DIVISION 17

ENERGY MANAGEMENT SYSTEMS

SECTION 17920: CAMPUS ENERGY MANAGEMENT SYSTEM

PART-I GENERAL

1.01 SCOPE

A. This section contains design guidelines pertaining to direct digital controls to be incorporated in new buildings as expansions of the existing Campus Energy Management System.

B. The Campus Energy Management System (EMS) is composed of direct digital controls (DDC) at buildings throughout the campus which communicate with an existing head end computer local area network (LAN) located at the Fackler Co-Generation Plant. In addition to minimizing equipment energy use, the system is also used to report malfunctions of critical equipment via alarms to the Physical Plant Watch Stander at the Co-Generation Plant.

1.02 RELATED GUIDELINES

A. See Parts 1, 2 , & 3 of these standards for general information regarding design process, building requirements, and site requirements.

B. See Section 15010 for general mechanical design guidelines applicable to this section of the work. (The general guidelines in Section 15010 General Mechanical Requirements shall apply to design work for Section 17920 also)

C. See Section15500 for guidelines pertaining to building HVAC systems.

D. See Section 15920 for guidelines pertaining to stand alone local controls.

E. See Division 16 for guidelines pertaining to Basic Electrical Materials and Methods.

F. See Division 16 for guidelines pertaining to Fire Alarm Systems and Smoke Detection.

1.03 SYSTEM COMPATIBILITY

A. All new DDC controllers shall be capable of communicating with the existing campus front end LAN which uses the Honeywell XBS platform. For compatibility with the existing front end, all new DDC controllers shall be from the Honeywell Excel 5000 family.

B. The campus has standardized around the following (2) controllers from the Honeywell Excel 5000 family: Excel 500 and Excel 10. Excel 500 panels shall be used for all DDC applications except for local temperature zone control which shall be Excel 10. (This is current as of 6-10-98. The design professional should re-confirm the DDC panels to be used for each project with the University's Representative due to the rapid evolution of DDC technology.)

C. To assure system compatibility , EMS controls must necessarily be bid with a proprietary specification. However, the campus wishes to encourage competitive bidding within limits that will assure a fully compatible EMS. To this end, UCSC has developed a guide specification for building DDC controls which is proprietary for DDC hardware yet open to competitive bidding of installation by qualified contractors. (Honeywell Minneapolis has approved various contractors to install the Excel 5000 family of DDC controls in addition to the local Honeywell Branch. These contractor are designated by Honeywell Minneapolis as ACS contractors) While UCSC 's guide specification is for DDC hardware, it is open for competitive bidding of the installation by both the Honeywell Branch and the ACS contractors.

D. The EMS for each building shall be broken out from the building stand alone local controls and bid under specification Section 17920 separate from Division 15. The separate specification section is preferred in order that the EMS installation be performed by a listed first tier subcontractor thus providing the University with more contractual control. This also assures that proprietary EMS vendors will not have an undue advantage in bidding portions of Division 15 work.

E. To assure fair competitive bidding, the Design Professional shall carefully review the plans and specifications to assure that the scope of the EMS work is completely called out. As a minimum:

1. There shall be no contractual ambiguity as to the required number and type (analog in, analog out, digital In, digital out) of input / output points required for each DDC panel.

2. There shall be no contractual ambiguity as to the location of DDC panels. DDC panel locations shall be indicated on the contract drawings.

3. There shall be no contractual ambiguity as to the required sequences of operation for each piece of DDC controlled equipment.

4. There shall be no contractual ambiguity as to relative location of EMS sensors and output control devices in the various systems (air handler, chilled water, etc.) Provide a typical control diagram for each type of system to be controlled by EMS.

5. There shall be no contractual ambiguity as to approximate location of EMS space temperature sensors. Indicate approximate location for each EMS space temperature sensor on the Mechanical floor plans.

1.04 BUILDING EQUIPMENT TO BE CONTROLLED & MONITORED BY EMS

A. All major energy consuming equipment permanently installed in buildings shall be controlled and monitored by the Campus Energy Management System. (Note that this is a mitigation measure called out in the EIR to the campus Long Range Development Plan.

B. Equipment controlled and monitored by the Energy Management System shall include:

1. Outdoor Lighting

2. Electric Meter Monitoring

3. Switching & monitoring of building main electric breaker to allow for emergency load shedding of non-essential building loads. (Confirm with the University's Representative, for specific projects.)

4. Air Handlers

5. Exhaust Fans on time of day schedule (i.e. not controlled by local thermostat)

6. Chilled Water Plants

7. Heating Water Plants

8. Campus district heating and cooling water system primary / secondary pumping interfaces at buildings.

9. *Package HVAC Equipment*

10. *HVAC zone controls (Confirm application with the University's Representative, for specific projects)*

C. *Stand Alone Local Controls: Stand alone local controls are preferred where control (or monitoring) by EMS would add little benefit in terms of decreased energy use or useful malfunction alarms. Confirm equipment to be controlled with stand alone controls with the University's Representative for specific project applications. Stand alone controls shall be bid under a separate division 15 specification section. Equipment typically falling into this category includes:*

1. *Zone controls for space heating hot water convectors.*

2. *Manual timers for art studio ventilation systems.*

D. *Supervisory EMS Control: EMS control of equipment commonly furnished with its own internal controls is typically limited to start/stop supervisory control. (Confirm with the University's Representative for specific projects.)*
Equipment falling into this category typically includes:

1. *Packaged air conditioning systems with self contained controls.*

2. *Individual boilers.*

3. *Individual chillers.*

1.05 BUILDING SYSTEMS TO BE INDEPENDENT OF EMS CONTROL & MONITORING

A. *Fire Alarm System: Building fire alarm systems shall be independent from the EMS and furnished under Division 16 to assure compatibility with the existing campus fire alarm system. Per Campus Standards the building EMS does not normally need to interface with the building fire alarm system.*

B. *Duct Smoke Detectors: Duct smoke detectors for code required fan shut down (HVAC systems supplying 2,000 CFM or greater) shall be furnished under division 16 to assure compatibility with the campus fire alarm system. Fan shut down shall be via hardwire interlock with the fan motor controls. Per campus standards the building EMS does not normally need to interface with the duct smoke detectors.*

C. *Smoke Dampers: Smoke dampers shall typically be activated by duct or local smoke detector as required by code. Duct or local smoke detectors for smoke dampers shall be furnished under division 16 to assure compatibility with the campus fire alarm system. Per campus standards the building EMS does not normally need to interface with the duct smoke detectors.*

1.06 BASIC EMS DESIGN CONSIDERATIONS

A. *Panel Locations: EMS panels (Excel 500) should be under cover and centrally located relative to controlled equipment. EMS panels shall be protected from pipe leakage, dust, and other hazards and shall have a minimum 30" working clearance in front of each panel . EMS panel may be located in either mechanical or electrical rooms with proper space coordination. A location close to the motor control center is often desirable. EMS panels shall not be located in*

Communications Rooms. Consider multiple EMS panels when controlled equipment is separated by long distances.

B. *Emergency Power to Panels: EMS panels shall be powered by dedicated emergency power circuits. Coordinate with Division 16 designers. (Exceptions: 1. Zone level Excel 10 controllers, 2. Excel 500 panels in buildings without emergency power; verify with the University's Representative)*

C. *Local Zone Controller Locations: Zone controllers (Excel 10) controlling VAV boxes and Terminal Heating /Cooling coils etc. may be located in the ceiling space adjacent to the controlled device. Care shall be taken to assure service space in front of the controller. This is particularly critical in situation where the ceiling space is shared with a cable tray. In such cases the relative location of various elements sharing the ceiling space and required clearances should be called in a typical detail on the contract documents.*

D. *HOA Switches at Motor Starters: EMS controlled motors (fans, pumps, etc.) shall be provided with magnetic motor starters with HAND-OFF-AUTO switches. (Coordinate with Division 16 designers.)*

E. *Interface Relays: EMS output points shall not be used for direct switching of motor control circuits. Provide an interface relay with 24 VAC coil at the motor starter panel.*

F. *Status Monitoring: Electric current sensor switches shall be used for EMS status monitoring of pumps and fans (as opposed to differential pressure switches or flow switches.) These shall be located in the motor starter panel.*

G. *Equipment Interlocks: To interlock equipment that must run concurrently (e.g. supply and return fans, air handler and corresponding toilet exhaust, small chiller and chilled water pump, etc.), use hardwire electrical interlock as opposed to software interlock through the EMS. EMS control points are expensive to install and maintain. Hardwire interlocks should be used when a complex sequence of operation is not required. (Exception: Large motors 25 horse power and above should be sequentially started)*

H. *EMS Panel Communication to Front End: All EMS panels shall communicate with the campus front end LAN at the Fackler Co-Generation Plant. Communication between EMS panels (Excel 500) and the campus front end LAN shall be accomplished via hardwire C-Bus connection (as opposed to dial up modem). The telecommunication network on campus is owned and operated by UCSC. This allows communication to be accomplished via hardwire dedicated pair over campus telecommunications cables. Section 17950 designers should extend the C-bus to the building telephone backboard and note the required number of telecommunication wire pairs to be reserved. (Coordinate with Division 16 designers). Campus personnel (CATS) are normally used to establish dedicated pair through the existing telecommunication network. (Coordinate with the University's Representative.) Repeaters should be provided for the C-Bus when the distance to the Co-Generation Plant exceeds 4,000 feet. C-Bus baud rate shall be 1Mbit, RS-485.*

I. *Front End Graphics: All pertinent information regarding equipment operation and alarms shall be mapped back to the campus front end LAN and displayed in graphical format. Required graphics should be coordinated with Physical Plant. Data from zone controllers and other minor equipment is typically restricted to avoid undue slowing of the communications bus.*

J. *Start-Up Testing (Commissioning): All EMS installations shall be commissioned as covered under start-up testing in the guide specification. In this testing, each control point and*

sequence of operation is verified for proper operation. The University Representative should verify that the Contractor has included EMS start-up testing in the construction schedule.

PART-2 GUIDE SPECIFICATION USE

2.01 SPECIFIC PROJECT USE

A. The Guide Specification (immediately following this Guideline) must be customized by the Design Professional for each specific project. In particular the following customization is necessary:

1. Provide a thorough written description of the EMS scope of work beginning with paragraph 1.1. B.1. (page 17920 - 1).

2. Provide a thorough written description of the sequence of operation for each piece of EMS controlled equipment under Part 4 of the specification. The DDC software necessary to accomplish a given sequence is a major portion of the EMS installation and may need to be custom . Control sequences should be covered in sufficient detail to assure no contractual ambiguity and should include the following: equipment start/stop control, equipment temperature control, equipment failure mode, and EMS alarms to the Physical Plant Watch Standee.

3. Verify that an accurate EMS I/O point count for each type of point is clearly called out within the contract documents either in diagrams on drawings or by filling out the EMS Points List chart at the end of the Guide Specification.

4. Delete hardware specifications not required for the specific project.

5. Review the specification to assure the hardware specifications are current and all field devices associated with each I/O point are specified. As previously noted this is a rapidly evolving industry. Inform the University's Representative of technology changes that may make the guide specification obsolete.

PART-3 APPLICATIONS

3.01 GENERAL

A. For some applications UCSC has standardized the I/O points and sequences of operation. The design professional may use these standardized EMS configuration where they apply. The design professional remains responsible for assuring that the standardized EMS configuration is compatible with the specific application. UCSC encourages feedback from design professionals regarding alternate methods of control for specific applications.

3.02 ELECTRIC METER MONITORING

A. Application: Monitoring of each Watt Hour Meter in the project.

B. EMS Control Points: (1) Digital input

C. Sequence of Operation:

The DDC controller shall receive the pulse contact closure from the Watt Hour meter for totalization of electrical energy usage and display of KW demand. The controller shall compute the KW demand of the building based on a 30 minute fixed window. The controller shall also

keep a running total of KWH energy usage which shall roll back to 000,000 with every 100,000 KWH of usage (similar to a car odometer.)

3.03 LARGE SINGLE ZONE AIR HANDLER

A. Application: Large constant volume single zone air handler serving an assembly space such as a lecture hall, recital hall, or theater. Air handler equipped with: supply fan, return fan, economizer cycle dampers, chilled water cooling coil, hot water heating coil.

B. EMS Control Points

1. Digital Outputs(DO):

a. Supply Fan Start / Stop

2. Digital Inputs (DI):

a. Supply Fan Electrical Current Switch

b. Return Fan Electrical Current Switch

c. Note: Air handler filter pressure differential switch is not necessary on UCSC projects.

3. Analog Outputs (AO):

a. Chilled Water Valve

b. Hot Water Valve

c. Economizer Dampers

4. Analog Inputs (AI):

a. Supply Air Temperature

b. Return Air Temperature

c. Mixed Air Temperature

5. Hardwire Interlocks

a. Return fan is hardwire interlocked to start with supply fan. (Provide separate EMS start/stop point for large return fans with motors 25 horse power and over for sequenced start with supply fan.)

C. Sequence of Operation

1. Start/Stop:

a. The supply fan in each air handler shall be started and stopped by the Excel 500 controller. The return fan in each air handler shall be hardwire interlocked to start and stop with its associated supply fan. (For large return fans with motors exceeding 25

horsepower, the return fan will be started by a separate EMS control point 15 seconds after the supply fan has been started.)

b. *Each air handler will be started and stopped based on either occupancy schedule, or by operator command through the C Bus. A separate seven day occupancy schedule shall be provided for each of the two air handlers. Each schedule shall accommodate multiple occupancy periods over the course of a single day. The occupancy schedule for each air handler shall be easily modified by operator through the C-Bus. Verify the initial occupancy schedules to be loaded into controller with the University's Representative.*

c. *Initial daily startup of each air handler will be by optimum start program for morning warm up. This program shall start the air handlers up to 3 hours prior to initial occupancy based on interior space temperature. The program will store into memory the actual rate of warm up for the interior space experienced each day. It will then use this information to optimize the warm up period so that the minimum warm up period is used based on actual space temperature. It shall also be possible for the operator to easily disable this program through the C-Bus if so desired.*

d. *When the each air handler is shut down the following will occur:*

1. *Outside air damper shall be driven to full closed. Exhaust and return air dampers shall be driven to the opposite position of the outside air damper (full open).*

2. *The heating valve shall be driven to full closed.*

3. *The chilled water valve shall be driven to full closed.*

2. *Temperature Control:*

a. *Through separate analog outputs, the Excel 500 controller shall sequence operation of each air handler,hot water valve, economizer dampers, and chilled water valve as required to maintain temperature set points as at a room air temperature sensor. The hot water valve, economizer dampers, and chilled water valve will each be provided with their own PID loops and shall be sequenced as follows:*

b. *At room temperatures of 70 (adjustable) and below the air handler will be in heating mode; the hot water valve will modulate to attempt to maintain a heating set point temperature of in the room 70 degrees (adjustable). The OSA damper will be at minimum position. The chilled water valve shall be full closed.*

c. *At room temperatures between 71 and 75 (adjustable), the air handler shall be in ventilation cooling mode. The economizer dampers shall be modulated to provide first stage cooling and attempt to maintain room temperature at a ventilation cooling set point of 72 degrees. The hot water valve and chilled water valve shall be full closed.*

d. *At room temperatures of 75 (adjustable) and above, the air handler will be in mechanical cooling mode; the chilled water valve will modulate to attempt to maintain a mechanical cooling set point temperature in the room of 75 degrees (adjustable). The economizer dampers will modulate as described below. The hot water valve shall be full closed.*

3. *The economizer dampers will be controlled by a single analog output point for each air handler and shall be used to accomplish first stage cooling. The actuators and linkages for the return and exhaust dampers will be set up to drive these dampers in the opposite direction from the direction the OSA damper is driven. The OSA damper will be driven to minimum position (20% open, adjustable); upon initial air handler start up, and when the air handler is in heating mode. When the air handler is in ventilation cooling mode or mechanical cooling mode, the economizer dampers will be modulated to attempt to maintain the ventilation cooling set point in the space. If return air temperature exceeds outdoor air temperature the outdoor air damper will be driven to minimum position.*

4. *Alarms will be generated and transmitted to the C bus under the following conditions;*

   a. *Fan Failure; No closure of the electrical current switch monitoring the fan motors when the air handler has been commanded to operate.*

   b. *Room Temperature Out of Range; Room temperature below 68 degrees (adjustable) or above 78 degrees (adjustable) when the air handler has been in operation for at least 30 minutes and the air handler is not operating in the optimum start up period.*

3.03 ZONE TEMPERATURE CONTROL, TERMINAL HEATING / COOLING COILS

A. *Application: Excel 10 zone temperature control for constant volume system with terminal heating / cooling coils. Excel 10 controllers in communication with front end LAN and other EMS controllers via E bus and interface to C-bus.*

B. *EMS Control Points*

1. *Digital Outputs(DO): None*

2. *Digital Inputs (DI): None*

3. *Analog Outputs (AO):*

   a. *Zone Chilled Water Valve*

   b. *Zone Heating Water Valve*

4. *Analog Inputs (AI):*

   a. *Zone space temperature*

C. *Sequence of Operation*

1. *The Excel 10 controller for each coil module shall modulate separate analog outputs controlling the zone chilled water coil control valve and the zone heating coil control valve to maintain setpoint at the zone temperature sensor. The controller shall be programmed with separate adjustable heating and cooling set points with a dead band in between. A separate PID loop will be provided for each valve. Initially the heating set point will be set at 70 degrees (adjustable) and the cooling set point will be set at 76 degrees (adjustable) . The controller will receive notification via the E-bus that the associated air handler is in operation. When the air handler is in operation the valves will modulate as indicated above. When the air handler is not in operation, both valves will be driven to full closed.*

SYSTEM(S) / POINT DESCRIPTION		XL 500 POINTS (Panel in Rm L111)										INTERLOCKED POINTS	
		OUTPUTS				INPUTS							
		ANALOG		DIGITAL		ANALOG				DIGITAL			
HEAT EXCHANGER; HX-1, SECONDARY HOT WATER PUMPS; HWP-1, HWP-2, BTU METER, ELECTRIC METER (EXAMPLE)	Equipment Quantity	Valve Position	Subtotal, Analog Outputs	Start / Stop	Subtotal, Digital Outputs	Temp. Sensor, Well Mounted	Flow Rate (4-20ma)	Instantaneous BTUH (4-20ma)	Subtotal, Analog Inputs	Electrical Current Switch	Total BTU's (Totalizer) KWH Meter Pulse Contacts (Totalizer)	Subtotal, Digital Inputs	Provide Motor Controls Electrical Interlock to Operate with; Subtotal, Interlocked Points
HX-1	1												
PRIMARY HWR VALVE	1	X	1										
PRIMARY HWS TEMP.	1					X			1				
PRIMARY HWR TEMP.	1					X			1				
SECONDARY HWS TEMP.	1					X			1				
SECONDARY HWR TEMP.	1					X			1				
HWP-1	1			X	1					X		1	
HWP-2	1			X	1					X		1	
BTU Meter (Primary HW)	1						X	X	2		X	1	
Electric Meter	1										X	1	
SUBTOTAL (THIS PAGE)			1		2				6			4	

SECTION 17000

ENERGY MANAGEMENT SYSTEM

(MODIFY PARTS IN ITALIC AND BOLD)

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section covers Direct Digital Controls to be installed under this contract which will be incorporated into the existing campus Energy Management System (BMS).

B. Provide a complete Direct Digital Control (DDC) based BMS system which; enables lighting systems, monitors equipment and monitors environmental parameters as; specified herein, indicated on the Drawings, and indicated in the BMS Points List following this Section or indicated on the drawings. The Division 17500 contractor shall connect the system to the existing central control computer (CCC) by an ethernet connection. The existing CCC is Honeywell EBi, manufactured by Honeywell Incorporated. For compatibility with the existing system, DDC controllers shall be Honeywell XL5000 products as specified here-in. No substitutions shall be considered or accepted for these controllers.

C. Y2K Compliance:

1. All equipment, systems, devices and appurtenances shall be fully Year 2000 compliant, i.e., any parts, components, equipment, devices, systems, hardware, software, etc. shall not fail or malfunction as a result of the year 2000 changeover or any other date issues. This requirement applies as long as the equipment, system or device is in service, even if the specified warranty period has elapsed.

2. Each vendor, manufacturer, supplier, installer and contractor shall certify their conformance with this requirement on their shop drawings and submittals. Where the Bid Documents require the vendor, manufacturer, supplier, installer or contractor to submit a technical proposal as part of their bid, they shall certify conformance with this requirement in the technical proposal. Non-conforming equipment, systems, etc. are unacceptable. In the event that there is a failure or malfunction caused by the year 2000 changeover or other date issues, the vendor, manufacturer, supplier, installer and contractor shall be responsible for correcting the problem, with all costs including consequential costs, to be entirely borne by them.

D. The work of this section shall be performed by a first tier sub-contractor who reports directly to the Contractor.

1.02 SCOPE OF WORK

A. Provide new Excel controllers, all required DDC software, field control devices, field hardware, and associated control wiring for a fully complete and functional system. At a single point of connection for the project site extend the C-bus to the telephone/data punch down blocks in the telephone/data room, provide terminal block and land C-bus.

B. The system specified herein and indicated on the Drawings shall be fully integrated, and installed as a complete package. Components required to accomplish the specified sequence of operation shall be included to provide a fully operable system.

C. The DDC panel and software shall be configured to support networking to the existing CCC front end, which is located in the UCSC Central Heating Plant.

D. The work shall include but not necessarily be limited to the following:

1. Provide all necessary control components associated with each BMS input & output as required for a complete and fully functional BMS capable of performing the specified sequences of operation.

2. Provide control and interlock wiring including associated above and below grade raceways as specified and required for a complete and working BMS, except where specifically shown on electrical Drawings to be by Division 16, Electrical.

3. Provide DDC controllers including; panel devices, software necessary for the specified sequence of operation, enclosures, mounting hardware, control transformers, electrical connections to power panels, etc. as required for a complete and fully functional EMS.

4. Interbuilding network connections between building BMS panels.

5. All university XL5000 projects have been completed in CARE version 1.5d. Use Version 1.5d on this project. UCSC is a CARE license holder and will provide proof of licensure upon request.

6. Furnish automatic control valves and liquid sensing wells as required for a complete and working BMS for installation in piping under Division 15, Mechanical.

7. Provide damper motors, linkages, and mounting hardware as required to operate automatic dampers controlled by the BMS. Dampers provided under Division 15.

8. Prior to completion of programming Contractor to submit programming to Division 17500 contractor who will review program and provide guidance to ensure compliance with new EBI headend. Contractor to implement required changes to final software program.

1.03 RELATED WORK

A. Overall general requirements: Refer to Division 1, General Requirements.

B. General requirements for mechanical systems, refer to Section 15010, Basic Mechanical Requirements.

C. General requirements for electrical systems, refer to Section 16010, Basic Electrical Requirements.

D. Stand alone HVAC controls not controlled by the DDC controllers covered in this section, refer to 15950.

E. ***Requirements of Section 17500, Head End Connections.***

F. OTHER SECTIONS DETERMINED BY CONSULTANT,

1.04 QUALITY ASSURANCE

A. Responsibility:

1. The Contractor shall be responsible for the performance of quality assurance activities to assure conformance with the requirements specified.

2. Equipment shall be the product of established reputable manufacturers normally engaged in the production of the particular item being furnished.

3. The standard line of equipment of each manufacturer shall be furnished unless special construction or performance is necessary to comply with specifications.

4. Obsolete or used product lines or equipment will not be accepted.

5. Where one (1) or more of any specific items are necessary, all shall be of the same type and manufacturer.

B. Inspection: The University's Representative will make inspections and review records as necessary during fabrication and installation of components.

C. Requirements of regulatory agencies, codes and standards:

1. Standards: Comply with applicable provision of the following standards, latest editions, except as otherwise shown or specified.

ARI	Air Conditioning and Refrigeration Institute
ASHRAE 85	Automatic Control Terminology for Heating, Ventilating, Air Conditioning.
ASME MC85.1	Terminology for Automatic Control
FM	Factory Mutual Insurance Companies
IEEE	Institute of Electrical and Electronic Engineers local area networking standards and architectures (i.e., IEEE 802.3, IEEE 802.5).
IRA/FIA	Industrial Risk Insurers
ISA	Instrument Society of America
JIC	Joint Industrial Council
MSS	Manufacturer's Standardization Society of Valves and Fittings Industry
NEMA EMCI	Energy Management Systems Definitions
NSC	National Safety Council

1.05 SUBMITTALS

A. As per Division 1, the Contractor shall submit the following information on the installation firm, materials, components, test inspection procedures including:

1. Firm Qualifications and Submittal:

a) ***Written qualification of installing firm and personnel, including verification of registration as a Honeywell BCI or ACS Controls Specialist.***

2. Material Submittal:

a) For all BMS components and control devices provided under this section submit; Catalog cuts, technical specification data sheets, description of function, performance data, materials of construction, manufacturers installation instructions, wiring diagrams, etc. as required to show full compliance with contract requirements.

b) For all installation materials to be provided under this section including; panel enclosures, mounting hardware, wiring & raceways submit; Catalog cuts, technical specification data sheets, performance data, materials of construction, manufacturers installation instructions, etc. as required to show full compliance with contract requirements.

3. Shop Drawing Submittal including:

a) System architecture schematic showing DDC controllers, peripheral devices (batteries, power

supplies, relays etc.),controller locations, trunk and interconnecting cable layout including; cable type, conductor number, & wire size. Cable termination locations. Schematic drawing labeling of cables shall be consistent with installation labeling.

b) List of connected data points, including connected control unit input device, and actual terminal connections.

c) Schematic drawing of each building system to be controlled or monitored by the BMS including all EMS input & output devices; locations, device tags, manufacturers part numbers, wiring diagrams, associated I/O point descriptors. Provide a written sequence of operation on the schematic for each EMS controlled system.

d) DDC sensor locations and wiring diagrams.

e) Electrical relay locations and wiring diagrams.

f) Conduit and wiring type, locations used, compliance with electrical specifications, routing through buildings and underground through site.

g) Control panels; detailed internal wiring showing terminal strips for different voltages within panel, panel component list and layout, locations, enclosure and mounting and external component terminal connections.

h) DDC sensors and actuators, indicating their locations and detailed technical description.

i) Detailed floor plans of electrical wiring and routing, sensor and device locations, and major equipment. Coordinated references to the detail DDC panel Drawings shall be provided on floor plans.

j) Riser diagrams to depict conduit runs and wiring counts.

k) DDC actuated valve locations and wiring diagrams.

l) Electrical relay locations and wiring diagrams.

m) Damper actuator locations, wiring diagrams and required mounting & linkage hardware

n) Conduit and wiring type, locations used, compliance with electrical specifications, routing through buildings and underground through site.

o) Control valve schedule including; tag number, location, valve gpm, cv, size, material, manufacturer and model number.

4. Software Submittal including:

a) A written detailed sequence of operation for each system to be controlled or monitored by the EMS.

b) Plant diagrams for each system to be controlled.

c) ***Electronic copy and Hard copy print-out of the project program file for each controller, including all program logic.***

d) Detailed list of descriptors, action and alarm messages. Descriptors and messages shall follow the University's approved format including The University's assigned equipment labels. For compatibility with the existing CCC computer and to avoid conflicts with the other XL5000 series controllers connected to the CCC the first three characters of all of the controllers 18 digit technical addresses shall begin with:

Building Name xxx

Submittal shall indicate compliance with this convention.

e) *Not used.*

f) Programmer's Manual from the DDC panel manufacture covering the programming procedures for each DDC controller being provided.

g) Software submittal to be submitted a minimum 2 weeks prior to start of work by the BMS ***controls specialist***.

5. Commissioning and Start-up Submittal.

a) Acceptance Testing forms showing full compliance with calibration, continuity and hardware check-out requirements

b) System by system commissioning/start-up work-sheets prepared in accordance with SMCANA publication HVAC System Commissioning, First Edition as a template for software sequence testing.

1.06 QUALIFICATION OF PERSONNEL AND INSTALLING FIRMS

A. Detailed design, installation, & programming of the BMS shall be by a firm approved for installation of Honeywell Excel 5000

Systems by Honeywell Minneapolis, Inc. This is required to assure compatibility with the existing BMS and CCC.

B. ***Division 17 shall be performed by a Honeywell certified "BCI or ACS" controls specialists.***

C. Qualifications- The Division 17000 contractor shall have completed (**specify special requirments)** controls projects of similar size within the last five (5) years. The Division 17000 contractor shall provide project name, approximate dollar value of controls contract and reference telephone number(s).

D. Division 17000 work shall be performed by a first tier subcontractor working directly for the contractor.

1.07 OPERATION AND MAINTENANCE MANUALS

A. Six (6) copies of equipment operation and maintenance manuals shall be submitted to the University's Representative at least two (2) weeks prior to training and acceptance testing. These manuals shall contain instructions on the proper operation and maintenance of equipment and apparatus provided.

B. Each manual shall be prepared with an index sheet listing the contents in alphabetical order and shall contain the following material:

1. Operator's manual step-by-step operating procedures. This manual shall be indexed, and shall have a separate tabbed section for each operator functions.

2. Description of sequences of operations. A Plant diagram for each sequence of operation.

3. Manufacturer's equipment parts list of functional components of the system, control diagrams and wiring diagrams.

4. "As-built" interconnection wiring diagrams, or wire lists of the complete field installed system with complete, properly identified ordering number of each system component and device.

5. Instructions on how to connect hardware points, and define points in software.

6. Maintenance instructions for each type of equipment or device.

7. Complete list of all components, circuit boards, sensors, and relays. List shall include local supplier, supplier address and telephone number, detailed part number, approximate cost, and warranty.

8. Complete system schematics & documentation covering the function, operation, and maintenance of the entire system including:

   CPU boards
   CPU memory boards
   All I/O boards
   Field control panels
   Relays, solenoid valves, restrictors, etc.
   Layout drawings
   Parts list for each system controls
   Electronic and electric motors

9. Complete software program documentation including hard copy print out and diskette copies suitable for loading into DDC controllers. Software provided with the O&M submittal shall be the final version and include all field installed modifications.

1.08 COMMISSIONING AND ACCEPTANCE TESTING DOCUMENTATION

A. Acceptance testing documentation shall include the following minimum information:

1. A complete document containing the University's Representative reviewed and signed start-up testing procedures organized by system name and type. Acceptance testing documentation shall contain the following sections at a minimum.

   a) List of instruments used in the testing, including date of calibration.

   b) Field verification of all hardware points including point address, point name, point type, point to point continuity test results and sensor offsets.

   c) Sequence of operation description for each control loop, in the controller(s). Use SMACNA publication titled HVAC System Commissioning, First Edition as a template for this part of the acceptance test documentation, see also Exhibit 1.

EXHIBIT 1 Sample Acceptance Test Documentation to be prepared by the controls specialist.
SECTION 1--Hardware

Specification section reference [*A1]Item 3.05 Item 3.06[*A1] Item 3.07[*A1]

Point number	Point type	Terminal	Descriptor	Equip. id tag	Calibration			Continuity	Contractor sign off
					Initial	Final	Offset		
xxx-xxx	Analog input		Boiler temperature	TS-01					
	Or		Or						
xxx-xxx	Analog output		HW valve	V-01					
	Or		Or						
xxx-xxx	Digital output		Boiler stop-start	BR-01 (place on remote relay)					
	Or								
xxx-xxx	Digital input		HW pump status	HWPSt (place on remote CT)					

Complete this list of hardware points, calibrate all sensors and devices, install all tags then submit to University as Submittal 17.1.

Tools Used: Contractor to list tools used for calibration including the date the test instrument last calibrated

Example:			
	Fluke DMM-80	voltmeter	calibrated new 1/1/99
	Fluke DMM-80	temperature probe	calibrated new 1/1/99
	Dwyer	micro-manometer	calibrated 2/2/00

ECTION II—Trending

ystem trends: Once EMS is installed trend all systems controlled per specification item 3.08.G.3 and include in ompleted testing documentation per specification item 3.08.A and 3.08.B.

t shall be the Division 17500 contractor's responsibility to connect the building system to the CCC for the purpose of rend generation on the CCC. If the Division 17000 controls specialist chooses they can provide a local XBS workstation t the building for purpose of trend data collection.

ECTION III—Software testing

se SMCANA publication HVAC System Commissioning, First Edition as a template for software sequence testing.

d) Sequence of operation verification results.

e) Trend data refer to 3.08.G.3

1.09 AS-BUILT DDC PANEL SOFTWARE DOCUMENTATION

A. Following acceptance testing, resubmit the following if changes have occurred.

1. Software program documentation including; hard copy print out, and diskette copies suitable for loading into DDC controllers.

PART 2 – PRODUCTS

2.01 DDC CONTROL PANELS

A. DDC Control Panels for shall be Honeywell Excel 500 where shown on the plans and shall include the following;

1. Provide with all required power, input, output and communications modules as required by schematic drawings and sequence of operation. Panel shall be NEMA 1 enclosed type provided specifically for the XL500 controller. Panel shall be constructed of stamped and coated steel and shall be provided with a locking hinged door. Two keys shall be provided to the University's Representative for each panel. Modules shall be as follows (but not limited to):

a) XP502 Power Supply Module

b) XC5010C CPU module with built-in e-bus connection

c) XD508 C-bus module

d) Analog input module; XF521A

e) Digital input module; DF523A

f) Analog output module; XF522A with 5 manual over-ride switches.

g) Digital output module; XF 524A with 5 manual over-ride switches.

Other Standard Parts:

g) Uninterruptable Power Supply (UPS): Honeywell part 14507420, Best Electronics Inc. or equal, 300 VA capacity.

h) UPS interface cable: Honeywell part 14507416 or equal to fit connection on XP502 module.

i) XI 582 AH Portable Operators Interface.

2. All points in the controller shall be wired out to external wiring terminals. All housings and components shall be mounted inside larger overall cabinets specifically made for Honeywell Excel 500.

3. External over-ride switches for digital outputs not included on the XF524A shall be provided for using an additional XF524A module in lieu of external override switches.

4. Miscellaneous panel components and hardware as required for a fully complete and fully functional panel including; power disconnect switches, control transformer, terminal strips, raceways (Panduit or equal), etc.

5. Each panel shall be provided with a duplex 120 volt convenience outlet inside the panel.

6. Each panel shall be equipped with a line voltage switch and fuses which will shut down and isolate the 120 volt power to all transformers, power supplies, and receptacles with in the panel.

7. Control transformers within panels shall be individually fused. Fuses shall be readily accessible and mounted in blocks fastened to the enclosure.

8. These DDC panels shall receive control power only from dedicated circuits originating at emergency power panels.

9. Each panel shall be provided with a door switch that is connected to and programmed as a digital input and alarm point indicating that the panel door has been opened.

B. **Where not specifically called out on the plans DDC panels and distributed controllers shall be XL5000 series controllers and devices and shall be directly connected to the XL500 system architecture through the E-bus and zone manager or C-bus connection. The elements not specifically called out shall be shown on the shop drawings and in the material submittal.**

2.02 EMS FIELD DEVICE PANELS

A. Field devices, transducers, relays, switches, sensors, etc., for equipment located within equipment rooms and on or in roof & grade mounted equipment shall be mounted in enclosed steel enclosures with hinged locking doors. Control devices for equipment located in exposed areas subject to outside weather conditions shall be rated for such conditions or if not

manufactured with rated enclosures shall be installed in waterproof enclosures. Location of each panel shall be convenient for adjustment service. Nameplates shall be provided beneath each panel-mounted control device describing function of the device.

B. Devices within panels shall be wired with a terminal numbering system consistent with shop drawings and coordinated throughout the installation, each terminal shall be uniquely identified and are labeled.

C. Electrical devices within panel shall be pre-wired to terminal strips with inter-device wiring within the panel completed prior to installation of the system. Terminal blocks shall be numbered.

2.03 EMS CONTROL WIRING

A. The Contractor shall provide the following:

1. Low and line voltage control wiring not indicated on Electrical Drawings or specifically excluded below as required for a complete and fully functional control system including wiring for field devices, data bus wiring, interlock wiring for fans, air handling units and other equipment, control power source to EMS panels and field devices.

2. All wiring shall be run in raceways.

3. All wiring and raceways shall conform to the requirements of Division 16.

4. No splices will be allowed except at junction boxes and control centers.

5. No two (2) wires of the same color shall be in one (1) conduit, unless all wires of the same color are tagged at both ends and at any splice points.

6. Wiring (as recommended by manufacturer). Provide a consistent color scheme throughout the installed system; therefore, alternate colors will be accepted, provided there is consistency in the system. Shielding of cables, not specifically called out below shall be in accordance with manufacturers recommendations and as determined by site conditions:

a) Data Communications (C-bus) Cabling between DDC panels and main telephone backboard shall be 18 AWG, TFN insulation, twisted pair with pvc jacket. Shielded cables shall be when cables are run outside a building or in areas with potential for electrical noise. Honeywell #AK3702, Carol, Belden, or equal.

b) Cabling between the DDC panels and Load relays (digital outputs) shall be 18AWG, TFN insulation, twisted pair, color to be black/blue for switching 0-40 VDC, #16 or #14 AWG, TFN twisted pair, color to be black/white for switching 24 VAC. Honeywell AK3712W, Honeywell AK3702BB, Carol, Belden, or equal.

c) Cabling between the DDC panels and digital inputs shall be 18AWG, TFN insulation, twisted pair, color to be black/red Honeywell AK3702BR, Carol, Belden, or equal.

d) Cabling between the DDC panels and analog input sensors shall be 18AWG, TFN insulation, twisted pair, color to be yellow/red or 18 AWG, TFN insulation, twisted triplet, color to be yellow/blue/red. Honeywell AK3702R, Honeywell AK3703R, Carol, Belden, or equal.

e) Cabling between the DDC panels and analog output devices shall be 18AWG, TFN insulation, twisted pair, color to be yellow/purple. Honeywell AK3702R, Carol, Belden, or equal.

f) For motor controls wiring within starter panels, and electrical hardwire interlocks to remote devices, refer to Division 16, Electrical.

g) Data communications (E-Bus) cabling between E-bus devices shall be 22 AWG, solid cooper, 1 or 2 twisted pairs with pvc jacket, Honeywell AK3781 or Ak3782, Belden, carol or equal.

2.04 EMS INPUT POINT FIELD DEVICES:

A. TEMPERATURE SENSORS (EXCEL 500); Temperature sensors for Excel 500 controllers shall be as follows;

1. Interior space temperature sensors shall be 20 K negative temperature coefficient with blank cover, occupied and unoccupied button and LED, Honeywell T7770, Precon ST-S42A, or equal

2. Outdoor air and duct temperature sensors shall be 20 K negative temperature coefficient with 9” stainless steel probe mounted on weather proof handi-box, Honeywell 7031-F, Precon ST-A42-XH, or equal.

3. Immersion sensors for use in piping systems shall be 20 K negative temperature coefficient with 5” nominal stainless steel probe, 1/2” NTP brass thermo-well, and weather proof handi-box, Honeywell C7031-D, Precon ST-W42-XH, or equal.

4. Averaging sensors for use in supply air, return air, exhaust air, mixed air and slab sensing applications shall be negative temperature coefficient for use with XF521A, analog input module and other I/O devices. Sensor shall be provided with sampling tube and junction box for connection to controller, Honeywell ***71xx*** or equal.

B. COMMAND RELAY--CURRENT SWITCH; Current transformer current switches and command relays used to remotely start and sense status of electric motors shall be; solid state, self powered, with NO/NC contacts and adjustable amp set point, rated for the intended load. The device shall be mounted in the motor starter enclosure, Hawkeye H-608 or equal. Field adjust amp set point to detect motor operation. For belt driven motors, field adjust amp set point to detect the difference between motor operation with and without fan belt installed. Combination relay-CT will be acceptable only if the panel power supply is protected as described in paragraph 2.05.A.1.

2.05 EMS OUTPUT POINT FIELD DEVICES

A. OUTPUT ISOLATION RELAYS:

1. DDC panel outputs shall not be used for directly switching motor starter control power, or voltages greater than 24 volts. Digital inputs and outputs controlling these types of points shall only switch local 24 VAC, within the panel. The intent is to protect the panels Power Supply or I/O terminals, depending upon the controller used, from damage by accidental contact with higher voltages in the field. All such outputs shall be protected by two isolation relays and one independent low voltage power supply mounted remotely from the DDC panel. For motors, isolation relays and the independent power supply shall be mounted in an auxiliary panel adjacent to the DDC panel. The independent relay power supply will be provided and will either switch another low voltage relay within the starter enclosure for the motor being controlled or will switch the motor itself.

2. Output isolation relays shall be plug-in type; double pole (minimum), double throw with; base, indicator light, 24 volt coil, and 10 amp rated contacts. UL Recognized. (IDEC RH Series or equal)

B. CONTROL VALVES (EXCEL 500) Control valves shall be electronic actuated globe type as follows;

1. GLOBE CONTROL VALVES;

a) Modulating straight-through control valves shall be provided with equal-percentage contoured throttling plugs. Three-way valves shall be

provided with linear throttling plugs such that the total flow through the valve shall remain constant regardless of the valve's position. Valves shall be 3-way or 2-way as indicated on drawings.

b) Valves three (3") inches and smaller shall be screwed type, valves four (4") inches and larger shall be flanged. Valves shall be factory-rated to withstand working pressures per the requirements of ANSI Class 150 for screwed valves, and ANSI Class 125 for flanged valves. Valves shall have stainless-steel stems and spring loaded Teflon packing. Valves shall have replaceable seats and discs.

c) Valve Cv shall be selected to provide a pressure drop equal to the water pressure drop through the coil being served.

d) Actuators shall be fully compatible with the valve and Excel 500 controller and accept a 2-10 volt DC control signal. Cooling valve actuators shall be provided with spring return to close the valve on loss of signal.

e) Two way valves and actuators shall be selected to provide full shut off against the shut off head of the system pump.

f) Manufactures and models shall be:

1) Two-way Valve; Honeywell V5011 with ML Actuator, **Spartan PD V131/V411 with ME Series actuator,**(or equal)

2) Three-way Valve; Honeywell V5013 with ML Actuator, **Spartan PD V345/V411/V431 with ME Series actuator,**(or equal)

3) Actuators to be installed outdoor or in locations subject to damage by moisture shall be **Spartan PD ME-L actuator/linkage with weather resistant housings,** Honeywell M series Modutrol IV motors (or equal) provided with NEMA 3 housings.

g) Manufactures shall be;

1) Two-way Valve; Delta Controls Products, (or equal).

2) Three-way Valve; Delta Controls Products, (or equal).

C. DAMPER ACTUATORS; Damper actuators shall be fully modulating, accept a 2-10 V DC control signal, and be fully compatible with the Excel 5000 series controller(s). Damper actuators shall be spring return. Damper actuators shall be selected with sufficient torque to drive dampers through their entire range of motion without stalling against a pressure equal to 1.5 times the design static pressure of associated air handler's supply fan. Damper actuators shall be provided with all mounting and linkages hardware as required to stroke dampers through entire range with no observed binding and as required to securely mount the actuator. Actuator housing shall be NEMA 3 rated or actuator may be mounted inside an outer NEMA 3R equivalent enclosure provided by the actuator manufacture. Damper actuators may either be linkage coupled or direct coupled. Damper actuators shall be; Belimo, Honeywell Series ML or M series like actuators for valves except rotary, or equal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Comply with State of California Code requirements. In case of conflict between the Contract Documents and governing Code, the higher standard shall prevail. Extra payment will not be allowed for work required by Code and enforcement authorities.

B. Location and Access: Observe good practice in locating and installing equipment and accessories. Maintain adequate clearances to valves and equipment so as to permit ready access to parts requiring adjustments, inspection, service and repair. Installation of any equipment with less than minimum clearances indicated by manufacturer or as required by Code or for proper maintenance will not be accepted by the University's Representative.

C. Connections: Indicated equipment connections are based on equipment of a given manufacturer. The Contractor shall assume responsibility to proper arrangement of pipes, valves and power connection to equipment in a proper and approved manner.

D. Follow equipment manufacturer's detailed instructions and recommendations in the installation and connection of equipment. No equipment installation and connections shall be made in a manner that voids the manufacturer's warranty.

3.02 FASTENING TO BUILDING STRUCTURES

A. Fastenings, supports, hangers, clamps and anchors shall be of the type made for the specific purpose for which they are to be used. Wiring shall be rigidly and firmly installed to prevent swaying, vibration or sagging.

B. The equipment shall be fastened to the floor or building structure in accordance with good practice, however, the methods of attaching or fastening equipment supports or hangers to the building structure shall be subject to review by the University's Representative.

C. Electrical and mechanical instrument equipment mounted against the interior surface of exterior walls shall be mounted at least one (1") inch away from the wall surface.

D. Equipment shall not be attached to or supported from the roof deck, from removable or knockout panels, temporary walls or partitions.

E. Electrical and mechanical instrument equipment mounted against interior walls situated in damp or wet locations or adjacent to liquid piping shall be installed at least one half (1/2") inch away from the interior surface.

F. Mounting locations of wall mounted sensors in the occupied space shall be approved by the University's Representative. In cases where a sensor is indicated as being mounted on a wall which will receive a special finish (i.e. wainscot, wallpaper, bulletin board, chalkboard, shelving, etc.), the University's Representative shall be notified of the condition prior to installation.

3.03 DDC CONTROL SEQUENCES

A. The sequences of operation called out in this section shall be accomplished by software logic built into the DDC controllers. The use of field devices (pneumatic receiver controllers, reset pneumatic thermostats, separate electronic controllers, relay interlock logic, etc.) to accomplish the specified sequences of operation shall not be allowed except where specifically indicated.

3.04 WIRING INSTALLATION AND TERMINATION

A. Installation of conduit, wire, sleeves, outlet boxes, insulating bushings, system cabinets, terminal boxes, pull boxes, junction boxes, inserts, anchors, system devices, etc., shall be in accordance with the appropriate requirements of Division 16, Electrical.

B. Installation of sensor wiring in finished areas shall be concealed. Where concealed wiring is not possible, written approval from the University's Representative for exposed in suitable raceway work shall be obtained prior to installation.

C. Termination: Wires shall be attached to screw terminals with non-insulated ring lug connectors except that spade lugs may be used on terminals with captive screws. Lugs shall be installed by the use of a Mil Spec. crimping tool specifically designed by the manufacturer for use with the lugs being installed.

D. Wiring within DDC and remote panels shall be executed as follows;

1. All wiring shall be landed on labeled terminal strips with screw down lugs. Separate terminals strips shall be provided for line voltage connections, analog input, digital inputs, analog outputs, and digital outputs.

2. All wiring within panels shall be neatly run at right angles to the enclosure sides. Wiring shall be routed so as not to pass in front of panel components. Low voltage wiring inside the panels shall be run inside plastic raceways (Panduit or equal).

3. Individual control wire conductors pairs shall be labeled on the insulation jacket for the pair at a point near the terminal strip termination. The labeling scheme shall be the same as used at the field devices.

4. Spare conductors pairs shall be labeled as spare and to what location they are run. Spare conductors shall be neatly coiled inside the panel.

E. Low voltage connections to temperature sensors with extended leads shall be soldered and covered with heat shrink insulation. Leads shall be fully extended per manufacturer’s directions.

3.05 IDENTIFICATION

A. Mounting and control devices shall have identification means attached to or painted on the front or most visible surface.

B. Nameplates and instrument tags shall be permanently attached to the field equipment. Tags wired or chained to the instrument are not acceptable for items inside of control panels. Nameplates or tags shall be visible from the walkway or access point nearest the instrument when the instrument is in its installed configuration. Nameplates on the interior of a panel shall be placed near the instrument and shall not be obscured by the instrument or panel wiring. The nameplates on the inside or outside of panels shall be attached to the panel by self-tapping screws.

C. Labels and label material for devices shall be submitted to the University's Representative for approval. This shall include but not be limited to:

1. Devices- milled laminate plates secured with epoxy cement.

2. Abbreviated words and numerals shall identify the system controlled, the function and the designator which appears on the control diagram which is furnished by the control manufacturer and framed under glass.

3. DDC input-output points shall be identified with a unique input/output address of the device.

D. Provide one inch by two-inch (1-inch x 2-inch) brass tags on valve indicating valve Cv, and valve label.

3.06 CALIBRATION:

A. Following initial EMS hardware installation, the Contractor shall be responsible for the calibration of the transmitters, indicators, controllers, function generators and other control equipment supplied. The certification sheet format and procedures for calibration and commissioning shall be approved by the University's Representative prior to the beginning of calibration . The calibration shall not be considered as completed work unless properly signed certification sheets have been transmitted to the University's Representative. Any re-calibration that my become necessary shall also be documented in a similar manner such that the University's Representative has current calibration data in their possession at all times. See also 3.08F for calibration sheet format.

3.07 CONTINUITY TESTING:

A. Verify that wiring between each end termination has continuity and is free of cross connects with other circuits. Continuity and freedom from cross connects may be accomplished over long runs by stationing personnel at either end of the particular run and using sound-powered phones for coordination and checking each wire pair by using a meter. The same instrument may be used to demonstrate the absence of cross connects with other wires in the cable. The wiring out shall also include the checkout of the wire marking labels for agreement with the assigned number and properly marked terminals. See also 3.08F for continuity test sheet format.

3.08 ACCEPTANCE TESTING:

A. The Contractor shall provide and demonstrate acceptance testing in the presence of the University’s Representative to demonstrate that the EMS System has been installed and tested in full compliance with the contract documents. The Contractor shall provide the University’s Representative with 2 weeks advance notice of the dates when acceptance testing will occur.

B. Acceptance tests shall be scheduled to begin a minimum of 2 weeks prior to the contract completion date. Acceptance testing shall be conducted only after the EMS installation is fully complete, in operation, and is fully functional. Calibration, continuity testing, trending and control sequence checkout shall be completed prior to University acceptance testing. See also 3.08F for acceptance format.

C. The cost of labor, materials, instruments, and supplies of any kind required for testing shall be at no change in Contract amount.

D. Any control hardware damaged, shown to be defective during tests or unable to perform at design or rated capacity shall be replaced by the Contractor at no change in Contract amount or Contract time.

E. Acceptance testing forms shall be submitted for review by the University's Representative at least thirty (30) days prior to start of acceptance testing. No testing shall proceed without the University's Representative's review. See also 3.08F for form requirements.

F. Each acceptance testing form shall individually detail acceptance testing procedure for each panel, and each control component and each system. Acceptance testing form shall include check boxes for "acceptance" and "rejection" of each test including calibration documentation, continuity testing documentation, trending documentation, hardware inspection, I/O testing, and sequence of operation testing. Forms shall have place for signatures of the University's Representative and Contractor to certify observation of tests.

G. Acceptance testing shall include the following tests and demonstrations as a minimum:

1. Presentation of documentation showing that calibrations and continuity testing have been completed.

2. ***Presentation of Live Care software testing results.***

3. ***Presentation of trend reports generated by the Excel 500 controllers covering at least 40 hours of data taken at 5 minute increments. The trend reports shall be organized by mechanical system and show the values of all input and output points. The trends shall indicate stable control of controlled variables at set points with no appreciable hunting by controlled devices.***

4. Hardware walk through inspection covering all panels and field devices.

5. ***Following the above, a lap top PC and walkie-talkies shall be provided by the Contractor for use during the remainder of acceptance testing. The PC shall be loaded with all required software to view system operation***

including Honeywell XBS and the front-end graphics. Each new Excel 500 controller shall be logged on to via the C-Bus.

6. The following shall be tested while logged on to each DDC controller;

   a) All input sensors and devices shall be modified in the field (i.e. heat applied to sensors, wire removed, motor switched by HOA to test CT's, etc.) . The change of state shall be observed at the PC logged on to the controller and confirmed via walkie-talkie.

   b) All outputs shall be tested by forcing a change of state at the DDC controller via the logged on PC. The change of state shall be observed at the controlled device and confirmed via walkie-talkie.

   c) The sequence of operation for each piece of controlled and monitored equipment shall be tested. The written sequence and program hard copy shall be reviewed line by line. Inputs associated with each sequence shall be modified to a fixed value in the controller via the PC. A change of state consistent with the sequence shall be observed at the controlled equipment and confirmed via walkie-talkie.

H. As each or all tests are reviewed, an appropriate notation will be entered at the time of joint inspection on the system report with counter signature of the University's Representative and date. A copy of this report shall be made for the University's Representative.

I. Where the Contractor is required to modify, alter, add, or remove hardware, or software programs of the Building Automation System, or related accessories for the purpose of eliminating punch list items, off-line operation and testing to implement them shall be done as required by the Contractor until such time as acceptable performance of the Building Automation System has been established. Problems which occur within accepted hardware or software shall be corrected in an appropriate fashion under the warranty. Any such occurrence may void previous approval; however, the Contractor shall be responsible to attend to and remedy such items within a reasonable time. Appropriate logs, schedules and reports shall be maintained to reflect these items and reduce their redress.

J. Upon receipt of detailed punch list from the University's Representative, an installation inspection report shall be prepared showing, by system, each outstanding item on the punch list. After items appearing on the installation inspection report are completed, a second written request for system acceptance testing shall be made to the University's

Representative. As each or all items are accepted, an appropriate notation shall be entered at the time of joint inspection on the system report, with counter signature of the University's Representative. A copy of this report shall be made for the University's Representative.

3.09 WARRANTY AND WARRANTY RESPONSE

A. Warranty response shall include response to isolated malfunctions within eight (8) hours or no later than the next day (including Saturdays, Sundays, and Holidays) from when notice of the malfunction by The University was given. The Contractor shall, however, respond within four (4) hours to any system failure which caused more than ten (10) percent of connected data points to be inoperable or as directed by The University's Physical Plant Personnel as a critical situation.

3.10 OPERATOR INSTRUCTION

A. Following acceptance testing and at such time acceptable performance of the distributed processing network system hardware and software has been established, provide on-site operator instruction the University's operating personnel. Operator instruction during normal working hours shall be performed by a competent representative familiar with the DDC software, hardware and accessories.

B. University's Operating personnel shall be provided with a minimum of eight (8) hours of training, at the Project site, for all EMS related hardware and software installed.

C. Provide, without additional cost to the University, the services of competent instructors, which will give full instruction to the designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being a general (canned) training course. Each instructor shall be thoroughly familiar with all aspects of the required instruction. Equipment and material required for classroom training shall be provided by the Contractor.

PART 4 - DDC SOFTWARE / CONTROL SEQUENCES OF OPERATION

4.01 SEQUENCES OF OPERATION, GENERAL

A. The sequences of operation described herein cover general requirements. These sequences do not necessarily cover all software features necessary for stable control or operation of equipment without damage. The Contractor shall be responsible for providing all additional software features (time delays, PID loops, etc.) as may be required for stable control and to operate controlled equipment consistent with equipment manufacturer’s recommendations.

B. Control loops for modulated output devices, shall be Proportional, Integral, Derivative (PID) unless otherwise indicated. Software factors affecting PID output shall adjusted in the field as required to obtain stable control of the output device (i.e.; no observed hunting or rapid cycling of the controlled device).

C. Programming of the Excel 5000 series controllers shall be compiled using Honeywell "Care" programming software, version 1.5d. Standard control sequences shall be used where possible to accomplish the specified sequences of operation.

D. All software to be installed in the Excel 5000 series controllers shall be tested prior to field installation using Honeywell "Live Care" testing software.

E. ***For the Excel 5000 series controllers; the control software shall accommodate the modification of all temperature set points, schedule parameters and calibration factors by transmission over the C-Bus. These values shall be readily available for viewing and modification via the CCC.***

F. ***For the Excel 5000 series controllers; the control software shall accommodate front-end graphics. The value of all; input, output, and pseudo points shall be transmitted over the C-Bus and be available for viewing via the Division 17500 controls specialst connection to the CCC***.

4.02 ***AIR HANDLING UNIT TO BE COMPLETED BY CONSULTANT***

4.03 ***BOILER AND HEATING WATER PUMP TO BE COMPLETED BY CONSULTANT***

4.04 ***CHILLER AND CHILLED WATER PUMPS TO BE COMPLETED BY CONSULTANT.***

4.05 ***EXHAUST FAN CONTROL TO BE COMPLETED BY CONSULTANT***

4.06 SPECIALTY ALARMS TO BE COMPLETED BY CONSULTANT

4.07 MAIN BREAKER CONTROL: (this might be moved to the feeder breaker at the stevenson site, the 800 amp main breaker at the porter site and the 600 amp main at the cowell site, upstream of the generators at all three sites) Consultant to modify as required to fit sites.

A. ***Open-Close: A digital output from the EMS panel shall be provided to manually (and remotely) open and close the building main breaker.***

B. Status: A digital input from the main breaker auxiliary contacts shall provide open-closed status of the building main breaker.

4.08 EXTERIOR LIGHT CONTROL: CONSULTANT TO COORDINATE WITH ELECTRICAL

C. ***Exterior lights shall be controlled via a time program.***

D. ***The system shall include lighting control panel relays and other devices required for a full operational lighting control system. CONSULTANT TO COORDINATE WITH ELECTRICAL***

4.10 INTERIOR LIGHT CONTROL: CONSULTANT TO COORDINATE WITH ELECTRICAL

4.11 EMERGENCY GENERATOR CONTROL:

A. Start-stop: A digital output from the EMS panel shall be provided to manually (and remotely) start and stop the complex emergency generator.

B. Status: A digital input from the emergency generator auxiliary contacts shall provide engine status of the complex emergency generator.

4.12 OTHER SYSTEMS DEFINED BY CONSULTANT

END OF SECTION

SECTION 17500

PROPRIETARY INTEGRATION OF ENERGY MANAGEMENT SYSTEM

[CONSULTANT TO MODIFY PARTS IN AND BOLD]

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section covers connection and integration of the building Direct Digital Controls, installed by the Division 17000 Controls Specialist to the Central Control Computer (CCC), the Honeywell Enterprise Building Integrator (EBI), located at the Central Heating Plant, via the campus Wide Area Network.

B. For the EBI CCC work associated with the **[project building name]**, provide a complete system including graphics, hardware, and software controller points, schedules and parameters and control logic fully integrated into the EBI CCC system database server.

C. All EBI CCC connected systems shall allow enabling systems, monitoring of equipment and environmental parameters as; specified herein, indicated on the Drawings.

D. The Division 17000 Controls Specialist shall install and commission the new Building Management System (BMS) at the **[project building name]**.

E. The Division 17500 Controls Specialist shall extend the BMS C-bus from the nearest C-bus device installed by the Division 17000 Controls Specialist and provide all hardware and software necessary to connect the C-bus to the NXN Terminal Point Server and connect the NXN Terminal Point Server to the campus Wide Area Network.

F. The Contractor shall coordinate the review of the Division 17000 Controls Specialist work in the building by the Division 17500 Controls Specialist. The Contractor shall coordinate implementation of the Division 17500 Controls Specialists recommendations into the Division 17000 Controls Specialists work to assure compatibility with the EBI CCC.

G. The Division 17500 Controls Specialist shall be Honeywell Home and Building Control, 21270 Cabot Blvd., Hayward California (510 265 2117) no exception or substitutions. The existing CCC is Honeywell EBI, manufactured by Honeywell Incorporated.

H. Y2K Compliance:

1. All equipment, systems, devices and appurtenances shall be fully Year 2000 compliant, i.e., any parts, components, equipment, devices, systems, hardware,

software, etc. shall not fail or malfunction as a result of the year 2000 changeover or any other date issues beyond 01/01/00. This requirement applies as long as the equipment, system or device is in service, even if the specified warranty period has elapsed.

2. Each vendor, manufacturer, supplier, installer and contractor shall certify their conformance with this requirement on their shop drawings and submittals. Where the Bid Documents require the vendor, manufacturer, supplier, installer or contractor to submit a technical proposal as part of their bid, they shall certify conformance with this requirement in the technical proposal. Non-conforming equipment, systems, etc. are unacceptable. In the event that there is a failure or malfunction caused by the year 2000 changeover or other date issues, the vendor, manufacturer, supplier, installer and contractor shall be responsible for correcting the problem, with all costs including consequential costs, to be entirely borne by them.

I. The work of this Section shall be performed by a first tier sub-contractor who reports directly to the Contractor.

1.02 SCOPE OF WORK

A. For the EBI work at the **[project building name]** provide new NXN Terminal Point Server software and associated hardware. Extend the C-bus to the NXN Terminal Point Server, provide line and low voltage connections for the NXN Terminal Point Server. Provide rack to mount NXN Terminal Point Server. Coordinate placement of NXN Terminal Point Server and NXN Terminal Point Server equipment rack with University Representative.

B. The NXN Terminal Point Server shall be configured to support networking to the existing EBI CCC front end via the existing Campus Wide Area Network System.

C. Provide control and power wiring including associated raceways as specified and required for a complete and integrated EBI, except where specifically shown on electrical Drawings to be by Division 16, Electrical.

D. For graphics for the **[project building name]** provide new auto text graphic screens on the EBI CCC system that includes all building controller points. There shall be no more then 25 points per graphic screen. In addition to the auto-text graphics provide a minimum of two graphics for each system, one graphic depiction of the system containing physical components and hardware points and one text based software point graphic containing hardware and software points necessary for manipulating the systems controlled variables. Provide additional graphics for each system such that no single graphic screen ever contains more then 25 individual

components on the screen, including system component depictions and software and hardware points.

E. Functionality of the EBI CCC and NXN Terminal Point Server shall include but not necessarily be limited to the following:

1. Mapping and scanning of all controllers and storage of the data points retrieved.

2. Point Algorithms and Action Algorithms on points programmed into the connected controllers.

3. Station displays including System and Custom Station Displays.

a. System displays shall include:

1. Summary, Status, and Configuration displays that show current values for alarms, points, controllers, channels, and zones.

2. Scanning statistics display that shows the current scanning performance of the system and scanning load.

3. Operating group displays that view logically related points on the same display.

4. Trend set displays that view historical data for points.

b. Custom displays unique to the **[project building name].**

4. Events and Alarms that notify operators of unusual conditions or unexpected changes reported by a controller. The alarm shall remain until the condition, which triggered the alarm, returns to normal and someone acknowledges the alarm.

5. The EBI CCC and NXN Terminal Point Server shall be capable of the following data manipulation on the controller programmed into the system:

a. Production of Standard, Custom, and Integrated Microsoft Excel reports both manual and scheduled.

b. Analyzing history of points for trends using:

1. Variable time periods

2. Trend display graphics

c. Archiving historical data in the server database.

d. Extended Event Archiving and Reporting System that periodically captures the events from the event journal and puts them into the extended event database for queries and reporting.

6. The EBI CCC and NXN Terminal Point Server shall provide Operator Security for the controller programmed into the system including:

a. Station-Based Security

b. Operator-Based Security

c. Point Control Access, which includes control level access, area access, and command segregation access.

d. Database access security

e. Command assignment of controllable states of status points that are defined for the devices and assigned to the areas.

7. The EBI CCC and NXN Terminal Point Server shall provide the following building management functions:

a. Global Scheduling to control a large group of points using a schedule.

b. XLNET Dial-Up Interface used to monitor, control, and acquire data from remote sites.

c. Alarm Paging System, which monitors station, alarms and determines whether new alarms should be paged out.

d. Phone control, which allows callers to perform monitoring and control functions using a touch-tone telephone.

1.03 RELATED WORK

A. Overall general requirements: Refer to Division 1, General Requirements.

B. General requirements for mechanical systems, refer to Section **[15010]**, Basic Mechanical Requirements.

C. General requirements for electrical systems, refer to Section **[16010]**, Basic Electrical Requirements.

D. Requirements of Section 17000, Building Management System.

F. [OTHER SECTIONS DETERMINED BY CONSULTANT]

1.04 QUALITY ASSURANCE

A. Responsibility:

1. The Contractor shall be responsible for the performance of quality assurance activities to assure conformance with the requirements specified.

2. Equipment shall be the product of established reputable manufacturers normally engaged in the production of the particular item being furnished.

3. The standard line of equipment of each manufacturer shall be furnished unless special construction or performance is necessary to comply with specifications.

4. Obsolete or used product lines or equipment will not be accepted.

5. Where one (1) or more of any specific items are necessary, all shall be of the same type and manufacturer.

B. Inspection: The University's Representative will make inspections and review records as necessary during fabrication and installation of components.

C. Requirements of regulatory agencies, codes and standards:

1. Standards: Comply with applicable provision of the following standards, latest editions, except as otherwise shown or specified.

ARI	Air Conditioning and Refrigeration Institute
ASHRAE 85	Automatic Control Terminology for Heating, Ventilating, Air Conditioning.
ASME MC85.1	Terminology for Automatic Control
FM	Factory Mutual Insurance Companies
IEEE	Institute of Electrical and Electronic Engineers local area networking standards and architectures (i.e., IEEE 802.3, IEEE 802.5).
IRA/FIA	Industrial Risk Insurers
ISA	Instrument Society of America
JIC	Joint Industrial Council
MSS	Manufacturer's Standardization Society of Valves and Fittings Industry
NEMA EMCI	Energy Management Systems Definitions
NSC	National Safety Council

1.05 SUBMITTALS

A. The Contractor shall submit the following information on the installation firm, materials, components, test inspection procedures including:

1. Firm Qualifications and Submittal:

   a) Written statement that individuals working on this project are employees of Honeywell Home and Building Control.

2. Material Submittal:

   a) For all NXN Terminal Point Server components and related devices provided under this section submit; Catalog cuts, technical specification data sheets, description of function, performance data, materials of construction, manufacturers installation instructions, wiring diagrams, etc. as required to show full compliance with Contract requirements.

   b) For all installation materials to be provided under this section including; panel enclosures, mounting hardware, wiring & raceways submit; Catalog cuts, technical specification data sheets, performance data, materials of construction, manufacturers installation instructions, etc. as required to show full compliance with Contract requirements.

3. Shop Drawing Submittal including:

   a) Provide a submittal for the EBI CCC and NXN Terminal Point Server at the **[project building name].**

   b) System architecture schematic showing the C-bus to NXN Terminal Point Server connection and the NXN Terminal Point Server to Wide Area Network connection. Indicate cabling type and size and cable termination locations. Schematic drawing shall show labeling of cables

   c) List of connected data points network connected through to EBI CCC.

   d) Hard copy print out of graphics representing each system controlled and monitored by the EBI CCC connected system in the building.

   e) Functional Testing Submittal including detailed sequence of steps demonstrating system functionality specified.

1.06 OPERATION AND MAINTENANCE (O&M) MANUALS

A. Six (6) copies of equipment operation and maintenance manuals shall be submitted to the University's Representative at least two (2) weeks prior to training and acceptance testing. These

manuals shall contain instructions on the proper operation and maintenance of equipment and apparatus provided.

B. Each manual shall be prepared with an index sheet listing the contents in alphabetical order and shall contain the following material:

1. Operator's manual covering PC, PC communications cards and software provided. This manual shall be indexed, and shall have a separate tabbed section for each operator functions.

2. Manufacturer's equipment parts list of functional components of the system, control diagrams and wiring diagrams.

3. "As-built" interconnection wiring diagrams, or wire lists of the complete field installed system with complete, properly identified ordering number of each system component and device.

4. Instructions on how to map controller points, and define points in software.

5. Maintenance instructions for each type of equipment or device.

6. Complete list of all components, list shall include local supplier, supplier address and telephone number, detailed part number, approximate cost, and warranty.

7. Complete NXN Terminal Point Server documentation including diskette copies suitable for loading into NXN Terminal Point Server. Database provided with the O&M submittal shall be the final version and include all field installed modifications.

8. Hard copy of front-end graphics installed in the EBI CCC.

PART 2 – PRODUCTS

2.01 TERMINAL POINT SERVER

A. NXN Terminal Point Server shall include all components necessary for the building controller to communicate to the EBI CCC system. PC shall be Optiplex GX1 or equal, with required network card and Honeywell XPC500 and XD508 add on cards. Minimum performance shall be:

1. Pentium II running at 400MHZ

2. 128 MB RAM

3. 4 GB hard disk drive

4. Adapter for Ethernet networking compatible with TCP/IP network protocols.

B. Uninterruptible Power Supply (UPS) system shall provide four power and surge protection outlets, LED indication of power disturbance and power exhaustion, have a user replaceable battery and automatic recharge. UPS shall be rated at a minimum of 650 VA, APC Smart-UPS 600 or equal.

C. The NXN Terminal Point Server software shall include but not necessarily be limited to the following:

1. The NXN Terminal Point Server will be a Windows NT workstation set up as client to the EBI CCC server.

2. The NXN Terminal Point Server software will provide a communications interface between the building's C-bus, RS485 network and the campus TCP/IP network protocol.

3. **[Point server software for integration of Echelon and MOD-BUS devices as required to interface equipment provided by Division 16.]**

2.02 NETWORK WIRING

A. Data Communications (C-bus) cabling between DDC panels and the NXN Terminal Point Server shall be 18 AWG, TFN insulation, twisted pair with pvc jacket. Shielded cables shall be when cables are run outside a building or in areas with potential for electrical noise. Honeywell #AK3702, Clifford of Vermont, Carol, Belden, or equal.

B. Data Communications (TCP/IP) cabling between the NXN Terminal Point Server and the campus Wide Area Network shall be as specified in Division 16.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Comply with State of California Code requirements. In case of conflict between the Contract Documents and governing Code, the higher standard shall prevail. Extra payment will not be allowed for work required by Code and enforcement authorities.

B. Location and Access: Observe good practice in locating and installing equipment and accessories. Maintain adequate clearances to equipment so as to permit ready access to parts requiring adjustments, inspection, service and repair. Installation of any equipment with less than minimum clearances indicated by manufacturer or as required by Code or

for proper maintenance will not be accepted by the University's Representative.

C. Connections: Indicated equipment connections are based on equipment of a given manufacturer. The Contractor shall assume responsibility to proper arrangement of power connections to equipment in a proper and approved manner.

D. Follow equipment manufacturer's detailed instructions and recommendations in the installation and connection of equipment. No equipment installation and connections shall be made in a manner that voids the manufacturer's warranty.

3.02 FASTENING TO BUILDING STRUCTURES

A. Fastenings, supports, hangers, clamps and anchors shall be of the type made for the specific purpose for which they are to be used. Wiring shall be rigidly and firmly installed to prevent swaying, vibration or sagging.

B. The equipment shall be fastened to the floor or building structure in accordance with good practice, however, the methods of attaching or fastening equipment supports or hangers to the building structure shall be subject to review by the University's Representative.

C. Electrical and mechanical instrument equipment mounted against the interior surface of exterior walls shall be mounted at least one (1") inch away from the wall surface.

D. Equipment shall not be attached to or supported from the roof deck, from removable or knockout panels, temporary walls or partitions.

E. Electrical and mechanical equipment mounted against interior walls situated in damp or wet locations or adjacent to liquid piping shall be installed at least one half (1/2") inch away from the interior surface.

3.03 WIRING INSTALLATION AND TERMINATION

A. Installation of conduit, wire, sleeves, outlet boxes, insulating bushings, system cabinets, terminal boxes, pull boxes, junction boxes, inserts, anchors, system devices, etc., shall be in accordance with the appropriate requirements of Division 16, Electrical.

B. Installation of data cabling in finished areas shall be concealed. Where concealed wiring is not possible, written approval from the University's Representative for exposed in suitable raceway work shall be obtained prior to installation.

3.04 IDENTIFICATION

A. Mounting and control devices shall have identification means attached to or painted on the front or most visible surface.

B. Nameplates and instrument tags shall be permanently attached to the field equipment. Nameplates or tags shall be visible from the walkway or access point nearest the device when the device is in its installed configuration.

3.05 ACCEPTANCE TESTING:

A. Presentation of trend reports generated by the Excel controllers and archived by the EBI system covering at least 40 hours of data taken at 10 minute increments and demonstrating EBI system functionality. Trends shall be organized by mechanical system in the building and shall show the values of all input and output points in the controller(s).

B. Hardware walk through inspection covering all field devices.

C. The following shall be tested while logged on to the EBI system:

1. Graphic call-up displaying live data from the controller for both connected physical points and program data pseudo points.

2. Trend call-up with real time view of data collection.

3. Point Detail call-up to permit the operator to change point report details, alarm limits, automatic/manual mode operation, manual set of position, offset values.

4. Controller data and time and controller reset.

5. Controller point schedule and assignment.

6. Communications Fail Annunciation

7. Operator Message Zone for display of alarm and controller information.

D. As each or all tests are reviewed, an appropriate notation will be entered at the time of joint inspection on the system report with counter signature of the University's Representative and date. A copy of this report shall be made for the University's Representative.

3.06 WARRANTY AND WARRANTY RESPONSE

A. Warranty response shall include response to isolated malfunctions within eight (8) hours or no later than the next day (including Saturdays, Sundays, and Holidays) from when notice of the malfunction by The University was given. The Contractor shall, however, respond within four (4) hours to any system failure which caused more than ten (10) percent of connected data points to be inoperable or as directed by The University's Physical Plant Personnel as a critical situation.

3.07 OPERATOR INSTRUCTION

A. Following functional testing and at such time acceptable performance of the EBI CCC system hardware and software has been established, provide on-site operator instruction the University's operating personnel. Operator instruction during normal working hours shall be performed by a competent representative familiar with the DDC software, hardware and accessories.

B. Provide, without additional cost to the University, the services of competent instructors, which will give full instruction to the designated personnel in the operation of the equipment and system specified. The training shall be oriented toward the system installed Each instructor shall be thoroughly familiar with all aspects of the required instruction. Equipment and material required for classroom training shall be provided by the Contractor.

END OF SECTION