SECTION 23 09 00
BUILDING MONITORING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install a complete direct digital control (DDC) Building Monitoring System (BMS) for automated building equipment control as manufactured by Schneider Electric, or other pre-qualified and Owner-approved vendor. All systems shall be provided directly by the manufacturer, or by a dealer licensed by the manufacturer. The manufacturer must provide full support to the licensed dealer throughout the guarantee period.

B. The BMS shall perform all sequences of operation, which may be listed in Part 3 of this specification and/or in the Appendix B & M801. The control system vendor shall provide all hardware, software, sensors and devices necessary to completely perform the specified sequences whether such devices are explicitly shown on the drawings, specified, or not shown or specified.

C. Provide the services of control vendor's representative to be on site during installation and during the entire time that the startup, testing and balancing procedures detailed in other sections, take place. Provide a full operational test of all systems and all sequences in the presence of the Owner and Engineer, and provide training for the Owner's maintenance personnel as specified herein. The representative shall be part of the manufacturer's service organization and shall be skilled in the adjustment and calibration of all control devices as well as being capable of modifying and checking system software.

D. Certify maintenance of local office within 50-mile radius of job site, staffed with factory-trained engineers capable of providing instructions to Owner's personnel, and performing routine and emergency maintenance on all system components. Provide service contract with 24-hour response time as specified below for first year of operation.

E. The scope of work includes, in general, monitoring and control of certain data center and Electric Room HVAC systems, including sequencing and monitoring of MAUs and Precision Cooling Systems, and support area equipment including exhaust fans and Humidifiers. In addition, the BMS shall interface with and monitor the operation of the electrical infrastructure systems, fire alarm, security, and power monitoring systems. See Part 3 - Control Sequences or the Appendix B for detailed descriptions of operating and safety controls, monitoring, and alarm functions for each system.

1. Control of Ventilation MAU, Computer and Electric Room Precision Cooling System is, in general, by the respective vendor.
2. Refer to Owner furnished document in Appendix A, DLR Data Center –- Liebert DSE Systems – Data Center and Electric Room - Sequence of Operation – Release Version 2.4 for specific and detailed sequences.
3. Refer to Controls Responsibility Matrix on drawing M803 for installer/vendor/contractor requirements.
4. Refer to Computer Room Design Criteria table on drawing M803 for indoor environmental requirements.

F. PBB RTUs, Fan Powered Terminals, PBB exhaust fans will also be in scope of work of this project. The PBB HVAC system will be incorporated into the existing PBB BMS.

G. Furnish and install all conduit and wiring to complete field-wired interconnection of sensors and control devices with packaged control systems for MAUs and exhaust fans as well as providing wiring for devices controlled by BMS. Provide network interface wiring between packaged unit control systems and the BMS for open communication of operating parameters and alarms.

H. The system shall provide for a specific allowance of I/O points as specified herein or on the drawings for monitoring of electrical equipment status and alarms, as well as providing virtual points and accepting communications from these systems through an open protocol. The system shall provide for future expansion of HVAC systems, and may also include monitoring of the, fire alarm systems, specified in other sections of the project specifications. Systems outside of the scope of HVAC systems are specified by others.

1.2 SYSTEM PERFORMANCE

A. The system shall operate continuously, and shall be provided with surge suppression and a minimum of 60-minutes of uninterrupted power supply, as well as with standby power from the data center generator system. The system shall remain in operation at all times, and shall provide an orderly start-up of controlled equipment after a power failure to avoid overloading the generator.

B. The performance of the system, with respect to minimum point scan rates, speed of command response, alarm response, etc. shall be adequate for the individual system response requirements, and every effort shall be made to minimize control response times through consolidation of points in a common building controller, and optimization of I/O signal routing. In any case, the maximum response time by any controlled device to act shall not exceed two seconds from the time the command is given (analog objects adjustment must start, but may not be complete, depending on the actuator). The object scan rate shall be such that any change of value or change of state data displayed on any operator interface shall be current to within the last six seconds.

C. Alarms shall be annunciated at the operator's workstation within 45 seconds of their occurrence, unless a software delay is included as part of the sequence of operation.

D. Controllers shall be able to execute PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

E. Graphic display pages shall be capable of loading and displaying data, or refreshing all points with current data within 10 seconds.

F. The system shall report all values with accuracy equal to the monitored sensor accuracies, which are specified in Part 2 - Products. Control loops shall maintain the measured variable at set point within the tolerances indicated in Part 3 - Control Sequences.

1.3 WARRANTY OF SYSTEM

A. The DDC system Vendor/Contractor shall guarantee the entire control system and its physical installation, including sensors and transmitters, actuators and other end devices, controllers and associated power supplies, transducers, transformers, and switches, and all wiring and pneumatic tubing to be free from defects in material and workmanship for a period of not less than one year from the acceptance of the system by the Owner. Only new equipment and devices shall be used on this project.

B. The Vendor/Contractor shall guarantee the performance of the entire control system, including accuracy of measurement and control outputs, speed of response, and applicability of device control capability and ranges to the controlled devices and the required tolerances around set point. The Vendor/Contractor shall provide the necessary labor to tune all control loops to an acceptable level of stability, and shall warrant that the control loops will function in a stable manner, free from defects in material and workmanship for a period of not less than one year from the acceptance of the system by the Owner.

C. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. The Vendor/Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

D. The Vendor/Contractor shall identify any deviations in his proposed warranty from the requirements noted above at the time of bid.

1.4 SUBMITTALS

A. The control systems installer shall provide full documentation on all equipment, hardware, software, and installation procedures for approval by the Owner and the Engineer. No work may begin on the installation of this project until the submittals have been reviewed and approved by the Owner and the Engineer. Submittals shall be provided as soon as possible after award of contract, and at least two weeks should be allowed for review and comments.

B. Submit six sets of the following shop drawings and device documentation for approval:

1. Control drawing for each system, with detailed piping and wiring diagrams, including bills of materials and written description of operation. All sensor and device points shall be labeled with I/O addresses corresponding to their BCU termination point. The sequence of operation shall not simply repeat the sequences specified on the contract document but shall provide full detail as to required interlocks, time delays, and calculation routines which are a part of each sequence.
2. System layout drawing showing DDC panels (BCUs and ASCs), central computer, paging and/or dial-up messaging equipment, and communication network. Indicate actual locations of equipment referenced to a floor plan.
3. Point List, listing every component to be sensed or controlled, including I/O device, signal type, control function, and associated alarms.
4. Damper schedules showing sizes, configurations, capacities, pressure drops and locations of equipment.
5. Data sheets and specifications for control system components, including sensors, transmitters, transducers, panels, controllers, and other devices.
6. Complete software information including names of software packages provided, control sequences performed including flow chart logic diagrams, complete information on user programmability (commands, language details, programming sequences, etc.), and complete description of operating system. Provide full description of central computer and color graphics system and accessories.

C. Within one month of contract award, furnish a schedule of the work, including intended sequence of work items, with start dates and durations, and critical path items. Provide a monthly written status report, including any revisions to the schedule. Work shall be completed as required by the overall construction scheduled and owner required completion date. Work shall be scheduled to be completed prior to system integrated testing.

1.5 VALIDATION REQUIREMENTS

A. Provide one hard copy and one electronic copy of as-built system documents to Owner's operating personnel, including as-built shop drawings and narrative descriptions of sequences of operation, including input and output signals (electronic and pneumatic), and performance and specification sheets for all sensors, controlled devices, controller units, and other hardware. Record drawings shall be furnished in AutoCad format on a CD.

B. Provide one hard copy and one electronic copy of operation and maintenance manuals, including as a minimum, procedures for operating the control systems, including logging on and off, alarm handling, producing point reports, trending data, overriding computer control and changing set points and other variables, and procedures for maintaining the system, including sensor and control device maintenance and calibration procedures.

C. Provide at least one hard and one electronic copies set of programming manuals with description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor. Provide building blocks for use in creating new graphics and new points for the system.

D. Provide testing and commissioning reports for calibration of sensors, loop tuning parameters, and start up of the system. Provide electronic backup files of all software, along with related licenses and warranties.

1.6 START UP AND PROGRAMMED MAINTENANCE

A. Start system and perform necessary testing and debugging. Perform acceptance test in presence of Owner's representative and Engineer. Provide 15 days notice before acceptance test. Notice shall certify that system is complete and operates as required by contract documents. When system performance is deemed satisfactory, system parts will be accepted for beneficial use and warranty shall begin.

B. Submit manufacturer's agreement to provide necessary programmed maintenance and to maintain systems for one year from date of final acceptance, within contract sum. Programmed maintenance agreement shall identify maintenance work to be performed and shall quote cost of work for two years subsequent to guarantee period. Update software free of charge during warranty as manufacturer's software is improved.

C. Provide a minimum of 24 hours of on-site instruction in operating DDC system, and provide at least six sets of training manuals for use by the operators.

1.7 COODINATION AND WORK BY OTHERS

A. The BMS Vendor/Contractor shall cooperate with other vendors/installers performing work on this project as needed to achieve a complete and working installation. Consult the drawings and specifications related to other trades to determine the nature and extent of others' work, and resolve potential conflicts by coordination with others through the construction manager.

B. The BMS Vendor/Contractor shall furnish all, control dampers, and similar instruments for installation by the Mechanical Installer, and shall provide field supervision for their installation.

C. The BMS Vendor/Contractor shall provide and install all control wiring to all sensors and devices included under this section, utilizing licensed electricians and working in accordance with the requirements of NEC and local building codes. Power wiring to motors and dedicated circuits for control wiring will be provided by the Electrical installer. Fire alarm system devices and panels will be furnished and installed by the Fire Alarm Installer, as will fan shutdown controls and power wiring to smoke dampers, however, wiring of alarm notifications specified herein shall be provided by the BMS Vendor/Contractor.

1.8 CODE COMPLIANCE

A. Provide BMS components and related equipment which are UL-916 Listed and labeled.

B. All equipment or piping located in conditioned air streams or plenums shall comply with NFPA 90A requirements for maximum flame spread/smoke developed/fuel contributed rating of 25/50/0.

C. All wiring shall conform to the Electric Code. Route all control wiring within rigid EMT or conduit.

D. All smoke dampers shall be rated in accordance with UL 555S.

E. Comply with FCC Rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments. Comply with FCC Rules Part 68 for telephone modems and data sets.

1.9 ADDITIONAL REQUIREMENTS

A. This specification covers the requirements for the BMS to monitor and control the HVAC systems and the resulting environmental conditions for the building. Additional points and sequences for monitoring and/or controlling process equipment, and fire alarm controls, if any, shall be specified by others, in other Sections of the Project Specifications.

B. The scope of work, materials and products, programming and installation specified herein shall be considered the minimum scope of work and deliverables for this project. The BMS Vendor/Contractor may offer extra cost options for the integration of packaged equipment controls, or may offer "value engineering" deductions based on his standard practice, as long as the proposed additions, deletions, or substitutions are proposed at the time of bid, and each one is specifically identified with a cost benefit or penalty. The Vendor/Contractor shall clearly identify any deviations from this specification in his proposed scope of work and deliverables with his bid.

C. Section 23 00 10 – General Mechanical Requirements, is an integral part of this section. Requirements and work indicated in 23 00 10 are not repeated in this section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner and Engineer in writing.

B. Spare parts and/or equivalent replacement devices shall be available for at least five years after the completion of this project.

2.2 SYSTEM ARCHITECTURE

A. The BMS shall consist of a dedicated high speed network of stand-alone building control units (BCUs) and secondary level controllers designed to monitor and control the data center HVAC systems and to provide hard-point monitoring and alarm functions for the mechanical and electrical infrastructure systems. In addition, the BMS shall accept and display virtual points for all RTUs, Precision Cooling Systems, UPS systems, PDUs, generators, and other equipment via open protocol such as Modbus or BacNET, to allow monitoring of all equipment via their individual microprocessors as described by the control sequences and input/output lists specified herein and on the drawings. The system shall include an operator interface with capabilities for communication and access with external locations via separate local area network, telephone, and/or broadband cable systems.

B. The BMS network shall operate on a true token pass, peer to peer communication basis. The internal microprocessors which reside within each BCU shall provide for full exchange of system information between each BCU on the network communication trunk. The system shall not rely on the central computer interface to exchange system information. Failure of any one of the network BCUs shall not affect the operation of other BCUs residing on the same network. Each BCU shall be fully programmable, and shall have full capability for monitoring, control, point trend data collection, and alarm functions for the equipment it serves, and shall be equipped for local operator interface in addition to its network connection.

C. The system architecture may also include secondary level, or application specific controllers (ASCs), connected between the BCU and the equipment to be controlled. Such controllers may be used to control an individual AC unit, and are expected to communicate through the respective BCU. However, all complex systems in this project, and monitoring functions shall be served by fully programmable BCUs as specified below.

D. The system architecture may include gateways to interface the BMS with packaged equipment controllers, or with other building or process control systems. The specific communication gateways may be specified as line item options in Part 1, or in the control sequences listed in Part 3.

E. Network transmission shall occur at typical Ethernet speeds of 10/100 mb/sec. All transmission shall incorporate data integrity and validity check routines.

2.3 BUILDING CONTROL UNITS (BCUs)

A. Each BCU shall monitor and control the HVAC and utility system functions for the specific group of equipment it serves. The analog and digital inputs from sensors, transmitters, and switches shall be continuously used with the individually programmed logic sequences to control analog and digital outputs to valve and damper actuators, motor starters and variable frequency drives, switches and relays, and other controlled devices. All BCUs shall be connected directly to the transmission network, but shall operate independently in that individual BCU functions shall not be degraded by loss of the central computer or failure of the transmission network that connects the BCUs and the computer.

B. Each BCU shall include the necessary software and firmware to provide for its independent operation, and shall be capable of upgrade by the system manufacturer for future enhancements or improvements. The BCU shall have sufficient memory to support its operating system, database, and programming requirements. The BCU shall execute application programs, calculations and commands through its microprocessor, and shall communicate with other BCUs on the network, as well as the central operator interface. The microprocessor shall be capable of proportional plus integral and PID control loops, and shall permit independent floating point calculations for all arithmetic functions. The microprocessor shall provide analog/digital conversions, alarm recognition and generation, and communications. Provide real-time clock with external synchronization feature to enable the BCU to perform time-based scheduling functions automatically. All programming and operator-adjustable values shall be accessible through the individual BCU, although operator interface will generally be via the central computer.

C. Each BCU shall be provided with a minimum of 16 universal (software selectable analog/digital input/output) points, alphanumeric display and keypad, and communications port for local connection of terminal or printer. The configuration of each BCU shall allow for at least two spare input and two spare output points for each panel. In general, a separate BCU shall be used for each major system depending on point count, e.g. one for each group of RTUs and all control points associated with a given control loop shall be monitored or controlled from a single BCU to optimize response times and ensure that a unit failure will not affect other systems.

D. The BCU shall continuously check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode and generate an alarm notification. Provide diagnostic LEDs for power, communication, and processor. Provide battery backup capable of retaining full system memory for a minimum of 72 hours.

E. Each BCU shall be capable of operating in ambient conditions between 32°F and 120°F and up to 90% RH (non-condensing). Install each BCU in a control cabinet rated for the intended environment.

F. Provide surge transient protection to BCU to suppress induced voltage transients. The controller shall be able to operate at 90% to 110% of its nominal voltage rating, and shall perform an orderly shutdown below 80% of nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz, and from keyed radios up to 5 watts at 3 ft distance.

G. The system shall be designed for phased start-up by providing all wiring terminals on the panel backplate with a plug-in microprocessor chassis. Installed BCUs shall be capable of communicating properly with I/O devices and with the central computer while remaining BCUs are being installed.

H. Each BCU shall be UL-916 listed and approved, FCC and CSA certified.

2.4 CENTRAL OPERATOR AND GRAPHIC DISPLAY INTERFACE

A. An operator's interface to the control system shall be provided.

B. The software shall be graphically oriented. The system shall allow display of up to ten graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and to change the size and location of graphic displays on the screen. The displays shall consist of full color graphic flow diagrams of the systems involved. Each graphic shall include all major HVAC components, control sensors and controlled devices, flow paths, alarms, and other pertinent information.

1. For each Precision Cooling System and MAU the graphic shall include a schematic drawing of the unit with filters, coils, fan(s), and ductwork or flow paths directly related to the unit. The graphic display shall indicate differential pressure across filters, along with alarm point and status, output signal or position of damper actuators, on-off command and status of fans, set points and real-time measured values for temperature, humidity or dew point, pressure and/or differential pressure, alarm points, and other data indicated in the control sequence descriptions which are related to the unit and to its respective system.
2. For each damper specified to have proof of position, the graphic display shall indicate the end switch or proximity switch closure as part of the valve or damper graphic image.
3. For each fan, or other motor-driven equipment item, the graphic display shall indicate the commanded state and the actual status, including speed reference and feedback for motors driven by VSDs. The graphic image shall include a means of determining normal vs. alarm status for each motor. For multiple units, such as the redundant exhaust fans, which are specified to be alternated periodically, the graphic display shall indicate total run-time hours, lead-lag position or active-standby status, and the date and time of the next scheduled unit alternation. The date and time shall be automatically indexed by the programmed schedule at the completion of each alternation event.

C. Graphic display screens, or pages, shall be arranged in a logical hierarchy, and shall be accessible either directly from a text-based menu or from a "control panel" graphic with icons for selecting each page, or through a progression from a basic building "overview" page to individual building areas and system pages, to individual room or equipment pages. The BMS vendor shall propose a list of graphic screens with their associated points, graphic images, and access hierarchy with his system submittal for approval. However, for this project, the following may serve as a guideline:

1. At the building "overview" level, the screen may show the complete building floor plan, including first floor and roof, with major areas and major systems indicated on each floor plan. Selection of a floor or system from the graphic screen via mouse click shall access the next level of detail for that selection.
2. The next level of detail may include for each floor, specific areas and systems, with basic point values, for example, selection of the data center may access a detailed floor plan of the area, with the space temperature, relative humidity, and equipment indicated.

Selection of a Precision Cooling System shall show basic measurements such as supply and return air temperatures, differential and static pressures, compressor operation, compressor data, etc.

3. Relative humidity, the next level of detail, based on the examples above, may be to select a specific item of equipment, which would access a graphic screen for that unit, showing the entire unit operating parameters and alarm conditions reported through the open communication interface. A mouse click on any of those graphics could access (through password protection) the ability to view and change individual set points and alarm points, reset schedules, and the like
4. The number of screens, and the number of levels of detail will depend upon the sizes of the systems, the ability of the graphic designer to present information in a logical manner without crowding a display page, and the ability of the system to display the screen and update the point measurements in real time. As a minimum, however, there shall be screens based on floor plans to show individual rooms and there shall be screens showing the individual systems and their relationship to other systems. Each graphic screen shall have a consistent and predictable means of accessing a higher or lower level screen for the respective system, as well as a selection for the "home page" index of systems. A consistent format shall be used for all screens to indicate the difference between set point and measured value, commanded state and status, output and feedback, normal and alarm states. See Part 3 - Control Sequences for more specific display requirements.

2.5 OTHER SOFTWARE REQUIREMENTS

A. The operating system shall be Microsoft Windows Vista, Windows XP Professional, or other equivalent multitasking operating system used as a standard by the BMS vendor. The operating system shall allow operator to run and display several applications at the same time.

B. The workstation shall provide the operator interface and off-line storage of system information. The workstation shall store on its hard disk a copy of the current database for each BCU.

1. This database shall be updated automatically whenever a change is made in any system panel. In the event of a database loss in any BCU, the workstation shall automatically restore that database to the BCU, unless the operator manually disables this feature.
2. A system operator with password access shall be able to save the database from any BCU manually, and shall be able to clear a panel database and manually download a specific database into any BCU in the system.

C. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security level and passwords shall be selectable for each operator by the system supervisor, to allow a range of access, from point viewing only, to specific point editing, to control loop programming and database controls. The system shall be set up for at least four levels of security, or as directed by the Owner's system supervisor.

D. The system software shall include a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications, and shall provide the relevant data for that particular screen.

E. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

F. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, time delays, states, and reactions for each object in the system.

1. The operator shall be able to define the actions to be taken for each alarm, including logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics.
2. Logs shall be kept automatically of all alarms and events in the system, maintained chronologically. An operator with the proper security level may acknowledge and clear alarms, and his user id shall be associated with the acknowledged or cleared alarms. Alarms and events shall be archived to the hard disk on the workstation computer on a regular basis.

G. The software package shall be capable of logging point data and providing trend reports in operator-selectable formats. The following capabilities shall be provided as a minimum:

1. The operator shall be able to log any point by selecting the point(s), start time and date, stop time and date, and time interval, or change of value interval. Each BCU shall have the capability to log several related points in a system simultaneously, or in a synchronized fashion to facilitate diagnostics, ie, to determine the effect that an event at one point may have on another point, such as the effect of temperature on relative humidity in a given airstream.
2. Each BCU shall have sufficient memory to handle the sampling and storage of data for all of its associated points for at least an eight-hour period, and shall be configurable to automatically archive the data to the hard disk of the workstation computer to allow long-term, continuous trend logs to be kept. All data shall be easily retrievable from the computer for use in spreadsheets and standard database programs, as well as in reports created through the system software package.
3. The operator shall be able to create standard or custom reports using the system software and logged points (or alarm messages). Each report shall be definable as to data content, format, interval, and date. The software shall facilitate the creation of tables, graphs, and charts for presentation of data.
4. Report data shall be stored on the hard disk of the workstation for historical reporting. Reports and logs shall be readily printed to the system printer, either on operator command, or at a specific time each day.

2.6 DDC SENSORS AND POINT HARDWARE

A. General

1. When providing instruments with 4-20 mA transmitters and conversion to voltage is required at the BCU, the controls contractor shall provide 250 ohm 1% precision resistor.
2. Analog pneumatic outputs (3-15 psi) from BCUs shall be produced by an analog output controlling a dedicated electronic to pneumatic transducer which is separately mounted in the BCU field device section of the enclosure for ease of field replacement. The electronic to pneumatic transducer shall be a separate device which is not printed circuit card mounted.
3. Analog outputs from BCUs should be linear variable outputs. If the BMS installer uses the mode of operation for analog output which incorporates "pulse band width modulation" then the "pulse band width modulated" signal shall be converted through a "pulse band width to analog output transducer" which then provides output to the final control element to eliminate an inherent offset that can occur in mechanical electrical "floating control" type control loops.

B. Alarms

1. Alarm contacts shall be wired normally closed (NC). If equipment only has normally open (NO) contacts, provide an intervening relay that will have NC contacts which shall open via the NO relay. When in alarm condition or if wire to contact is opened (say wire cut in field), BCU shall sense condition and generate alarm.
2. Common alarms shall be wired to alarm terminals on manufacturer's control panel. Contacts shall input to BCU. Line printer shall indicate normal or alarm.

3. Priority levels shall be provided for alarms, and alarm messages shall allow different levels for message outputs.
4. Where shown in sequence, alarms shall be provided with software time delays to prevent nuisance alarms due to momentary, non-critical deviations from design conditions.

C. Temperature Sensors and Transmitters

1. All temperature sensors shall be accurate to +/-0.36°F or better over their respective minimum operating ranges. Stability shall be rated at not more than 0.24°F change over 5 years. Sensor, associated circuitry and readout shall have minimum resolution of 0.5°F. All sensors shall withstand ambient temperatures of -30°F to 240°F, but performance requirements must be met only for ranges specified.
2. Furnish and install room temperature sensors and transmitters as indicated on the control schematics and in the sequence of operation for the data center, UPS room, and battery room, and for all offices and support spaces conditioned by the rooftop units. Wall-mount units shall include surface-mount, low profile, white plastic covers. Operating range shall be 40° to 100°F.
3. Furnish and install duct-mounted temperature sensors/transmitters as indicated on the control schematics and in the sequence of operation for each packaged rooftop units and the battery room exhaust systems. Use single probe type sensors for supply and exhaust ducts and plenums, and use averaging type inside air handling units for intermediate section temperature measurement. Range shall be -20°F to 140°F.
4. Furnish and install temperature sensor for outside air temperature measurement. Sensor shall be mounted in 24 hour shade location, in proximity to a light colored wall, in an aspirated enclosure insulated with foam from thermal transfer with adjacent structure. Sensor shall operate within the following minimum range: -20°F to 140°F.

D. Humidity Sensors and Transmitters

1. Furnish and install wall-mounted humidity sensor/transmitter where shown on the plans and/or control schematics for monitoring space relative humidity. The sensor shall be a resistive polymer type, with minimum accuracy of +/- 2% at 77°F, including hysteresis, linearity, and repeatability. The range shall be 0-100% RH, and transmitter output shall be 4-20 mA, linear with the range. The sensor shall contain an integral single point calibration potentiometer.
2. Furnish and install an outdoor air humidity sensor/transmitter in an aspirated enclosure, with specifications as indicated for room sensors, above.

E. Pressure Sensors and Transmitters

1. All space and underfloor pressure instruments shall conform to the following minimum standards. Additional specifications are given for specific applications below.
2. All space and underfloor pressure sensors shall be Ashcroft CXLDP or XLDP type sensors with 0.4% accuracy and provided with a nine point NIST calibration certification.
   a. All space pressure sensors shall have a range of +/-0.25” wc.
   b. All underfloor pressure sensors shall have a range of 0 to +0.25” wc.
3. Furnish and install a differential pressure air flow switch in the battery room exhaust duct to provide a loss of flow alarm. The switch shall be equal to a Penn Model P32AC.

F. Equipment Status

1. Flow status for the split systems, rooftop units, and exhaust fans shall be proven by motor current sensing transformers. If more than one fan, or other piece of equipment is started from one start/stop command, each shall have its own current transformer for status proof.
2. Sensors shall be capable of producing analog current value proportional to equipment current load. Sensors shall be accurate to +3% of full scale current. Sensors shall be capable of reading 125% of full load amps (FLA).

3. The BMS shall accept status inputs from specific "customer useable" contacts in packaged HVAC equipment, including the CRACs. See the control sequences in Part 3 for more information.

2.7 HARDWIRED/ELECTRICAL CONTROL DEVICES

A. MAU duct mounted smoke detectors will be furnished by Division 28, installed under Division 23, and wired by Division 28. The smoke detector will be wired to the fire alarm system, with control wiring to the MAUs motor starter for fan shutdown. Wiring to fire alarm system shall be part of work of Division 28. Auxiliary contacts will be provided at each duct smoke detector, and the BMS may use these contacts to provide actions associated with the shutdown of the respective fan.

2.8 MOTORIZED CONTROL DAMPERS

A. Dampers: AMCA-rated, parallel-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

B. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

C. Operating Temperature Range: From minus 40 to plus 200 deg F.

D. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.9 MOTORIZED CONTROL DAMPER ACTUATORS

A. All control dampers, including automatic isolation dampers, shall be furnished and wired by this vendor, and installed by the mechanical installer. Dampers shall be furnished with 120 VAC electric actuators.

B. Actuators for motorized dampers shall be fast acting (15 second) integral spring return, two position units.

C. Actuators for smoke damper applications shall also meet UL 555S and be rated for 350F.

D. All actuators shall be provided with end switches for monitoring by BMS.

E. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

F. Accessories:

1. Auxiliary switches for position indication.
2. Test and reset switches, remote mounted.

2.10 ELECTRICAL WIRING

A. Wiring and connections required for the BMS shall be done under this Section, unless shown otherwise on Drawings, and shall comply with applicable requirements of the Electrical Section. Necessary normal and emergency power wiring to control devices shall be done under this section. Electrical circuits for all controls shall be dedicated only to the control

system. Wiring from building control units to point of use devices shall be a part of the work of this section.

2.11 ADDITIONAL FIELD SERVICES REQUIRED DURING CONSTRUCTION

A. Provide services of control supplier's field engineer to supervise work specified in other Sections:

1. Installation of separable wells, valved pressure taps, and piping furnished under this Section.
2. Provision of auxiliary contacts on magnetic starters with buttons and switches in required configurations.
3. Installation of motorized dampers.

PART 3 - CONTROL SEQUENCES

3.1 GENERAL CONTROL SYSTEM NOTES

A. All control sequences for temperature, relative humidity, air flow rate, and pressurization control shall be PID (proportional-integral-derivative) unless specified otherwise.

B. All set points for temperature, relative humidity, air flow rate, and static or differential pressure shall be adjustable by the operator (with password access), and shall be programmed with operator-adjustable high and low alarm points. In some instances, additional control actions may be specified to occur between the set point control range and the alarm point. In the control sequences that follow, initial set points are indicated where known.

C. All alarm points shall be programmed with an operator-adjustable time delay for alarm reporting, to prevent nuisance alarms due to momentary excursions in a system which is slow response by design. In the control sequences that follow, initial time delays are indicated where known.

D. For any motor or system specified for start/stop control by the BMS system, a digital input shall be reserved for a status tell back, typically via a motor current transformer or a differential pressure switch. The tell back shall indicate actual operation of the system, not just the energizing of a starter or contact. Whenever a “start” or “stop” command is given, and the status of the motor or system does not match the command within an operator-adjustable time limit, a failure alarm shall be generated.

E. The graphic display for each system shall include as applicable, manual command buttons and indication of operating state for on-off controls, such as motors and two-way valves, as well as lead-lag and/or standby status for systems with multiple units, and set point display and associated measured value for all operator-adjustable variables. The individual set point, limit, and alarm point input fields shall be easily accessible (at the correct password level) in a sub-menu display from selection of an icon next to or part of the respective set point in the main graphic display (see graphic display requirements in Part 2 of these specifications).

F. For all fan systems, there shall be a labeled and easily accessible means to shut down each fan manually in case of an emergency, in accordance with NFPA 90A. This may be a run/stop or H-O-A switch on the fan motor starter or variable frequency drive, but in any case, the contractor shall provide a label indicating its use for emergency shutdown of the respective fan. When any fan is shut down manually, the BMS system shall disable associated controls which are designed to function only with the fan in operation (such as dampers, valves, humidifiers, etc.) and shall generate a “fan failure” alarm.

G. Refer to Computer Room Design Criteria table on drawing M001 for indoor environmental requirements.

3.2 PRECISION COOLING SYSTEM SEQUENCE OF OPERATION

A. General

1. The mechanical cooling system includes nine Refrigerant Based Precision Cooling Systems with direct expansion cooling and integral refrigerant economizer operation. The graphics display shall show for each unit, it's on/off and alarm status and total run-time hours. The BMS shall enable each system to operate as described in the attached Sequence of Operation document. Systems are sized to handle the peak estimated cooling load for the data center with one or two units redundant depending on operating conditions.

B. Refer to Owner furnished document in Appendix B, DLR Data Center – Liebert DSE Systems – Data Center and Infrastructure Room - Sequence of Operation – Release Dated 04/01/2016, Version 2.1, for specific and detailed sequences.

C. Refer to Computer Room Design Criteria table on drawing M802 for indoor environmental requirements.

3.3 SMOKE ALARMS

A. HSO & Smoke Alarms

1. In the event of smoke sensed in an MAU supply duct, a relay shall disable the respective MAU from operating.
2. In the event of a simultaneous cross-zoned smoke detection in the computer room subfloor, the fire alarm shall activate the HSO switch which will then shut down all the CRACs serving the computer room.
3. In the case of smoke alarm, an indication will be sent to the BMS and an alarm will be generated.
4. In the case of an HSO trip, an alarm will be generated from the HSO active contact closure at the HSO device itself.

3.4 ELECTRICAL/UPS ROOM CRAC UNITS SEQUENCE

A. The Electrical Rooms are served by four CRACs, each sized to handle the load of each room. A NC motorized damper isolates each UPS room in raised floor (see plans).

B. Refer to Owner furnished document in Appendix B, DLR Data Center – Liebert DSE Systems – Data Center and Infrastructure Room - Sequence of Operation – Release Dated 04/01/2016, Version 2.1, for specific and detailed sequences.

C. During normal operation all electrical room CRACs will serve their respective UPS rooms.

D. Upon a failure of any one CRAC, and if there is no detection of smoke, the isolating motorized damper in the supply and return common headers will open. The active CRAC will increase output (air flow and cooling) to meet the load for all the rooms.

1. Refer to Electrical Room CRAC Damper Diagram on Drawing M201 and Fire Alarm Matrix for additional and specific information.

3.5 PACKAGED ROOFTOP VENTILATION UNIT

A. L230-242 have two ventilation Makeup Air Units (MAU) serving each computer room for ventilation and humidity control.

B. The MAU shall be started and stopped through the BMS, but once started, shall operate continuously through its packaged controls to provide conditioning of outside to the computer

room. Each MAU control package shall communicate through a communications link with the BMS.

C. The BMS graphics shall indicate the MAU, with temperature set points and measured values shown on a floor plan of the building. Hard I/O points related to the MAU, as well as any parameters available through an open communication interface shall be accessible through a sub-menu by clicking the mouse on a specific area of the plan.

D. Refer to Appendix B, DLR Data Center – Liebert DSE Systems – Data Center and Infrastructure Room - Sequence of Operation – Release Dated 04/01/2016, Version 2.1, for specific and detailed sequences.

3.6 COMBINATION FIRE/SMOKE DAMPER

A. Each transfer air opening between UPS rooms shall be equipped with a combination fire/smoke damper, with an actuator which is powered to open, and fails closed by a spring mechanism. Both dampers shall close automatically upon loss of power, upon the detection of smoke in either room. In addition, either damper shall close via its respective fusible link upon sensing air temperatures exceeding 165°F at the damper. The graphics display shall indicate the dampers and their open/closed status and any related alarms.

3.7 UPS ROOMS BATTERY EXHAUST SYSTEM

A. Each UPS room exhaust system includes one in-line duct fan as shown on the plans. The fan is connected via ductwork to exhaust intake register located within the UPS room, near the top of the rooms. It is intended that exhaust be provided on a continuous basis for the UPS rooms.

B. A motor current transformer shall be used to prove operating status for each fan. In addition, an airflow switch shall be installed within the exhaust ductwork below the roof.

C. Upon failure of the fan, as sensed by a loss of flow in the exhaust duct, or by loss of amperage at the current sensing transformer, the BMS shall de-energize the fan and generate a fan failure alarm.

D. The graphics display shall indicate the fans, and the exhaust air ductwork, showing the commanded state and status of fan. The display shall also show the duct air flow switch and its alarm status.

3.8 HUMIDIFIER

A. Humidifier units are located in CRAC gallery as shown on plans. BMS shall control the Humidifiers based on underfloor T/H sensors. Refer to Appendix B, DLR Data Center – Liebert DSE Systems – Data Center and Infrastructure Room - Sequence of Operation – Release Dated 04/01/2016, Version 2.1, for specific and detailed sequences.

3.9 ELECTRICAL INFRASTRUCTURE EQUIPMENT

A. The electrical infrastructure system includes packaged standby generators, located outdoors at grade, as well as utility switchgear, and four complete UPS systems located in the UPS room, and multiple power distribution units (PDUs) located within the computer room.

B. As a minimum, the BMS shall reserve at least twenty-four (24) digital input points (confirm with owner) for acceptance of status or alarm points from the electrical infrastructure equipment, and shall be configured to accept a communication interface from the UPS, PDUs, and the

generators, and display all operating parameters and alarm points as virtual points by selecting the individual equipment item from the layout graphic screen.

3.10 MISCELLANEOUS INTERFACES

A. The BMS shall be capable of interfacing with the data center and/or building security system, fire alarm system, and lighting system, all to be defined and specified under separate Sections.

END OF SECTION