CONSTRUCTION STANDARD SPECIFICATION

SECTION 13943

FACILITIES CONTROL SYSTEM

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PART 1 - GENERAL

1.01 SUMMARY

A. Instrumentation and control systems required for HVAC systems and Sandia National Laboratories Facilities Control System (FCS).

B. Remote control units, called Modular Building Controllers (MBC's), located in individual buildings provide local monitoring and control functions. Each MBC communicates with an existing Facilities Control System (FCS) Host Computer in Building 887 for remote monitoring and control purposes.

C. SNL uses a Siemens Building Technologies, Landis Division System 600 as its existing FCS System. All FCS control FID's (Field Interface Devices) shall be System 600 products.

1.02 SUBMITTALS

A. Provide submittals in accordance with Section 01330, "Submittal Procedures".

B. Provide catalog and calibration data and procedures for all sensors, switches, and controllers as part of submittals.

C. Provide control diagrams in the form of shop drawings for each system or sub-system. Use the control diagrams included in the contract drawings for this purpose. Each diagram shall be altered to show all proposed controls and controlled devices, together with name, catalog number, set point, and action of each controlled device.

D. Furnish reproducible copies of all contract drawings for use in preparing there shop drawings.

E. Point verification forms shall be submitted for all points that will be installed as part of the FCS. These forms shall be based on the point verification tests (PVT's) defined in Part 3 of this specification. Once approved, these forms shall be used during the startup verification phase of this work.

F. Detailed functional performance tests (FPT's) that test all aspects of the sequence of operation. These aspects include the testing of safeties, PID loops, emergency switch over routines, alarm enunciation, temperature control, air volume control, pressurization controls, flow control, fume hood control, graphics, etc. The test procedures shall be comprehensive step-by-step procedures that can be repeated by different individuals with the same expected outcome. Equipment to be tested shall include the supply and exhaust Air Handler Systems, Hot Water System, Chilled Water System, Variable Volume Terminal Units, and Fan Coil Unit controllers.

1.03 QUALITY ASSURANCE

A. The contractor shall furnish, install, adjust, calibrate, and make ready for use all required devices as stated in the controls equipment schedule, on the drawings, wiring, instrument air piping, and accessories required for a complete and totally functioning HVAC control system. SNL shall only furnish the MBC cabinet, Controller Modules, Power Supplies and I/O modules to the contractor.

B. The contractor shall provide all power, FCS, and interlock wiring as required by the drawings and specification. This work includes all trenching, coring, etc. necessary to support installation of the wiring systems.

C. Unless otherwise specified Sandia National Laboratories (SNL) will provide the PPCL programming, code and graphics. SNL will provide, load, and checkout the PPCL and point database and perform controls system functional test.

D. The contractor will perform all start-up, database, and programming for the Terminal Equipment Controllers (TEC's) using contractor supplied equipment. The programming shall be completed in accordance with FCS department established standards.

PART 2 - PRODUCTS

2.01 GENERAL

All control devices and products shall be selected in accordance with the equipment schedule on the contract drawings. Installation of the components shall be in accordance with Part 3 of the Section. If a component is required to meet the requirements shown on the drawings and is not specified, the Supplier shall select and submit on components that meets all design requirements indicated on the drawings, stated in the sequence of operation, and elsewhere in the Contract documents. The quality of the submitted product shall be commensurate with other products.

2.02 WIRING

A. All wiring shall comply with this specifications and SNL Standard drawing MI5001STD.

B. FCS Class II wiring

1. Field wiring for each analog sensor shall be two conductor 20 AWG twisted, shielded stranded with white sheath.

2. Field wiring for each digital input device shall be two conductor 20 AWG twisted, shielded stranded with blue sheath.

3. Field wiring for each digital output device shall be #14 type THWN. Wiring shall be black.

4. Power wiring for end-controlled devices shall be 18 AWG cable with white sheath.

5. All wiring shall be installed in electrical-metallic tubing (EMT) with watertight compression-type thread less fittings or rigid galvanized steel conduit (RC) or Intermediate Metal Conduit (IMC).

6. All buried conduit shall be installed in accordance with the Division 2 Exterior Site Construction sections of these specifications.

C. FCS Class I wiring

1. All materials required for installation of Class I circuits or circuits operating at greater than 48 VAC or VDC shall meet the requirements stated in Section 16001 “Electrical Work”, National Electric Code, and all applicable building codes as they apply to Class I circuits.

2.03 INSTRUMENT AIR PIPING

A. Instrument air piping shall be copper or flame-retardant poly tubing installed in EMT conduit.

B. All instrument air piping shall be 1/4" O.D. unless approved prior to the start of any work.

PART 3 - EXECUTION

3.01 GENERAL

A. All field hardware, control devices, conduit, wiring, etc. shall be new and installed in a neat professional manner by skilled persons fully qualified for their respective area of expertise.

1. The installation of all aspects of the system shall comply with all applicable codes and regulations.

2. The installation of all materials shall be in accordance with the published manufacturer's recommendations without exception. If for some reason a particular component cannot be installed in compliance with these recommendations, the Contractor shall advise the Construction Observer of the situation.

3. Coordinate with other trades and other Contractors where installation of a particular component requires other trades or Contractors to be involved. Installation coordination includes the correct location and placement of thermo wells, flow switches, dampers, control valves, control power circuits, etc. Care must be exercised to identify locations that meet the requirements of the manufacture including upstream and downstream distances, pressures, temperatures, and accessibility for maintenance.

4. All signal wiring requiring shielding shall have the shield terminated at the MBC end only.

5. Label all wiring in MBC cabinet and at all devices with permanent Brady type labels, or equal, using point description or Apogee logical point name.

B. When programming is specified to be done by the contractor all software database development shall be completed by programmers that been trained and approved in the programming and graphics development techniques of the FCS. All software database shall be written using SNL standard routines. All tools required shall be contractor supplied. Loading of any program, database, graphic system, or connection to the FCS Network shall be done under the supervision and/or consent of the SNL FCS organization.

3.02 MODULAR BUILDING CONTROLLER

A. General

1. Install MBC's where indicated on the drawings and a minimum of 5 feet from all power sources greater than 100 kVA.

2. Install the MBC I/O Modules, power supply, communication controller, expansion modules, communications line, and I/O keys in accordance with the manufacturers instructions.

3. All MBC's shall be installed in accordance with manufacturers instructions. 120 VAC power shall be provided to each MBC Controller as under a separate contract. All power shall be verified as work of this section prior to powering the MBC's.

4. Separate all I/O, power, and communications conductors in accordance with the NEC, the electrical sections of these specifications and SNL Standard drawing MI5001STD. All conduits shall terminate at wire gutters located above and/or blow the MBC with home runs routed from the gutters to the MBC's.

B. Communications

1. It shall be the work of this section to coordinate and connect new MBC's to a building level network as indicated by the project drawings.

C. Input/Output

1. All I/O wiring shall be terminated on the respective I/O module in accordance with the details on the SNL Standard drawing MI5001STD and in accordance with the manufacturers instructions.

2. Each point shall be checked by the contractor for voltage, short circuit, grounded circuit etc. prior to termination to the MBC to prevent potential damage to the controller.

D. Software Requirements

1. All sequences of operation as stated on the drawings are to be implemented. In addition to these specific sequences, the following general requirements shall be implemented for a complete operating software package.

2. All digital input, digital output points, and digital software points (triggers or flags) shall be setup to accumulate totalized run time information. The frequency of accumulation and reset shall be based on report and trending requirements.

3. Alarm points and destinations will be determined by SNL FCS group and furnished to the system programmer.

3.03 TERMINAL EQUIPMENT CONTROLLERS (TEC)

A. General

1. Install TEC's where indicated on the drawings. TEC's and damper motors for terminal units may be shipped to the terminal unit manufacturer's factory for factory mounting.

2. All TEC's shall be installed in accordance with manufacturer's instructions. TEC's shall be installed inside of NEMA 1 electrical enclosures or enclosures furnished with the terminal units. A maximum of 5 TEC's per 24 VAC power circuit shall be allowed.

3. For electrical sources of 50 volts or greater, effectively shield and insulate all transformer primary terminations inside TEC enclosure to prevent inadvertent contact by personnel or install transformer in separate NEMA 1 enclosure.

4. Separate all I/O, power, and communications conductors, and label wiring in accordance with the NEC, SNL Standard drawing MI5001STD, and the electrical sections of these specifications.

B. Communications

1. It shall be the work of this section to coordinate and connect new TEC's to a floor level network as indicated by the project drawings.

C. Input/Output

1. All I/O wiring shall be terminated on the respective I/O module in accordance with the details on the SNL Standard drawing MI5001.STD and in accordance with the manufacturers instructions.

2. Each point shall be checked by the contractor for voltage, short circuit, grounded circuit etc. prior to termination to the TEC to prevent potential damage to the controller.

3.04 ELECTRONIC DIFFERENTIAL PRESSURE TRANSMITTER

A. All differential pressure transmitters shall be installed where indicated by the drawings. The transmitters and housings shall be rigidly supported to prevent vibration and shall not be mounted to ductwork or piping. Access to the transmitter shall be provided. Connections from the “HI” and “LO” pressure port to the differential pressure transmitter shall be 1/4" copper tubing or poly tubing in conduit. Sensor tubing shall be connected to static pressure probes (indicated in the equipment schedule) installed in ductwork or air handler.

3.05 CURRENT SENSING SWITCH

A. Current switches shall be installed on one leg of three phase circuits and the hot leg of single phase circuits and in all cases, after the local disconnect. The switch shall be securely mounted in the associated motor starter housing or motor control center. Adjustable type switches shall not be used unless approved by FCS personnel.

3.06 CONTROL RELAYS

A. Control relays shall be mounted where indicated on the drawings. If a relay must be field mounted in locations other than control cabinets, it shall be installed in an appropriate NEMA rated enclosure, and shall be properly labeled.

B. All relays shall have plug-in type bases or be mounted on DIN rails. All accessories including end clips, jumpers, etc. shall be provided and installed. All wiring shall be labeled. Multiple conductors shall be bundled and run by wiring class. Conductors inside control cabinets shall be run in plastic wire ways. Relays shall be labeled as indicated in the shop drawings for ease in troubleshooting.

3.07 CONTROL TRANSFORMERS

A. Control transformers shall be mounted where indicated on the drawings and as specified on SNL Standard drawing MI5001STD. See 3.03A3 for special installation instructions.

B. A phenolic label shall be placed on each transformer enclosure. The label shall identify the voltage level and the power source by breaker panel and circuit.

3.08 CONTROL VALVES

A. All automatic control valves shall be delivered to the contractor for Installation per the Division 15 Mechanical Specifications.

B. Control valves 2 inches of smaller shall be screwed pattern with bronze body unless indicated otherwise on the drawings.

C. Control valves larger than 2 inches shall be flanged with cast iron body unless indicated otherwise on drawings.

D. All 2-way control valves shall be capable of tight shut-off against total system differential pressure.

E. Valve pressure-temperature ratings and materials of construction shall be suitable for the intended service. Valves intended for steam service shall be rated for 350F.

F. Modulating control valves shall be fitted with equal percentage or linear Characteristic-modulating plugs, as the services requires.

G. Valve sizing data, including capacity index, shall be indicated on the control submittal diagrams and shown on the flow diagram drawings.

H. Visible position indicators shall be provided on all automatic valves.

3.09 CONTROL VALVE ACTUATORS

A. Valve actuators shall be ordered factory mounted to control valves whenever possible.

3.10 WIRING

A. General

1. All Class I and Class II wiring shall be run in a metallic raceway or conduit system of the appropriate design for the application. Refer to section 16001, “Electrical Work” for details.

2. Conductor type (solid or stranded), sheath color and gauge shall be as specified on SNL standard drawings. Wire sheathing type shall be selected by circuit class. Conductor sheath types stated on drawings are provided to indicate the design intent only.

3.11 DAMPER /ACTUATORS

A. Control Damper

1. Damper shall be low leakage type, Ruskin CD-50 series airfoil unless otherwise noted on the drawings.

2. Damper shall be standard louver type of heavy duty construction with each leaf reinforced. Damper shall be provided with non-ferrous self-lubricating bearings.

3. Damper shall be of aluminum unless indicated otherwise on the drawings

4. Damper frame, blades, shafts, linkage, bearings shall be non-corrosive.

5. Damper blade edge seals shall be replaceable and of vinyl, silicone rubber, neoprene, or other synthetic elastomer.

6. Damper shall have a published leak rate note exceeding 5 scfm per square foot at 1.5 inches W.C. differential pressure unless indicated on the drawings.

7. Modulating dampers shall have opposed acting blades, unless indicated otherwise on the drawings.

8. Each damper section shall have an individual motor, derated so there is 10 percent over-capacity available over published rating for dust and corrosion buildup and shall be additionally sized to operate against the total static pressure of the system

B. Electronic Damper Actuators

1. Damper actuators shall be mounted on the damper jackshaft or shaft extender using a "V" clamp in accordance with manufacturers instructions provided with the unit. All actuators shall be securely anchored to ductwork or damper housings.

C. Pneumatic Damper Actuators

1. Damper actuators shall be mounted in accordance with manufacturers instructions provided with the unit. All actuators shall be securely anchored to ductwork or damper housings.

3.12 POINT VERIFICATION TESTS (PVT'S)

A. PVT's are intended to document the proper operation of hardwired points from the field devices through to the man machine interface port at the attached control cabinet. PVT's shall be witnessed by necessary system engineers, FCS representatives, operators, test and balance personnel, and a contracting administrator or appointed representative.

B. Each hardwired point of the FCS shall be tested and approved with a PVT prior to the start of the functional performance tests (FPTs).

C. PVT's are not intended to troubleshoot problems or calibrate field devices. This effort should occur prior to the actual implementation of the PVT. This work includes control, installation, verification, calibration, terminations, labeling, software integration, etc.

D. The following PVT procedures outline the type of testing that will be required for each point of each system. Field conditions may dictate a change in the test procedures. In these cases the test shall be modified to accommodate the field conditions while still retaining the effectiveness of the test procedure.

1. Motor start/stop

a. The respective motor starter "hand-off-auto" switch shall be placed in the "off" position and the motor shall stop.

b. The motor starter "hand-off-auto" switch shall then be placed in the "hand" position and the motor shall run.

c. The motor starter "hand-off-auto" switch shall then be placed in the "auto" position. From the control cabinet, the "hand-off-auto" switch on the point module (if applicable) shall be placed on the "off" position and the motor shall stop.

d. From the control cabinet, the "hand-off-auto" switch on the point module (if applicable) shall be placed on the "on" position and the motor shall run.

e. From the control cabinet, the "hand-off-auto" switch on the point module (if applicable) shall be placed on the "auto" position.

f. From the MMI at the control cabinet, the respective motor control start/stop point shall be placed in a manual "off" position. The motor shall stop.

g. From the MMI at the control cabinet, the respective motor control start/stop point shall be placed in a manual "on" position. The motor shall run.

2. Motor status

   a. Start the motor using the motor starter "hand-off-auto" switch and verify, using the current switch LED (if provided), that the current switch closes when constant speed motors are running, or at a point below the minimum set running speed of speed controlled motors.

   b. Verify that the LED status indicator on the MBC I/O module indicates operating status.

   c. Return the motor starter "hand-off-auto" switch and the control cabinet "hand-off-auto" switch to the "auto" position.

   d. At the MMI at the control cabinet, read the calculated transmitter signal in inches W. C.

   e. Compare the reading at the local pressure transmitter to the reading at the MMI. The two readings should be within 2% of the full-scale reading of the FCS transmitter.

   f. From the MMI at the control cabinet, command the motor to run and verify that the associated status is verified at the MMI.

3. Modulating valves and dampers.

   a. Start the respective fan or pump motor.

   b. From the MMI at the control cabinet, position the actuator at 100% open. Allow the actuator to travel fully and visually verify that the device is 100% open.

   c. Repeat (b) for 50%, 25%, and 0% positions.

4. Static and Differential Pressure Transmitters, and flow meters (connected to the FCS)

   a. Install a calibrated portable differential pressure meter at the connection location of the FCS pressure transmitter.

   b. For flow meters, compare the calculated flow value at the MMI to that measured by the test and balance contractor. The two readings should be within 5% of the full-scale reading of the FCS transmitter.

c. Manipulate a flow damper or other mechanical device manually to test each point at four distinct values, including two values close to the minimum and maximum ranges of the transmitters, and repeat steps a through d as necessary.

5. Temperature Sensors

a. All temperature sensors shall be verified with a calibrated temperature meter for accuracy.

3.13 PRE-FUNCTIONAL PERFORMANCE TEST REQUIREMENTS

A. Prior to the beginning the Functional Performance Testing (FPT), the following work shall have been completed and approved. Functional Performance Testing is intended to test the final installation and sequence of operation, not a simulation or a partially completed system.

1. Each system and/or piece of related equipment have been cleaned and/or flushed for operation.

2. The equipment/systems have been inspected for proper installation. Mechanical/Electrical components and equipment of the related systems have been checked for motor rotation belt alignments and mechanical clearance of all moving parts.

3. Each instrument has been installed as per manufacture's specifications and calibrated prior to or after placement in the systems.

4. Factory start-ups have been performed on required equipment.

5. Test and Balance has been performed on all related systems.

a. All PVT's relative to the system have been successfully completed and accepted.

b. All equipment safety circuits have been tested and adjusted (Freeze Stats)

c. All system DDC point databases and programming has been installed in control cabinet and tested to verify proper sequence of operation.

3.14 FUNCTIONAL PERFORMANCE TEST PROCEDURES

A. General

1. The Functional Performance Test Procedures (FPT) are designed to test all aspects of the sequence of operations as outlined in the contract drawings and specifications.

2. All FPT's will be developed by the contractor, and checked by FCS personnel, and submitted in accordance with Part 1 of this section.

3. FPT's shall be witnessed by necessary engineers, operators, FCS personnel, and contracting administrators or appointed representatives.

4. All tests shall be documented with the testing results recorded during the testing period.

5. The following test is provided as an example of a written FPT. It may be used as a template when developing the FPT procedures.

System Functional Performance Test (EXAMPLE)
Hot water system

A.	Ensure that all systems/equipment needed to operate the hot water system are operational.	Date:_____ Initial:_____
B.	Trend logs shall be implemented for the entire 24-hour testing period. Verify all FCS graphics are correct and functional.	Date:_____ Initial:_____
C.	Verify that all hot water pumps are operator selectable.	Date:_____ Initial:_____
D.	Vary the range of the outside air temperature through the FCS from 75 deg F to 35 deg F. Verify that the steam valves modulate to maintain the hot water supply temperature linear reset schedule.	Date:_____ Initial:_____
E.	With the hot water system in operation verify the condensate flow meter for proper operation/calibration and the FCS shall be verified for proper reading of the flow meter.	Date:_____ Initial:_____
F.	Simulate a lead pump failure. Verify the starting of the lag hot water pump. Repeat procedure for both pumps.	Date:_____ Initial:_____

END OF SECTION 13943