

The following standard specification is intended to be edited according to the specifics of the project. Brackets [] and areas shaded in gray [e.g. format] indicate requirements that are optional depending upon the type of system being provided or per instructions associated with the [] and project requirements. Consult with University's Representative and campus stakeholders.

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SECTION 25 95 00 - DDC EMS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide a Direct Digital Control (DDC) Energy Management System (EMS) utilizing, but not limited to, the following: DDC EMS Server, Web Server, Interface Server, Historian Trend Server and operator workstations, hand-held and portable operator's terminals, web-based operator interface, microprocessor based digital controllers, and electric/electronic and pneumatic control devices to perform control sequences and functions documented on the Drawings and in these Specifications.
- B. The DDC EMS for this project shall consist of the monitoring and control of: air handling systems (AHUs), CHWS/HWS systems, air terminal units (ATUs), mechanical systems/equipment and their associated control devices and other miscellaneous devices. Refer to the control diagrams and points lists found on the Drawings.
- C. Provide a DDC EMS Server System, which meets the requirements defined in Section 25 95 30 DDC EMS Hardware (2.1), if the proposed manufacturer does not already have a central DDC EMS Server System at the main campus energy management facility.
- D. Provide the following spare parts:
 1. Two primary controllers
 2. Two secondary controllers
- E. Provide factory training as described below:
 1. Five 8-hour days of Advanced Factory Training for 2 University People, including all travel expenses to and from training and hotel expense.
- F. A minimum of five (5) simultaneous users shall be able to log in to the DDC EMS. For DDC EMS manufacturers that have existing systems on campus, the number of simultaneous users shall be increased by five (5).
- G. Prior to submittal of shop drawings, EMS manufacturer's technical representative and installer's programmer shall attend two separate 8-hour workshops with University's Representative and design consultants to review control strategies and technical commissioning issues.

1.2 QUALITY ASSURANCE

- A. Comply with the following Codes and Standards in addition to the requirements of Section 01 41 00 Regulatory Requirements:
 1. Underwriters Laboratories (UL):
 - a. UL 916: Energy Management Systems
 2. National Electrical Manufacturers Association (NEMA) Compliance:
 - a. NEMA 250: Enclosure for Electrical Equipment
 - b. NEMA ICS 1: General Standards for Industrial Controls.
 3. National Fire Protection Association (NFPA) Compliance:
 4. NFPA 90A: "Standards for the Installation of Air Conditioning and Ventilating Systems" (where applicable to controls and control sequences).
 5. NFPA 70: National Electrical Code (NEC)
 6. Institute of Electrical and Electronics Engineers (IEEE)

7. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
8. Electronics Industries Associations (EIA):
 - a. EIA 232: Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
 - b. EIA 485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multi-point Systems.

1.3 QUALIFICATIONS

A. DDC EMS Contractor Qualifications

1. Shall have been in business and licensed as a controls contractor by the State of California for a minimum of 5 continuous preceding years.
2. Shall be a manufacturer's authorized representative of the DDC products and systems provided for this project.
3. Within 5 preceding years, the DDC EMS Contractor's office which will service the UC Davis campus, shall have performed at least 25 projects which included the installation of not less than 500 hardware input/output (I/O) points, using proposed manufacturer's products and systems.
 - a. 5 of the 25 projects shall have included the installation of not less than 2,500 hardware I/O points using proposed manufacturer's products and systems.
 - b. 5 of the 25 projects must have been pursuant to a written contract that required a warranty service with a mandatory response time of less than one hour from receipt of notice for service.
 - c. 3 of the 25 projects must have each integrated at least 50 variable air volume laboratory controllers with a minimum of 100 I/O points per project into the proposed DDC EMS manufacturer's products through the use of an interface device using either MODBUS, BACnet, or LONtalk protocol.

B. DDC EMS Manufacturer Qualifications

1. Products and systems shall be manufactured by a manufacturer that has been continuously and regularly engaged in the manufacture of automatic temperature controls, including pneumatic, electric, and direct digital control equipment of the types and sizes described for at least 5 preceding years.
2. Manufacturer has had gross sales revenue exceeding \$5,000,000.00 for automatic temperature controls including pneumatic, electric and direct digital control equipment.
3. Proposed products and systems shall be the manufacturer's standard integrated hardware and software products and systems.
4. LAN interface devices, Primary Control Units and Secondary Control Units shall be by the same manufacturer. All control Units and LAN interface devices shall be factory assembled, burned-in, tested and UL listed as one integral unit.

1.4 DEFINITIONS

- A. Energy Management System (EMS) - The entire integrated energy management and control system including all components.
- B. Direct Digital Control (DDC) - Microprocessor based control including analog-to-digital (A/D) conversion and program logic.
- C. Local Area Network (LAN) Interface Device - Device or function used to facilitate communication and sharing of data throughout the DDC EMS.
- D. Interbuilding LAN: Used for communication between Primary Controller LANs located in each building and multiple networked Operator Workstations located in selected buildings.
- E. Primary Control Unit (PCU) – Fully featured, customizable, intelligent, stand-alone, single controller residing on the Primary LAN.

- F. Secondary Control Unit (SCU) - Intelligent control unit with limited capabilities designed for controlling terminal devices or packaged equipment, and residing on the Secondary LAN.
- G. Control Unit (CU) - Intelligent stand-alone control unit including both primary and secondary units.
- H. Stand-alone Device - A single device/control unit that does not require any other device/control unit to perform it's specified functions.
- I. Operator Interface - A device used by the operator to manage the DDC EMS including Operator Workstation, Portable Operator's Terminal, and Hand Held Operator's Terminal.
- J. Operator Workstation (OWS) - Personal Computer (PC) and peripherals directly connected to the inter-building LAN, and supporting dial-up communications to remote buildings without a campus Ethernet connection.
- K. Portable Operator's Terminal (POT) - Laptop PC used both for direct connection to a CU and for remote dial up connection.
- L. Hand Held Operator's Terminal (HHOT) - Manufacturer's microprocessor based custom device for direct connection to a CU.
- M. Server - Computer (or computers) that maintain the systems configuration and programming database.
- N. Temperature Control Panel (TCP) – Wall mounted panel that houses all DDC controllers and associated control system devices including, but not limited to: relays, transducers, etc.
- O. Bill of Materials (BOM) – Temperature control system's parts list defining each device used or installed and its part number, manufacturer, quantity, size or type, etc.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 33 23, "Shop Drawings, Product Data, and Samples."
- B. Product Data
 - 1. Submit manufacturer's technical product data for each control device, panel, and accessory furnished. Indicate dimensions, capacities, performance and electrical characteristics, material finishes, and as referenced. Also include installation and start-up instructions.
- C. Shop Drawings (control system drawings):
 - 1. Submit shop drawings for the entire proposed DDC EMS/temperature control system design for review. Shop drawings shall be submitted both hardcopy and electronic copy utilizing the latest version of AutoCad. Include all font and "x-reference" files on that disk. Shop drawings shall consist of a complete set of control drawings detailing each air handling unit, water system, etc., with its corresponding unit controller wiring diagrams having all controller addresses, point descriptors and point names indicated accordingly. Provide completed submittal shop drawing documentation with consecutively numbered pages and that includes, but is not limited to, the following information. Drawing set to be ordered in the manner similar to that outlined below:
 - a. Title page with Table of Contents (TOC). The TOC listing shall specify sheet number, drawing title with description of the system it represents, latest revision for that particular drawing/system. The title page itself shall include the project name, location, creator and approval signatures, original creation date, and the latest revision of the entire drawing set. The title page shall also include all general notes, legends and list of symbols and abbreviations.
 - b. System LAN architecture diagram indicating location of all OWSs and peripherals, LAN interface devices, primary and SCUs, etc. Indicate individual controller addresses and type for each workstation, primary and SCUs (on the LAN architecture drawing or respective controller wiring diagram). Indicate protocol, baud rate, and type of each LAN.

- c. Floor plans depicting all mechanical rooms in relation to building footprint and locations of HVAC equipment, LAN conduit and routing, LAN architecture main control devices, TCPs, and motor control centers (MCC's). These drawings will be required for end-user workstation graphics interface screens.
- d. Provide an overall project BOM as a separate document and also diagram specific BOM(s) on the face of each control drawing schematic. Indicate device identification (tag) to match schematic and actual field labeling and, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. where applicable.
- e. Schematic control diagram(s) for each air handling unit, water system, etc., depicting individual control devices comprising that system (i.e. fans, dampers, valves, pumps, etc.). Typical drawings for similar mechanical systems shall not be acceptable. No more than one system per drawing. Identify (tag) each device accordingly (i.e. TCV-1, DPT-1, etc.) and label each control device with its individual setting or adjustable range of control (i.e. 0-10V), each input and output with its appropriate range (i.e 3-15psi). Cross-reference each device's ID (tag) with the drawing's specific BOM (as well as the project's overall BOM) and with its respective submitted technical data sheets.
- f. Include a written detailed description of sequence of operation, along with a defined points list, for each particular drawing on the face of each control system schematic diagram. Points lists shall include all physical I/O and virtual points for identification in programming. Points list shall be provided in both hard copy and in electronic format (Quote and Comma Delimited, ACCESS data table, EXCEL or equal spreadsheet formats are acceptable formats).
- g. Temperature control valve and damper schedules including, but not limited to, the following information: valve manufacturer, model number, Cv, design flow (GPM), design pressure drop (delta P), valve actuator close-off rating, damper size, damper actuator torque rating/close-off. Indicate direct or reverse acting actuation and normal positions of all valves and dampers.
- h. Electrical control wiring diagrams shall include both of the following: ladder logic type diagrams for motor starter, control, and safety circuits and detailed TCP and point termination wiring diagrams with all wire numbers and terminal block numbers clearly identified and cross-referenced to their respective control system diagrams/drawings. Clearly identify existing wiring, wiring provided by the Contractor, and factory- installed wiring.
- i. Details of temperature and system control panels, including controls, instruments, devices, and labeling shown in the Drawings indicating their installed locations. Wiring terminations shall be identified using the University standard controls wiring identification scheme as follows:
 - 1) 120VAC = 120Axxx
 - 2) 24VAC = 24Axxx
 - 3) 24VDC = 24Dxxx
 - 4) 4-20mA = 20Mxxx
 - 5) 0-10VDC=10Dxxx
 - 6) Temp Sensor = 0AIxxx
 - 7) Dry Contact Input = 0DIxxx
- j. Wire Tabulation List with wire identification number, wire color, "from" terminal, and "to" terminal in a columnar format.
- k. Submit calculated and guaranteed system response times of the most heavily loaded LAN(s) in the system, including respective controller memory allocation projections under separate cover.
- l. Graphics including all system schematics

D. Field Mounted Control Drawings

1. Control drawings shall be no smaller in size than 11 inch by 17 inch, with minimum 3/32 inch lettering size. Field mounted control drawings shall show all as-built conditions and shall be dated with the latest revision date. TCP mounted drawings shall be laminated in clear plastic and shall be either permanently fastened flush on inside of panel door, or permanently attached by a metal bead chain. Provide all permanently mounted control drawings at the Project Site as follows:
 - a. System control schematics shall be wall-mounted adjacent to key pieces of equipment for that system.
 - b. Panel termination drawings shall be mounted in or wall-mounted adjacent to respective TCP's.

E. Control Logic Documentation

1. Submit control logic documentation for the entire DDC EMS temperature control system programming design for review after programming is complete and prior to system start-up and commissioning as outlined in Section 25 08 00 Commissioning of Integrated Automation. Control logic documentation shall be submitted both on paper and electronic media. Documentation should consist of programming logic defining algorithms to be used for each specific air handling unit, water system, etc., corresponding to its respective unit controller addressing and cross-referencing that controller's wiring diagram. Provide completed submittal control logic documentation with consecutively numbered pages and that includes, but is not limited to the following information:
 - a. Title Page with Table of Contents (TOC): The TOC listing must specify the following information: sheet number, control logic diagram/programming sheet title with description of the system it represents, latest revision for that particular diagram/system. The title page shall include: project name, location, creator and approval signatures, original creation date, and the latest revision of the entire drawing set. The title page shall also include all general notes, legends, and list of symbols and abbreviations.
 - b. Include a complete set of control logic diagrams/programming sheets documenting the control software used for each and every primary and secondary control unit.
 - 1) Each control logic diagram/programming sheet shall have a title indicating the building number/name, controller designation(s), and the HVAC system controls.
 - 2) All control logic and programming should be annotated to describe how it accomplishes its particular sequence of operations for the system it serves and any peripheral systems it affects.
 - 3) For block programming, annotations shall be sufficient to allow an operator to relate each program block to corresponding portions of the specified sequence of operations. Any 2 interconnected programming "blocks" that are shown on one sheet shall be shown with an interconnecting line, with limited use of references. Any 2 interconnected blocks that are shown on separate sheets shall include references to the connected block and the sheet number where the connected block is located.
 - 4) For text-based programming, submit programming code with annotations in English which shall be provided throughout the programming code to guide the reader through the workings of the sequences of operations.
 - 5) Include all related/specified control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits as required on each control logic diagram/programming sheet.
 - c. Submit at least 1 complete set of primary and secondary control unit programming and operating manuals for all DDC controllers that are to be used. This set will count toward the required number of Operation and Maintenance manuals specified below and in Section 01 78 00 Close-out Submittals.

F. Commissioning DDC EMS Software

1. Provide a fully licensed copy of the required DDC EMS OWS graphical software interface for review and approval. This copy shall be in addition to quantities of licensed copies required elsewhere in these Specifications.
 2. This software copy will also be used by the University's Representative on a remote computer for accessing the DDC EMS network. This software copy shall be used only for the purpose of commissioning this project and the University's Representative agrees that the commissioning DDC EMS software license shall become null and void upon termination of the Contract Warranty Period.
 3. Software shall include required off-the-shelf DDC EMS software and project specific database such as point assignments, and specified graphic screens, alarms, and reports. Software shall include required trend logs, configured as specified in Section 23 08 00, "Commissioning of DDC/EMS System."
 4. Provide required telephone assistance upon request to assist University's Representative in setting up software on University's Representative's remote computer.
 5. Submit 1 complete set of programming and operating manuals for the DDC EMS OWS graphical software. This set will count toward the required number of Operation and Maintenance manuals specified below and in Section 01 78 00 Close-out Submittals
- G. DDC EMS Pre-Commissioning Test Report
1. Prior to system start-up and commissioning, submit Agenda which shall consist of all required test sheets and checklists required for the Pre-commissioning Test Report(s) as specified in Section 23 08 00, "Commissioning of Integrated Automation." The blank checklists (Appendix A) included in these Specifications shall be included in that Agenda.
 2. Submit Final Test Report(s) documenting that the DDC EMS has been fully tested, adjusted, calibrated, and is ready for demonstration and commissioning. Report(s) shall include, but shall not be limited to, completed test sheets and checklists. Required details of the report(s) shall be as specified in Section 23 08 00, "Commissioning of Integrated Automation."
- H. Operation and Maintenance Manuals
1. Submit DDC EMS documents under provisions of Section 01 78 00 Close-out Submittals. Provide at least 1 hard copy and 1 CD.
 2. Submit the requested number of DDC EMS system User's Guides (Operating Manuals) for each controller type and for all OWS hardware, software, and peripherals.
 3. Submit the requested number of DDC EMS system advanced Programming Manuals for each controller type and for all OWS software.
 4. Submit maintenance instructions for each type of CU, control device, and control system accessory used on the project as part of the DDC EMS documentation requirements above.
 5. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions) in accordance with requirements of Section 01 33 23, "Shop Drawings, Product Data and Samples."
- I. Manufacturers Certificates: For all listed and/or labeled products, provide a copy of the certificate of conformance, issued by the listing/labeling agency to the manufacturer.
- J. Product Warranty Certificates: Submit manufacturers product warranty certificates covering the hardware provided.
- 1.6 PROJECT RECORD DOCUMENTS (AS-BUILT DOCUMENTATION)
- A. Submit documents under provisions of Section 01 77 00 "Closeout Procedures," and Section 01 78 00 "Close-out Submittals."
 - B. Include the entire commissioned DDC EMS database, files/software, all BACnet objects and their properties, LANID TCP/IP addresses, and as-built shop drawings (control diagrams), current control logic programming, project specific graphical interface files/software, and all product data updated to reflect the final commissioned system installation.

1.7 MAINTENANCE DURING WARRANTY PERIOD

- A. Contractor shall warrant all products and labor for a period of at least 1 year after Final Acceptance and commissioning of the DDC EMS.
- B. At any time during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:
 1. Maintenance services shall be provided for all DDC EMS devices and hardware. All equipment shall be serviced per the manufacturer's recommendations. All devices shall be re-calibrated within the last month of the warranty period to insure proper EMS operation per the designed system parameters and/or to reflect the final acceptable EMS conditions.
 2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control logic programming that would result in possible immediate personal injury, property damage, or loss of comfort control shall be considered an "emergency service" problem and shall be corrected and repaired by the Contractor, following telephone notification by the University's Representative, as defined in the guidelines that follow:
 - a. A response by telephone to any request for service shall be provided within 30 minutes of the University's Representative's initial telephone request for service.
 - b. It will be acceptable for the Contractor to make corrections by remote interface to the campus DDC EMS from the Contractor's office if, and only if, those changes correct the immediate problem to the satisfaction of the University's Representative.
 - c. In the event that the malfunction, failure, or defect is not corrected through the telephone communication or remote interface, the Contractor shall dispatch at least 1 hardware/software technician, trained in the system to be serviced, to be at the Project Site within 1 hour of the University's Representative's initial telephone request for such services, as specified above.
 3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control logic programming that would not result in immediate personal injury, property damage, and loss of comfort control shall be considered a "normal service" problem and shall be corrected and repaired by the Contractor, following telephone notification by the University's Representative, as defined in the guidelines that follow:
 - a. A response by telephone to any request for service shall be provided within 2 hours (Contractor specified 40 hrs/wk normal working period) of the University's Representative's initial telephone request for service.
 - b. It will be acceptable for the Contractor to make corrections by remote interface to the campus DDC EMS from the Contractor's office if, and only if, those changes correct the problem to the satisfaction of the University's Representative.
 - c. In the event that the malfunction, failure, or defect is not corrected through the telephone communication or remote interface, the Contractor shall dispatch at least 1 hardware/software technician, trained in the system to be serviced, to be at the Project Site within 4 hours of the University's Representative's initial telephone request for such services, as specified above.
 4. At the University's Representative's request for service by telephone, the Contractor shall specify a maximum of 3 telephone numbers for University's Representative to call in the event of a need for service. At least 1 of those lines shall be attended to at all times (24 hrs/day, 7 days/week). Alternatively, pagers or cellular phones can be used for technicians trained in the system to be serviced. Those technicians shall respond to any call within a 30 minute window (24 hrs/day, 7 days/week).
 5. Contractor shall provide technical support by telephone throughout the warranty period.
 6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.

1.8 LISTING AND LABELING

- A. The DDC EMS and all associated system components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All equipment of the same device or type serving the same function shall be identical and from the same manufacturer.
- B. The Siemens Apogee Control System is the basis of design, or equal.
- C. The University has identified the following manufacturers as meeting the criteria listed above: Siemens Apogee Controls (Basis of Design), Automated Logic Controls, and Johnson Controls, or equal.
- D. Siemens Interface Server, or equal

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which the control system(s) are to be installed. Do not proceed with controls Work until the other Work is complete to the point that will allow controls to be installed in accordance with controls manufacturer's instructions.

3.2 INSTALLATION OF CONTROL SYSTEMS

- A. General: Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and details shown on the approved shop drawings.
- B. Refer to additional requirements in other sections regarding all other installation requirements.

3.3 CONTROL UNIT QUANTITY AND LOCATION

- A. Individual TCPs are referenced to indicate allocation of points to each TCP and TCP location. TCP shall consist of 1 or multiple CUs to meet requirements of this specification.
- B. Where a TCP is referenced, Contractor shall provide at least 1 PCU, and additional Primary and SCUs as required, in sufficient quantity to meet the requirements of this Specification. Restrictions in applying CUs are specified in Division 15.
- C. Stand Alone Functionality: Provide CUs so that all points associated with and common to 1 air handling unit or other complete stand-alone system/equipment shall reside within a single CU. When referring to the CU pertains to the stand-alone functionality, reference is specifically made to the processor CPU. One processor shall execute all the related functions. I/O point expander boards may be added to expand the point capacity of the CU. Where any I/O point expansion devices are connected to the main controller board via communication, that communication sub LAN shall be dedicated to that controller and include no other devices including secondary controllers.
- D. It is the Contractor's responsibility to provide enough CUs and TCPs to ensure a completely functioning system, according to the BOM and sequence of operations.
- E. Contractor shall provide a minimum of the following:
 - 1. One TCP (including at least 1 PCU) in the Building's main mechanical room.
 - 2. One PCU for each air handling unit.
 - 3. One PCU for each laboratory, BSL-3, and Vivarium exhaust system.
 - 4. One PCU or SCU shall be provided for each fan-coil unit and other terminal unit unless indicated otherwise.

3.4 CONTROL POWER SOURCE AND SUPPLY

- A. Contractor shall provide all power wiring required for all DDC EMS equipment and devices. Power wiring practices shall meet the requirements of Division 26. All power wiring shall be installed in conduit.
- B. General requirements for obtaining power include the following:
1. To the extent practical, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from spare branch circuits in the electrically most proximate 120v source fed from a common origin, or provide a control transformer fed from the equipment's panel.
 2. Spare branch circuits used for control equipment and devices shall be dedicated to serve only controls equipment and devices. Control equipment and devices shall not coexist with other non-controls related loads on the same branch circuit.
 3. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and has the correct voltage to supply the controls it shall be used. If the equipment's control transformer is not large enough, it shall be the responsibility of Contractor to either procure a larger control transformer from the equipment manufacturer or provide a separate transformer.
 4. For equipment that is powered from an emergency power source, control power shall also be obtained from an emergency power source.
 5. The Contractor shall furnish and install any power supply surge protection, power isolators/filters, etc. as necessary for proper operation and protection of all CUs, operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no affect on hardware, software, communications, and data storage.

END OF SECTION 25 95 00