at the hood sash opening.
   i) Fume Hoods
1) Face velocity control input shall be **sash position**. Other types of sensing are **not acceptable**.

2) Controllers shall be BAS supplier’s **OEM products**. Controllers shall reside on the BAS floor level network. **Third-party controllers are not acceptable**.

3) The airflow through the open face of the hood, regardless of sash position, shall be controlled at a face velocity of between 100 FPM and 120 FPM.

4) The controller shall control, based on this input, a damper in the hood discharge terminal to maintain specified face velocity.

2. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 0-10 Vdc, allowing for interface to a variety of modulating actuators.

3. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, ALN or MLN is not acceptable.

2.7 PORTABLE OPERATOR’S TERMINAL (POT)

(** Note: Shown for information only; OPTIONAL; Owner to furnish as required **) 

A. Provide industry standard, commercially available portable operator terminals with a liquid crystal display (LCD) and a full-featured keyboard. The POT shall be handheld and plug directly into all DDC Controllers, HVAC & Mechanical Equipment Controllers, and Floor Level Network Controllers as described below. Provide a user-friendly, English language-prompted interface for quick access to system information, not codes requiring look-up charts.

B. Functionality of the portable operator’s terminal connected at any DDC or HVAC & Mechanical Equipment Controller shall include, but not be limited to:

1. Access all DDC Controllers and HVAC & Mechanical Equipment Controllers and ASCs on the Automation Level Network.

2. Backup and / or restore DDC Controllers and HVAC & Mechanical Equipment Controller databases for all system panels on the Automation Level Network, not just the DDC or HVAC & Mechanical Equipment Controller connected to.

3. Display all point, selected point and alarm point summaries.

4. Display trending and totalization information.

5. Add, modify and / or delete any existing or new system point on the Automation Level Network.
6. Enable or disable any system point on the Automation Level Network.

7. Command any commandable system point on the Automation Level Network.


9. Program and load custom control sequences as well as standard energy management programs.

10. Acknowledge alarms.

C. Functionality of the portable operator's terminal connected to any application specific controller:

1. Provide connection capability at either the Floor Level Network Controller or a related room sensor to access controller information.

2. Provide status, setup and control reports.

3. Modify, select and store controller database.

4. Enable or disable any controller point.

5. Change any controller setpoint.


D. Connection of a POT to a DDC Controller, HVAC & Mechanical Equipment Controller or ASC Controller shall not interrupt nor interfere in any way with normal network operation, prevent alarms from being transmitted or preclude centrally-initiated commands and system modification.

E. Portable operator terminal access to controller shall be password-controlled. Password protection shall be configurable for each operator based on function, points (designating areas of the facility), and edit / view capability.

2.8 LOCAL USER DISPLAY

Where specified, the DDC Controllers and HVAC & Mechanical Equipment Controllers on the peer-to-peer Automation Level Network shall have a local user interface. A keypad shall be provided for interrogating and commanding points in the controller.

A. The display shall use the same security password and access rights for points in the display as is used in the associated controller.

B. The LCD display shall be capable of a 2-line 40-character display.
C. The LCD display shall include the full 30-character English point name and value (numeric, digital or state text).

D. The LCD display shall display point priority and alarm status on one screen.

E. The LCD shall dynamically update the value, priority, and alarm status for the point being displayed.

F. The display shall be mounted either on the door of the enclosure or remote from the controller.

2.9 PERSONAL COMPUTER OPERATOR WORKSTATION HARDWARE

(** Note: Shown for information only; OPTIONAL; Owner to furnish as required **)

A. Personal computer operator workstations shall be provided for command entry, information management, system monitor, alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers and/or HVAC & Mechanical Equipment Controllers to facilitate greater distribution, fault tolerance and reliability of the building automation system.

1. Provide workstation(s) of equal capability located at ________.

2. Workstation shall consist of a personal computer with minimum of 512 MB RAM, hard drive with 3.0 GB to 4.0 GB available space, video card capable of supporting 1024 x 768 resolution with a minimum of 16 Bit color, CD-ROM, CD-R, CD-RW, or DVD-ROM Drive, mouse and 101-key enhanced keyboard. Personal computer shall be a Windows XP, 2000 or Server 2003 Compatible PC and shall include a minimum 933MHz Pentium-III processor. Microsoft .NET Framework 1.1 or later software shall be installed.

B. Provide an Epson FX-880 or equivalent printer at each workstation location or on the network (Ethernet) for recording alarms, operator transactions and systems reports.

C. Alarm Display shall list the alarms with the most recent alarm at the top of the display and shall provide a mechanism for the operator to sort alarms. The alarm display shall provide selector buttons for display of any associated point graphic and / or message.

2.10 WORKSTATION OPERATOR INTERFACE
A. Basic Interface Description

1. Operator workstation interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 30-character English language point identification, on-line help, and industry standard Windows application software. Interface software shall simultaneously communicate with and share data between any combination of dedicated RS-485, modem autodial, and dedicated Ethernet-connected Automation Level Networks. The software shall provide, as a minimum, the following functionality:

   a) Real-time graphical viewing and control of the BAS environment.
   b) Reporting.
   c) Scheduling and override of building operations.
   d) Collection and analysis of historical data.
   e) Point database editing, storage and downloading of controller databases.
   f) Utility for combining points into logical Point Groups. The Point Groups shall then be manipulated in Graphics, trend graphs and reports in order to streamline the navigation and usability of the system.
   g) Alarm reporting, routing, messaging, and acknowledgment.
   h) “Collapsible tree,” dynamic system architecture diagram application:
      1) Showing the real-time status and definition details of all workstations and devices on a management level network.
      2) Showing the real-time status and definition details of all DDC Controllers and HVAC & Mechanical Controllers on the Automation Level Network(s).
      3) Showing the status and definition details of all floor-level network application specific controllers.
   i) Definition and construction of dynamic color graphic displays.
   j) Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
   k) On-screen access to User Documentation, via online help or PDF-format electronic file.
   l) Automatic database backup at the workstation for database changes initiated at DDC Controller or HVAC & Mechanical Equipment Controller operator interface terminals.
      1) Backups shall produce a configuration file that contains pertinent details regarding the specific backup. This log file shall be created each time a backup is run and be stored in the backup directory.
      2) Restore dialog box shall list detailed information to facilitate the restore of the correct database.
      3) Ability to restore selected components of a backup.
      4) Delete old backup directories automatically or individually from a detailed list.
   m) Display dynamic trend data graphical plot.
      1) Must be able to run multiple plots simultaneously.
      2) Each plot must be capable of supporting 10 points per plot minimum.
3) Must be able to command points directly off dynamic trend plot application.
4) Must be able to plot both real-time and historical trend data.
n) Program editing
o) Transfer trend data to third-party spreadsheet software
p) Scheduling reports
q) Operator Activity Log
r) Open communications via OPC Server (**Note: Add Option **)
s) Open communications via BACnet Client & Server (**Note: Add Option**)
t) Tracking of supervised objects (**Note: Add Option**)
u) Tracking of points through the alarm process (**Note: Add Option**)
v) Provide remote notification of points in alarm (**Note: Add Option**)

2. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation. Selection of applications within the workstation software shall be via a graphical toolbar menu. The application toolbar menu shall have the option to be located in a docked position on any of the four sides of the visible desktop space on the workstation display monitor, and the option to automatically hide itself from the visible monitor workspace when not being actively manipulated.

3. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software shall run on a Windows XP or Server 2003 operating system. System database parameters shall be stored within an object-oriented database, which is compliant with the Open Database Connectivity (ODBC) or Structured Query Language (SQL) standards. Standard Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information.

a) Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via adjustable user-sized windows. Operator shall be able to drag and drop information between the following applications, reducing the number of steps to perform a desired function (e.g., Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend on the desired point):

1) Dynamic color graphics application
2) Alarm management application
3) Scheduling application
4) Dynamic trend graph data plotter application
5) Dynamic system architecture diagram application
6) Control Program and Point database editing applications
7) Reporting applications

b) Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.

4. Operator-specific password access protection shall be provided to allow the administrator/manager to limit users’ workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported). The administrator/manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BAS workstation application. Each BAS workstation user account shall use a Windows user account as a foundation.

a) The workstation software shall also include an application to track the actions of each individual operator, such as alarm acknowledgement, point commanding, schedule overriding, database editing, and logon/logoff. The application shall list each of the actions in a tabular format, and shall have sorting capabilities based on parameters such as ascending or descending time of the action, or name of the object on which the action was performed. The application shall also allow querying based on object name, operator, action, or time range.

5. Dynamic Color Graphics application shall include the following:

a) Must include graphic editing and modifying capabilities.

b) A library of standard control application graphics and symbols must be included.

c) Must be able to command points directly off graphics application.

d) Graphic display shall include the ability to depict real-time point values dynamically with animation, picture/frame control, symbol association, or dynamic informational text-blocks.

e) Animation status indicators shall give you a quick visual indication of a point’s value, priority or status in the form of an icon.

f) Navigation through various graphic screens shall be optionally achieved through a hierarchical “tree” structure or view recently opened graphics through a backward and forward paging.

g) Graphics viewing shall include zoom capabilities.
h) Graphics shall automatically display the HAND status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.

i) Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.

6. Reports shall be generated on demand or via pre-defined schedule, and directed to CRT displays, printers or file. As a minimum, the system shall allow the user to easily obtain the following types of reports:

a) A general listing of all or selected points in the network
b) List of all points currently in alarm
c) List of all points currently in override status
d) List of all disabled points
e) List of all points currently locked out
f) List of user accounts and access levels
g) List all weekly schedules and events
h) List of holiday programming
i) List of control limits and deadbands
j) Custom reports from third-party software
k) System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
l) List of programs
m) List of point definitions
n) List of logical point groups
o) List of alarm strategy definitions
p) List of DDC Controllers and HVAC & Mechanical Equipment Controllers
q) Point totalization report
r) Point Trend data listings
s) Initial Values report
t) User activity report

7. Scheduling and override

Provide a calendar type format for simplification of time and date scheduling and overrides of normal building operations. Schedule definitions reside in the PC workstation/server, DDC Controller, and HVAC & Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line -- PC shall not be required to execute time scheduling. Provide override access through menu selection, graphical mouse action or function key. Provide the following capabilities as a minimum:

a) Weekly schedules
b) Zone schedules
c) Event schedules – an event consists of logical combinations of equipment and/or zones
d) Report schedules
e) Ability to schedule for a minimum of 365 days in advance

Additionally, the scheduling application shall:

f) Provide filtering capabilities of schedules, based on name, time, frequency, and schedule type (event, zone, report)
g) Provide sorting capabilities of schedules, based on name, time and type of schedule (zone, event, report)
h) Provide searching capabilities of schedules based on name – with wildcarding options

8. Collection and Analysis of Historical Data

a) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals (up to four time-based definitions per point) or change of value, both of which shall be user-definable. Trend data shall be collected stored on hard disk for future diagnostics and reporting. Automatic trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

b) The entire collection process shall be automated so that the data collection definition, amount of data to be collected, collection report and scheduling take the form a wizard, or online assist utility, in order to complete this process within a small amount of time for a large group of points. Provide the ability to produce a summary of changes in a log file.

c) Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. BAS supplier shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. BAS supplier shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.

d) Provide additional functionality that allows the user to view real-time trend data on trend graphical plot displays. A minimum of fifteen points may be plotted, of either real-time or historical data. The dynamic graphs shall continuously update point values. At
any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of plot screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of 8 true graphs shall run simultaneously. Operator shall be able to command points directly on the trend plot by double clicking on the point. Operator shall be able to zoom in on a specific time range within a plot. The dynamic trend plotting application shall support the following types of graphs, with option to graph in 3D: line graph, area graph, curve graph, area-curve graph, step graph, and scatter graph. Each graph may be customized by the user, for graph type, graph text, titles, line styles and weight, colors, and configurable x- and y-axes.

B. Dynamic Color Graphic Displays

(** Note: Customize this to specific job requirements**) (Unit Price Add)

1. Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems and hot water boiler systems, and room level terminal units, shall be provided by the BAS contractor as indicated in the point I/O schedule of this specification to optimize system performance, analysis and speed alarm recognition.

2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association, or text-based commands. Graphics software shall permit the importing of Autocad or scanned pictures for use in the system.

3. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations within the system schematics or graphic floor plan displays, and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.

   a) Provide the user the ability to display real-time point values by animated motion or custom picture control visual representation. Animation shall depict movement of mechanical equipment, or air or fluid flow. Picture Control shall depict various positions in relation to assigned point values or ranges. A library (set) of animation and picture control symbols shall be included within the workstation software's graphics application. Animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for up to five rates of animation speed. Animation shall also indicate the priority and alarm status of the point.

   b) Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on
the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.

c) Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.

d) Equipment state or values shall be able to be changed by clicking on the associated point block or graphic symbol and selecting the new state (on/off) or setpoint.

e) State text for digital points shall be user-definable up to eight characters.

4. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.

5. Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.

6. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

7. Off-the-shelf Microgafx Designer or Corel Draw graphic software shall be provided to allow the user to add, modify or delete system graphic background displays.

4. A clipart library of HVAC application and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and laboratory symbols. The user shall have the ability to add custom symbols to the clipart library. The clipart library shall include a minimum of 400 application symbols. In addition, a library consisting of a minimum of 700 graphic background templates shall be provided.

5. The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller’s control values and parameters, without the need to create separate and individual graphic files for each controller.

C. System Configuration & Definition

1. A “Collapsible tree” dynamic system architecture diagram / display application of the site-specific BAS architecture showing status of
controllers, PC workstations and networks shall be provided. This application shall include the ability to add and configure workstations, DDC Controllers or HVAC & Mechanical Equipment Controllers, as well as third-party integrated components. Symbols / Icons representing the system architecture components shall be user-configurable and customizable, and a library of customized icons representing third-party integration solutions shall be included. This application shall also include the functionality for real-time display, configuration and diagnostics of dial-up modems to DDC or HVAC & Mechanical Equipment Controllers.

2. Network wide control strategies shall not be restricted to a single DDC Controller or HVAC & Mechanical Equipment Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.

3. Provide automatic backup and restore of all DDC controller and HVAC & Mechanical Equipment Controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller or HVAC & Mechanical Equipment Controller. Changes made at the user-interface of DDC Controllers or HVAC & Mechanical Equipment Controllers shall be automatically uploaded to the workstation, ensuring system continuity.

4. System configuration, programming, editing and graphics generation shall be performed on-line. If programming and system back-up must be done with the PC workstation off-line, the BAS supplier shall provide for at least 2 operator workstations.

5. Point database configuration shall be available to the user within a dedicated point database editor application included in the workstation software. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database. The point editor shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the option for editing the point database in an online or offline mode with the DDC Controllers and HVAC & Mechanical Equipment Controllers.

   a) The workstation software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points. This function shall allow the user to choose the properties to copy from a selected point to another point or set of points. The selectable attributes shall include, but are not limited to, Alarm management definitions and Trend definitions.
6. Control program configuration shall be available to the user within a dedicated control program editor application included in the workstation software. The editor shall allow for creation, modification and deletion of control programs. The editor shall include a programming assistance feature that interactively guides the user through parameters required to generate a control program. The editor shall also include the ability to automatically compile the program to ensure its compatibility with the DDC Controllers and HVAC & Mechanical Equipment Controllers. The editor shall provide the option for editing the control programs in an online or offline mode, and also the ability to selectively enable or disable the live program execution within the DDC Controllers and HVAC & Mechanical Equipment Controllers. The editor shall also provide the option of importing and exporting control programs as text files for offline use in other Windows applications and / or documents.

D. Alarm Management

1. Alarm Routing shall allow the user to send alarm notification to selected printers or workstation location(s) based on time of day, alarm severity, or point type.

2. Alarm Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each alarm point: name, value, alarm time & date, alarm status, priority, acknowledgement information, and alarm count. Each alarm point or priority shall have the ability to sound a discrete audible notification.

3. Alarm Display shall have the ability to list and sort the alarms based on alarm status, point name, ascending or descending alarm time.

4. Directly from the Alarm Display, the user shall have the ability to acknowledge, silence the alarm sound, print, or erase each alarm. The interface shall also have the option to inhibit the erasing of active acknowledged alarms, until they have returned to normal status. The user shall also have the ability to command, launch an associated graphic or trended graphical plot, or run a report on a selected alarm point directly on the Alarm Display.

5. Each alarm point shall have a direct link from the Alarm Display to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each alarm which can be viewed from the alarm display screen, graphic display screen, and anytime the point is being commanded to a new value or state.

6. Alarm messages shall be customizable for each point, or each alarm priority level, to display detailed instructions to the user regarding actions to take in the event of an alarm. Alarm messages shall also have the optional ability to individually enunciate on the workstation display via a separate pop-up
window, automatically being generated as the associated alarm condition occurs.

7. Alarm Display application shall allow workstation operators to send and receive real-time messages to each other, for purposes of coordinating Alarm and BAS system management.

2.11 FIELD DEVICES

A. Provide instrumentation as required for monitoring, control or optimization functions.
   (** Note: See Section 23 09 13; add/modify as required **) 

B. Provide **two** digital inputs for fire alarm systems as follows. **Fire alarm system circuiting to BAS shall provide Form C dry contacts with no shorts and no voltage.**
   1) General Fire Alarm
   2) Panel Trouble (general; any condition requiring action outside normal business hours)

C. Provide two digital inputs for emergency generators. **Generator circuiting to BAS shall provide Form C dry contacts with no shorts and no voltage.**
   1) Generator Run (with or without transfer)
   2) Generator Fault

D. Water flow measuring (consumption) meters

Acceptable manufacturer: Badger Meter Co., Inc.

Steam condensate service:

1) Badger Meter; M Series , M2000
2) Provide data jack near meter.
3) **Shall be mounted 48” – 60” AFF in accessible location.**

Well water service:

1) Magnetic flow meter, sized as required. Basis of design is Badger Magnetoflow.
2) Badger Primo amplifier with LCD display. Output shall be dry contact closure through interposing Matsushita HC2-H-AC24V relay, programmed to 1 pulse = 100 gallons. An additional rate output programmed to yield 4-20 mA = 0 – (nnnn) gpm shall be provided, where nnnn = maximum pump flow as specified elsewhere in Division 15. Positive zero reset shall be programmed or otherwise provided for such that no flow is shown when the pump is off. The amplifier shall be remote mounted rather than mounted at the flow tube if required/specified.

3) Both meter and amplifier shall be mounted 48” – 60” AFF in accessible location.

PART 3 – EXECUTION

3.1 PROJECT MANAGEMENT

Provide a designated project manager who will be responsible for the following:

1. Construct and maintain project schedule.
2. On-site coordination with all applicable trades, subcontractors, and other integration vendors.
3. Authorized to accept and execute orders or instructions from Owner / Architect.
4. Attend project meetings as necessary to avoid conflicts and delays.
5. Make necessary field decisions relating to this scope of work.
6. Coordination / Single point of contact.

3.2 SEQUENCE OF OPERATION

** See Section 23 09 93 Sequence of Operation for HVAC **

** Number of DDC Controllers and HVAC & Mechanical Equipment Controllers and associated systems and / or groups of systems controlled by each controller to be specified here and referenced in 23 09 93. **

3.3 POINT SCHEDULE MATRIX - I/O SCHEDULE

** Attach I/O schedule **

The BAS supplier shall collaborate with the Owner directly to obtain point names, naming conventions, etc. before entering the data into the system.

3.4 START-UP AND COMMISSIONING

A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. The BAS supplier shall complete all testing, calibrating, adjusting and final field tests.
Verify that all systems are operable from local controls (if required / specified) in the specified failure mode upon panel failure or loss of power.

B. **Provide any recommendations for system modification in writing to the Owner.** Do not make any system modification, including operating parameters and control settings, without prior approval of the Owner.

C. After BAS supplier has completed system start-up and commissioning, joint commissioning of any integrated system segments shall be completed.

### 3.5 ELECTRICAL WIRING AND MATERIALS

A. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories.

B. **Power and Control Wiring:** *Control voltage for the Building Automation System shall be 24VAC nominal.* Power and control wiring and conduit shall be run in a neat and workmanlike manner, parallel and perpendicular to the building structure, concealed wherever possible, without splices between terminal points, and properly supported from structure.

   1) All electrical wiring shall be done in accordance with Division 26 and/or 27 requirements.

   2) All wiring over 30 volts shall be color-coded wire, No. 14 minimum, run within electrical metallic tubing.

   3) All wiring under 30 volts shall be color-coded, Class 2, plenum rated, shielded if and where required / specified.

   4) Cable shall be by The Cable Company as follows (or approved equal):

      a) Automation Level Network (ALN) (RS-485): 5200BLN
      
      b) Floor Level Network (FLN)(RS-485): 5200FLN
      
      c) I/O for DDC Controllers and HVAC & Mechanical Equipment controllers: 5031LAN or 5041LAN
      
      d) Outputs for Application Specific Controllers: 5033LAN

   5) Low voltage wiring (under 30 volts) shall be run within electric metallic tubing *where exposed to view or where subject to physical damage,* such as in mechanical equipment rooms; and *where inaccessible,* such as in concrete walls or floors, in furred walls, or above ceilings with no access.

   6) Low voltage wiring (under 30 volts) where accessible and concealed, such as within instrument panels or above suspended ceilings with easy access, may be run without conduit. Such wiring shall be neatly run, bundled with a
maximum unsupported length of 4'-0", or installed in cable tray.

7) **Number-code, color-code, or otherwise clearly label cables, except local individual room control cables, for future identification and servicing of the system.**

C. Provide wiring between thermostats, aquastats and unit heater motors, all control and alarm wiring for all control and alarm devices for all Sections of Specifications.

D. Provide 120 volt, single phase, 60 hertz emergency power to every B.A.S. DDC Controller panel, HVAC & Mechanical Equipment Controller, PC console, power supply, transformer, annunciator, modem, printer and to other devices as required. It is the intent that the entire building automation system except terminal equipment shall be operative under emergency power conditions in the building. The power supplies are to be extended in conduit and wire from **dedicated emergency circuit breakers in emergency power panelboards. (Repeat this verbiage in Electrical Specification)**

E. Provide status function conduit and wiring for equipment covered under this Section.

F. Provide conduit and wiring between the B.A.S. panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring in conduit.

G. Provide conduit and control wiring for devices specified in this Section.

H. Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in B.A.S. panels located in the vicinity of motor control centers.

I. Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contractors, and B.A.S. panels, as shown on the drawings or as specified.

J. All wiring to be compliant to local building codes and the NEC.

K. Provide electrical wall box and conduit sleeve for all wall mounted devices.

3.6 CONTROL AIR AND SENSING LINES

1. All control actuators to be electric.

2. ¼" poly lines are acceptable for sensing lines.

3.7 PERFORMANCE

A. Unless stated otherwise, control temperatures within plus or minus 2°F, humidity within plus or minus 3% of the set point and static pressure within 10% of set point.
3.8 COMMISSIONING, TESTING AND ACCEPTANCE

A. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets. Copies of said sheets shall be submitted for record prior to acceptance testing. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the Owner to ensure systems are available when needed. Notify the Owner and the Owner’s operating personnel in writing of the testing schedule so that authorized personnel from the Owner and/or the Owner’s operating personnel may be present throughout the commissioning procedure.

1. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications and approved shop drawings. Test, calibrate (if necessary) and bring on line each control sensor and device. Commissioning to include, but not be limited to:
   a. Sensor accuracy at 10%, 50% and 90% of range.
   b. Sensor range.
   c. Verify analog limit and binary alarm reporting.
   d. Point value reporting.
   e. Binary alarm and switch settings.
   f. Actuator ranges / positioner settings.
   g. Fail safe operation on loss of control signal, electric power, network communications.

B. After control devices have been commissioned (i.e. calibrated, tested and signed off), each BAS program shall be put on line and commissioned. The BAS supplier shall if specified, demonstrate in the presence of the Owner’s designated personnel, each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and retested.

C. After all BAS programs have been commissioned, the BAS supplier shall verify and document the overall system performance as specified. Tests shall include, but not be limited to:

1. Data communication, both normal and failure modes.
2. Fully loaded system response time.
3. Impact of component failures on system performance and system operation.
4. Time / Date changes.
5. End of month / end of year operation.
7. Global application programs and point sharing.
8. System backup and reloading.
10. Diagnostic functions.
11. Power failure routines.
12. Battery backup.
13. Smoke Control, stair pressurization, stair, vents, in concert with Fire Alarm System testing (if required / specified).
14. Testing of all electrical and HVAC systems with other divisions of work.

D. After the above tests are complete and the system is demonstrated to be functioning as specified, a (insert desired number) day performance test period shall begin. If the system performs as specified throughout the test period, requiring only routine maintenance, the system shall be accepted. If the system fails during the test, and cannot be fully corrected within eight hours, the Owner may request that performance tests be repeated.

3.9 EXISTING CONTROL DEVICES

A. The bid for the control work shall be based on the premise that existing control devices that are to remain are operational and are not in need of repair or replacement, unless otherwise noted.

B. The BAS supplier shall notify the Owner's representative in writing of existing control devices that need to be replaced or repaired that are noted in the process of installation of the new work.

3.10 TRAINING

A. The manufacturer shall provide a factory-trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be
thoroughly familiar with all aspects of the subject matter they are to teach. The manufacturer shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 7:30 AM to 4:00 PM weekdays.

B. Provide eight (8) hours of training for Owner’s designated operating personnel. Training shall include:

- Explanation of drawings, operations and maintenance manuals
- Walk-through of the job to locate control components
- Operator workstation and peripherals
- DDC / HVAC & Mechanical Equipment Controller and ASC operation / function
- Operator control functions including graphic generation and field panel programming
- Operation of portable operator’s terminal
- Explanation of adjustment, calibration and replacement procedures
- Student binder with training modules

C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Manufacturer. If the Owner requires such training, it will be contracted at a later date.

23 20 00 – HVAC PIPING AND PUMPS

23 21 00 – HYDRONIC PIPING AND PUMPS

A. Hydronic heating and cooling coils shall be piped for counterflow.

B. When new roof openings are required for existing buildings, verify with the Owner’s Representative whether roof is under warranty. If roof is under warranty, all openings must be made according to roof manufacturer’s details so that warranty will not be made void.

C. All piping shall be sized on drawings. Do not use pipe-sizing schedules.

D. All interconnections between domestic water and any other services shall include a backflow preventer in the domestic water line. If line is used for filling system, include a water meter that reads in gallons.

E. Oversize incoming domestic water service by 25% to allow for some future expansion. Contractor shall be required to furnish and install the water meter(s) and coordinate installation with the utility. Specify Badger meter with remote read in cubic feet (gallons will not be accepted).

F. Piping mains, with the exception of sanitary and storm piping, shall not be buried under floor slabs. Accessible piping tunnels shall be installed as required.
G. All equipment in mechanical spaces shall be readily accessible. This includes but is not limited to, dampers, valves, actuators, etc.

H. Basis for high pressure steam design shall be 150 psig, 550°F.

I. For well water used in cooling systems, maximum discharge temperature leaving building is 97°F.

J. All steam vaults shall have a sump pump.

K. Backflow preventers shall be used where city water could be contaminated through siphoning or back pressure.

L. Chemical pot feeders shall be included on all hot water systems and on chilled water systems.

M. Provide meter for well water system. Badger industrial turbo/MSERI Register. Connect and transmit data via the building automation system to UNI Energy Management.

23 22 00 – STEAM AND STEAM CONDENSATE PIPING AND PUMPS

A. Steam trap capacity shall be at least twice the maximum rating of the anticipated load requirements.

B. Traps shall be piped for easy servicing. Install inspection valve for testing trap.

C. Traps shall be piped a minimum of 12” below the outlet of the devices they serve.

D. Do not use inverted bucket traps on any application over 50 psig. Use Armstrong, Hoffman, or TLV steam traps. – See appendix for details. Owner will supply all high pressure steam traps.

E. Safety valves shall have the appropriate ASME stamp.

F. Desuperheaters will feed from condensate receiver tank.

G. Steam pressure reducing valves shall provide tight shut-off for “dead end” service to prevent safety valve pop off. This shall include reducing valves on autoclaves and other equipment supplied with steam.

H. Pressure reducing valve (PRV) shall be Masoneilan Camflex 3500 Series. Normally closed valve. Reverse acting control head.

I. Condensate pumps need a union, a check valve, and a stop valve on discharge connections. Grundfos preferred. Packaged receiver/pump unit – Sterling preferred.
(steel tank, 40 psi discharge). DO NOT place condensate receiver underground. Install condensate bypass and receiver drain per Condensate Pump detail in Appendix.

23 20 00 – REFRIGERATION PIPING

A. Vibration isolators shall be provided in the suction and discharge lines of all refrigeration compressors. Both suction and discharge lines shall be insulated.

23 25 00 – HVAC WATER TREATMENT

A. Initial glycol concentration shall be 35% for heating.

23 25 14 – WATER TREATMENT (CLOSED SYSTEM)

A. Materials

1. Proprietary blend containing the following items:

   a) Corrosion Inhibitors: Sodium, nitrite-borax with added inhibitors such as mercaptobenzothiazole, sodium tolytriazole, or phenyltriazole to protect copper and brass and minimize dielectric pitting of steel. Maintain 2,000 ppm nitrate in heating systems and 900 ppm in cooling systems. Adjust borax content to maintain correct pH for type of system (mainly steel or mainly copper).

   b) Scale Inhibitor: Organic phosphonates such as aminomethylene-phosphonate; phosphonates such as hydroxyethylidenediphosphonate or polyamino-substituted phosphonates; or synthetic polymers such as low-molecular-weight polyacrylates, poly-methacrylates and polyacrylandies. Inorganic polyphosphates are not acceptable. Maintain residual concentration as recommended by the manufacturer.

B. Equipment

1. Bypass (Pot) Feeder with funnel, fill valve, drain valve, air cock, working pressure of 300 psig. Install eyewash station near the chemical pot feeder.

23 30 00 – HVAC AIR DISTRIBUTION

A. Maximum length of flexible duct at any one point shall be 3’-0” for terminal boxes and 6’-0” for diffuser.

B. Provide air blenders in air handling units to mix outside air and return air to prevent stratification.

C. Fume hood exhaust fans shall be installed on roof or near air discharge point from building in order that most of exhaust duct is under negative pressure.

D. Provide exhaust fans for each fume hood.

E. Do not locate exhaust fan discharge near building outside air intakes.
F. Provide exhausting of one custodial room to allow battery operated floor scrubber storage and recharging.

G. Drains from rooftop exhaust fans shall be run to the nearest roof drain (not drained onto the roofing material).

H. Utility set type fume hood exhaust fans are preferred. Provide special construction and linings as required.

23 31 00 – HVAC DUCTS AND CASINGS

A. All ductwork drawings shall be double line type.

B. Fume hoods require stainless steel or other non-corrosive metal ductwork. Verify requirements for each project.

C. Low-pressure ductwork shall have all joints sealed.

D. Medium and high-pressure ductwork shall be sealed and leak tested per SMACNA standards. Seal class shall be specified.

E. Outside air ducts subject to snow or water infiltration shall have drain pans piped to floor drain.

F. Duct thickness and construction shall be specified for all materials used.

G. Do not line fume hood exhaust ducts or HVAC ducts unless requested by Owner.

23 33 00 – AIR DUCT ACCESSORIES

A. Automatic dampers shall be a low leakage type with replaceable seals.

B. Fire dampers shall have an access panel for inspection and replacement of fusible links. Locations of all fire dampers shall be shown on drawings.

C. Access panels shall be insulated and quick opening.

D. Flexible connections shall not exceed 6” in width.

E. Manual dampers shall be provided at all trunk duct branches.

F. Manual dampers shall be provided with a locking type quadrant at exterior of duct.

G. Splitter dampers will not be allowed. Use 45º takeoffs.

23 33 19 – DUCT SILENCERS

A. Duct systems shall not transmit excessive airborne or radiated noise to occupied spaces. Fan selection, duct construction, air velocity and sound attenuators shall be evaluated to produce acceptable noise levels.
B. Use sound attenuation to reduce room to room noise transmission as needed.

23 34 00 – HVAC FANS

23 34 16 – CENTRIFUGAL FANS

A. General

1. Fans shall meet Class III standard when this class is available for the fan size involved.

2. Housings shall be constructed of continuously welded steel to assure no air leakage.

3. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.

4. Fan wheel shall be of the non-overloading backward inclined centrifugal or air foil type.
   a) Wheels shall be statically and dynamically balanced.
   b) The wheel cone and fan inlet cone shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

5. Turned, precision-ground and polished steel shafts shall be sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.

6. Bearings shall be heavy duty grease lubricated, self aligning ball bearing or roller pillow block type.
   a) Bearings shall be selected for a minimum B-10 life of 200,000 hours at the specified operating condition.

7. Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices.
   a) Fans shall be licensed to bear the AMCA Certified Ratings Seal.

8. After assembly, each fan shall be given a final balance test at the specified operating RPM to ensure smooth, vibrating-free operation and meet section 15240 requirements.

B. Variable frequency drives are the preferred equipment for volume control.

23 34 23 – HVAC POWER VENTILATORS

A. Provide fan coatings and/or explosion-proof motors as required for service.

B. Install drip pans below power roof ventilators which do not have ductwork connected.

23 36 00 – AIR TERMINAL UNITS

A. The selection of air terminal units has great impact on the acceptability of the design.
1) The units should be pressure independent in operation.

2) The units must be acceptably quiet in operation.

3) Flow sensor air test hose shall be provided with factory installed brass plugs. Plastic and caps shall not be acceptable.

23 37 00 – AIR INLETS AND OUTLETS

A. Perforated air supply diffusers shall not be allowed.

23 40 00 – HVAC AIR CLEANING DEVICES

A. The filtration system should provide a good habitable environment for the average person in a reasonably cost-effective manner when projected for the life of the system.

B. Low ventilation rates of VAV systems tend to concentrate contaminants and should be addressed.

23 50 00 – CENTRAL HEATING EQUIPMENT

23 54 00 – FURNACES

A. Furnaces will not be installed except in special cases approved by the Owner’s Representative.

B. Duct furnaces will only be installed in special cases approved by the Owner’s Representative.

23 57 00 – HEAT EXCHANGERS FOR HVAC

A. Unit Heater

1) The preferred unit heater will be steam. Gas or electric units will only be approved in cases where steam or hot water is unavailable.

B. Provide check valve vacuum breakers on the shell of steam-to-water heat exchangers to assure free condensate drainage when control valve closes.

C. Plate type steam-to-water heat exchangers shall not be used.

D. Plate Frame Heat Exchangers: Contact Owner to determine if a spare set of gaskets are to be provided. Acceptable Manufacturers: Alfa Laval, Tranter, WCR. Plate shall be 304 stainless 0.5 mm thick with clip on gaskets.

23 60 00 – CENTRAL COOLING EQUIPMENT

23 61 00 – REFRIGERATION COMPRESSORS

A. Compressors shall be equipped with some type of capacity control, (unloaders, variable speed, step control, etc.) when their normal capacity is 5 tons or more.
B. All compressors which are placed outdoors should be equipped with crankcase heaters.

C. All compressors are to have the normal safety controls:
   1) A combination high and low pressure cutout.
   2) An oil failure switch.

D. See ASHRAE-IESNA 90.1, codified version, for minimum efficiencies.

23 63 00 – CONDENSING UNITS

A. Condensing units shall not be installed except in special cases, approved by the Owner’s Representative.

B. All condensing units which are located outdoors shall be provided with the following equipment:
   1) Head pressure stabilization control, either through condenser fan control or a head pressure control valve.
   2) Heat tape on the condenser receiver.
   3) A compressor crankcase heater.

C. Compressors in condensing units shall comply with the guidelines in Section 15655 Refrigeration Compressors.

D. Unit must be capable of using a condenser air fan motor speed control device for head pressure control. Unit must also have provisions for low ambient starting, when the low pressure switch is connected at the liquid line service valve port.

E. See ASHRAE/IESNA 90.1, codified version, for minimum efficiencies.

F. Air-cooled condensers shall have some type of head pressure stabilization control either through condenser fan control or a head pressure control valve.

G. All condenser coils shall be easily accessible for cleaning.

H. All outside condenser coils must have a hail guard.

I. Water flow shall be controlled by discharge temperature with an automatic valve.

J. When there are multiple water cooled condensers that would normally use city water, the preference is to recirculate condenser water through a chilled water-to-condenser water heat exchanger to avoid wasting water.

K. Domestic water cooled condensers are not allowed.

23 64 00 – WATER CHILLERS
A. All water chillers shall be equipped with freeze protection on the evaporator heat exchanger.

B. Refer to Section 15655 Refrigeration Compressors and Section 15740 Condensers for other applicable guidelines.

C. See ASHRAE/IESNA 90.1, codified version, for minimum efficiencies.

D. Specify a minimum of 2-year warranty for chillers. Consultant shall contact major vendors to discuss extended warranty options and review with UNI for inclusion into the specifications.

E. Specify lifting eyes on headers to accommodate removal.

F. Specify lifting beam above chiller at both ends for head removal.

G. Specify spool pieces on piping to accommodate head removal at both ends of chiller.

H. Specify appropriate clear space to accommodate re-tubing of unit.

23 65 00 – COOLING TOWERS

A. Do not use indoor cooling towers.

B. Ceramic towers preferred.

C. Towers shall not be installed on roofs.

D. Provide condenser water treatment.

23 72 00 – AIR TO AIR ENERGY RECOVERY EQUIPMENT

A. The use of energy recovery units is encouraged, providing the economics are based on acceptable payback.

1) The designer must exercise special care if these items are adapted to laboratory air exhaust streams. The maintenance of such a system may not be possible.

23 73 00 – INDOOR CENTRAL -STATION AIR-HANDLING UNITS

A. Provide space at air handling units to allow coil and fan shaft replacement without major building revision.

B. Provide space at air handling units for filter replacement.

C. HVAC units requiring large amounts of outside air shall include preheat coil per OA prior to mixing with return air. Use steam distribution, “non-freeze”, heating coils with 1” tubes, wing or control air vertical tube coils for preheat.

D. Install ½” ball valves with ¾” hose connection on supply and return piping at coils to allow venting and drainage.
E. Provide a light (interior) at all AHU with interior mounted motors. Light should be a weatherproof type.

F. Variable frequency drives are the preferred equipment for volume control.

G. Coil drying connections are required. See appendix.

23 80 00 – DECENTRALIZED HVAC EQUIPMENT

23 81 00 – DECENTRALIZED UNITARY HVAC EQUIPMENT

A. Consult Owner regarding use.

23 82 00 – CONVECTION HEATING AND COOLING UNITS

23 82 16 – AIR COILS

A. Chilled water coils for air handlers shall have minimum 0.035” copper tube with minimum 0.049” bends and shall have aluminum fins. Must be certified to ARI Standard 410.

B. Cooling coils using raw well water shall have minimum 0.049” copper tube with removable heads and shall have aluminum fins.

C. Integral drain pans and center supports shall be provided according to good construction techniques and application of coil.

1) Standard design shall be 45ºF EWT, 55ºF LWT, chilled water.

D. Water fan coil units shall have 0.016 copper tube and aluminum fins.

E. Steam and hot water coils for air handlers shall have 0.035” tube thickness.

1) Non-freeze type coils shall have 1” tube diameter and wall thickness of 0.035”.

F. All water coils should be provided with integral ½” minimum vent and drain connections, and they shall be extended to the outside of the housing and valved.

G. Cooling coils shall not exhibit condensate carry over. Preferred cooling coil face velocity is 500 FPM or less.

H. The maximum number of rows for any single coil shall be 6. Install coils in series if more rows are required. Provide space between coils to allow for coil repair and cleaning.

I. Provide space to remove coils.

J. Provide access panels to inspect coils.

23 83 00 – RADIANT HEATING UNITS
A. Steam and hot water unit heaters, convectors, and finned tube radiation shall meet the following guidelines.

1) Coils in all units are to be easily accessible for cleaning and removal.

2) All units should have individual automatic control.

3) Provide shut off valves on both sides so that all parts can be repaired or replaced.

B. Use electric heating only where no other means is available.

23 84 00 – HUMIDITY CONTROL EQUIPMENT

A. In general, use steam grid dry bar type humidifiers with jacketed manifolds.

B. Building steam supply shall not be directly injected into airstream. Provide steam-to-steam exchanger type packaged humidifiers, or a steam fired steam boiler serving grid type humidifiers. Omit manufacturer control package. Control humidifier with BAS.

C. Install humidifier at proper location in air system. Verify that design conditions of air at humidifier mounting point will allow humidifier to work properly.