NYS Office of General Services
Serving New York

STATE OF NEW YORK
OFFICE OF GENERAL SERVICES
DESIGN AND CONSTRUCTION GROUP
THE GOVERNOR NELSON A. ROCKEFELLER
EMPIRE STATE PLAZA
ALBANY, NY 12242

ADDENDUM NO. 5 TO PROJECT NO. 44180

CONSTRUCTION WORK, HVAC WORK, AND ELECTRICAL WORK
REPLACE SWITCHGEAR
PERRY B. DURYEA STATE OFFICE BLDG.
250 VETERANS MEMORIAL HIGHWAY
HAUPPAUGE, NY 11788

September 7, 2016

NOTE: This Addendum forms a part of the Contract Documents. Insert it in the Project Manual. Acknowledge receipt of this Addendum in the space provided on the Bid Form.

ELECTRICAL WORK SPECIFICATIONS

1. Page 261313-12, ARTICLE 2.11 – AUTOMATIC SWITCHING SYSTEM FOR 13.2KV MAIN SWITCHGEAR AND 480V MAIN SWITCHGEAR: Delete this Article in its entirety and replace with the following:

"2.11 AUTOMATIC SWITCHING SYSTEM FOR 13.2KV MAIN SWITCHGEAR AND 480V MAIN SWITCHGEAR

A. Provide a fully automated, circuit-breaker control system to switch main, tie, and feeder circuit breakers in the 13.2kV switchgear and 480V switchgears E-1 and E-2 to an alternate source upon loss of a normal source. Circuit breaker control shall be as described in Section 261314. In addition, this control system shall control load shedding of all circuit breakers in the 480V Switchgear E-1 and E-2 which will be manually configurable by the facility.

1. A central PLC-based control system shall be provided in the switchgear house complete with all required I/O to execute the sequence of operations described in Section 261314 and as shown on the drawings.
2. All 13.2kV switchgear I/O shall be routed to the PLC-based control system cabinet in the switchgear house and all 480V switchgear I/O shall be routed to the mimic panel located in the office building control room.
3. The mimic panel in the office building shall contain an identical PLC to the central PLC in the switchgear house as well as all required I/O to for the 480V switchgear control as shown on the drawings.
4. All required communication equipment shall be provided to integrate both PLC cabinets.
5. The connection between each PLC cabinet shall be fiber optic cable provided by the Electrical Work Contractor.

6. Each PLC-based control system shall be programmed to provide full controls redundancy for the other, to carry out switching operations if one controller fails.
7. In the event of a PLC-failure, the remaining PLC shall seamlessly assume control of the system to perform the sequence of operations as described in Section 261314.

B. Human Machine Interface (HMI): Provide a touchscreen HMI with color graphics display, 12 inch nominal screen size, NEMA 250 Type 12 enclosure. An HMI shall be provided for both the central PLC controller cabinet in the switchgear house and for the mimic panel in the office building control room. The HMI shall be an Allen-Bradley Panelview, or approved equal.
1. The HMI shall display a system single-line complete with status (open, closed, tripped) of all main, tie, and feeder breakers for all 13.2kV and 480V switchgear lineups. The HMI shall also display metered data from all digital meters located in 13.2kV and 480V switchgear lineups as shown on the drawings.
2. The HMI shall allow manual initiation of all automated main-tie-main switching schemes as referenced in Paragraph A above. Alternatively, the HMI shall allow the operator to open and close main and tie breakers one-at-a-time manually, following the proper sequence for each switching scheme. The HMI shall also provide capability to manually switch each feeder breaker in all 13.2kV and 480V switchgear lineups.

C. The automatic switching system controls, including the HMI, shall be housed in a separate NEMA 12 control panel. Each control panel shall be located remote from the switchgear lineups at the locations shown in the drawings."

HVAC WORK SPECIFICATION

2. SECTION 230923 – DIRECT DIGITAL BUILDING CONTROL SYSTEM: Discard the Section bound in the Project Manual and substitute the attached Section (pages 230923-1 thru 230923-26) noted "REVISED 9-7-2016".

ELECTRICAL WORK DRAWINGS

3. Drawing E-405, GENERAL NOTES, Note 2: Delete this Note in its entirety and replace with the following:
"2. All fire alarm devices shown shall be furnished by others to be installed by the contractor. The electrical contractor shall provide all conduit, wiring, and back boxes as required for installation. Programming of the existing Simplex fire alarm system shall be by others."

HVAC WORK DRAWINGS

4. Drawing M-401, DRAWING NOTES, Note 11: Delete this Note in its entirety and replace with the following:

   "11. DDC CONTROL SYSTEM SHALL BE TIED INTO EXISTING TRANE BMS SYSTEM. THE CONTRACTOR SHALL PROVIDE WIRE TERMINATIONS AT LOCAL DDC CONTROL PANEL, AND AT PROGRAMMING AND GRAPHIC DISLAYS AT THE OPERATOR WORKSTATIONS. PROVIDE ALL CONTROL POINTS AS IDENTIFIED ON CONTROLS POINTS LIST. PROVIDE GRAPHICS TO SHOW EACH PIECE OF EQUIPMENT, TEMPERATURE SENSOR, AND ALARM POINT. ALL SET POINTS SHALL BE FULLY ACCESSIBLE AT OPERATOR STATIONS."

CONSTRUCTION WORK

5. No Addenda at this time.

END OF ADDENDUM

Margaret F. Larkin
Executive Director

SECTION 230923

DIRECT DIGITAL BUILDING CONTROL SYSTEM

PART 1 GENERAL

1.01 OVERVIEW

A. The intent of this specification is to provide a peer-to-peer, networked, DDC system by companies in the HVAC control field.

B. LonTalk BACnet, Arcnet, or Ethernet communication protocols will be used as the primary communication network for communications between multi-BAS/EMS vendors systems in a non-proprietary manner. Project implementation, as specified, requires transferring, receiving and controlling information that resides in multi-BAS/EMS Vendors' "building controllers".

C. LonTalk, BACnet, Arcnet, or Ethernet communications protocol will be used as the communication network between BAS/EMS Vendor Terminal Equipment Controllers (TECs) and secondary network management devices, and between network management devices and future "smart devices and sensors", as they become available. Secondary communications data protocol shall operate on a peer-to-peer open protocol communication network. Minimum system speed shall be 76k baud.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Wiring for Motors and Motor Controllers: Section 260523 – (Included in E contract).

B. Basic Electrical Materials and Methods for Direct Digital Building Control System: Section 260502.

1.03 REFERENCES

A.	ASHRAE Standard 135 - 1995	(1995; Publication pending) BACnet - A Data Communication Protocol for Building Automation and Control Networks
B.	ASHRAE Standard 114 - 1986	(1986; to be re-named as Guideline 13P) Recommended practices guide for verification of end-to-end accuracy in Energy Management and Control Systems (EMCS)
C.	NFPA 70	(1994) National Electric Code
D.	UL 916	(1984; Rev thru Dec 1992) Energy Management Equipment

E. UL UUKL 864 (1991); Smoke Control Equipment

1.04 ABBREVIATIONS AND ACRONYMS

CSIP	Control System Interface Panel
BAS	Building Automation System
DCP	Distributed Control Processors
DDC	Direct Digital Control
EEPROM	Electrically Erasable Programmable Read Only Memory
EMS	Energy Management System
EPROM	Erasable Programmable Read Only Memory
FAIP	Fire Alarm Interface Panel
FTT	Free Topology Transceiver
FSCS	Fire Fighter's Smoke Control System
GDU	Graphic Display Unit
HOA	Hand-Off-Automatic
OS	Operating System
PCP	Digital Plant Control Processors
POS	Primary Operator Station
POT	Portable Operators Terminal
RAP	Remote Access Panel
SCAP	Status and Command Annunciator Panel
TEC	Terminal Equipment Controllers
TP	Time Programs
VAV	Variable Air Volume

1.05 SYSTEM DESCRIPTION

A. The system shall operate as an integrated Direct Digital Building Control System (DDC).

1. Provide new DDC panel in the Switchgear House including associated equipment and accessories. Provide each control system complete, and operating as specified. Manufacturer's products, including design, materials, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with ASHRAE Standard 114 - 1986, ASME B31.1 and NFPA 70, except as modified herein or indicated otherwise.
2. Provide the DDC panel to maintain stable temperature control and all other conditions as indicated. The end-to-end accuracy of the system, including temperature sensor error, wiring error, A/D conversion, and display, shall be 1 degree F.
3. The DDC pane and associated components shall be compatible with the existing Trane BAS system. All equipment, components, and software shall be compatible with the existing system.
4. Changes in the status of monitored points are detected by the microprocessor based Primary Operators Station (POS) utilizing a primary data communication peer bus and microprocessor based distributed control processors (DCPs) located throughout the facility.

5. The system is to provide overall monitoring and control of all HVAC control functions for all analog and digital (binary, on/off, open/close) input control signals to microprocessor based digital controllers located in the Switchgear House. The digital controllers perform all of the control logic, analog output and digital output signals to the HVAC field equipment.
6. The HVAC Work Contractor shall integrate the Direct Digital Building Control Work System.

B. This system will have interface ports to allow connection to a portable computer and a central site computer utilizing a LonTalk, BACnet, Arcnet, or Ethernet communication protocol. Operators shall be able to control thermostat set points and monitor equipment status for all control points as identified in the controls points list on the contract drawings.

C. Provide all wire terminations at local DDC control panel, programming, and graphics displays at the operator workstations. Provide all control points as identified on the controls points list. Provide graphics to show each piece of equipment, temperature sensor, and alarm point. All set points shall be fully adjustable at operator workstation.

D. BAS/EMS equipment will provide day to day control of HVAC systems, allowing system operators to enable and disable equipment, change set points, change operating schedules, receive trends and alarms, while dynamically uploading and downloading control programs.

1.06 DESIGN REQUIREMENTS

A. The system shall be designed by the engineering staff of the Company producing the system or the engineering staff of a Company that specializes in the design of Direct Digital Building Control Systems.

B. For LonMark System Architectures: Provide certification of interoperability for each LonMark device proposed for this project.

1.07 SUBMITTAL

A. Waiver of Submittal: The “Waiver of Certain Submittal Requirements” in Section 013300 does not apply to this Section.

B. Submittal Package: Submit the shop drawings, product data, and quality control submittal specified below at the same time as a package.
1. Certification of interoperability is required for each LonMark device submitted for the project.

C. Shop Drawings:
1. Provide a system architecture drawing that diagrammatically shows all equipment and sensors, panels, controllers, their locations, how they connect to the overall communication riser, and the specified HVAC

systems they each serve. The system architecture wiring layout must match specific site requirements.

2. Sketches of all graphics.
3. Graphic penetration tree showing all graphics and all points.
4. Composite wiring and/or schematic diagrams of the complete system as proposed to be installed (standard diagrams will not be acceptable).
    a. Include wiring diagrams showing interconnection with other Contractors systems.
5. Scaled floor plan and elevation drawings showing location of all major components associated with the system.

D. Product Data:
1. Catalog sheets, specifications and installation instructions.
2. Bill of materials.
3. Detailed description of system operation.
4. Point description, program list, and sequences.
5. Data from the Company producing the system, proving that:
    a. The system is UL listed.

E. Quality Control Submittal:
1. Installer's Qualifications Data:
    a. Name of each person who will be performing the Work and their employer's name, business address and telephone number.
    b. Names and addresses of 3 similar projects that each person has worked on during the past 3 years.
2. Company Field Advisor Data: Include:
    a. Name, business address and telephone number of Company Field Advisor secured for the required services.
    b. Certified statement from the Company listing the qualifications of the Company Field Advisor.
    c. Services and each product for which authorization is given by the Company, listed specifically for this project.

F. Contract Closeout Submittal:
1. System acceptance test report.
2. Certificates:
    a. Affidavit, signed by the Company Field Advisor and notarized, certifying that the system meets the contract requirements and is operating properly.
3. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative. Include:
    a. Operation and maintenance data for each product installed in system.
    b. Original licensed versions of all software loaded into the system, with disks and manuals.
    c. Complete point to point wiring diagrams of entire system as installed. Identify all conductors and show all terminations and splices. (Identification shall correspond to markers installed on each conductor.)

d. Name, address, and telephone number of nearest fully equipped service organization.

4. Provide 2 hard copy back-up disks and CD-ROM backup of all software programs and configurations as the system exists at final acceptance.
   a. Deliver one set of back-up disks to the Directors Representative for turnover to the facility.
   b. Deliver one set of back-up disks and the CD-ROM to:
      Office of General Services
      Facilities Services Unit
      Service Team Leader
      34th Floor, Corning Tower
      Albany, NY 12242
   c. Upon closeout with the first year, send updated disks and CD-ROM to the above listed personnel.
5. Provide all revisions and/or upgrades made to the system software during the one year guarantee warranty period, at no additional cost to the State.

1.08 QUALITY ASSURANCE

A. Equipment Qualifications For Products Other Than Those Specified:
   1. At the time of submission provide written notice to the Director of the intent to propose an “or equal” for products other than those specified. Make the “or equal” submission in a timely manner to allow the Director sufficient time to review the proposed product, perform inspections and witness test demonstrations.
   2. If products other than those specified are proposed for use furnish the name, address, and telephone numbers of at least 5 comparable installations that can prove the proposed products have performed satisfactorily for 3 years. Certify in writing that the owners of the 5 comparable installations will allow inspection of their installation by the Director's Representative and the Company Field Advisor.
      a. Make arrangements with the owners of 2 installations (selected by the Director) for inspection of the installations by the Director's Representative. Also obtain the services of the Company Field Advisor for the proposed products to be present. Notify the Director a minimum of 3 weeks prior to the availability of the installations for the inspection, and provide at least one alternative date for each inspection.
      b. Only references from the actual owner or owner’s representative (Security Supervisor, Maintenance Supervisor, etc.) will be accepted. References from dealers, system installers or others, who are not the actual owners of the proposed products, are not acceptable.
         1) Verify the accuracy of all references submitted prior to submission and certify in writing that the accuracy of the information has been confirmed.
   3. The product manufacturer shall have test facilities available that can demonstrate that the proposed products meet the contract requirements.

a. Make arrangements with the test facility for the Director's Representative to witness test demonstrations. Also obtain the services of the Company Field Advisor for the proposed product to be present at the test facility. Notify the Director a minimum of 3 weeks prior to the availability of the test facility, and provide at least one alternative date for the testing.

4. Provide written certification from the manufacturer that the proposed products are compatible for use with all other equipment proposed for use for this system and meet all contract requirements.

B. UL Listing: The system shall be UL listed for Energy Management UL 916.

C. Qualifications: The persons installing the Work of this Section and their Supervisor shall be personally experienced in building control system work and shall have been regularly employed by a Company installing direct digital building control systems for a minimum of 3 years.

1. For LonMark System Architectures: BAS/EMS vendors shall be certified in LonMark system installation.

D. Test Facility: The Company producing the system shall have test facilities available which can demonstrate that the proposed system meets contract requirements.

E. Company Field Advisor: Secure the services of a Company Field Advisor for a minimum of 200 working hours for the following:

1. Render advice regarding installation and final adjustment of the system.
2. Assist in initial programming of the system.
3. Render advice on the suitability of each monitor and control device for its particular application.
4. Witness final system test and then certify with an affidavit that the system is installed in accordance with the contract documents and is operating properly.
5. Train facility maintenance personnel in operation, programming and routine maintenance of the system.
   a. Provide the services of competent instructors to instruct designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the installed system rather than being a general (canned) training course. Each instructor shall be thoroughly familiar with all aspects of the subject matter they are to teach. The number of man-days of instruction furnished shall be as specified below. All equipment and material required for classroom training shall be provided.
   b. For each trainee (minimum of 8) provide workbooks, worksheets, sample problems and other printed matter to serve as illustrative reference material. Unless deemed unnecessary by OGS, Contractor shall include copies of all overheads used in the training either separately or as part of said printed matter. Contractor shall provide all overhead projectors, computer LCD

panels, video players or projectors, projection screens, hands-on materials, etc. as required for the training.

d. Submit for OGS review and approval, at least four weeks in advance of each phase of the training, the following:
   1) A detailed proposed outline of training, including timing.
   2) All printed materials, visual aids and hands-on material.
   3) All overheads (transparencies or computerized)
   4) All other training aids.
   5) Qualifications of all proposed training personnel.

e. Training Program: A training day is defined as 8 hours of instruction including two 15-minute breaks and excluding lunch time.
   1) For a period of 3 days prior to the acceptance test period at a time mutually agreeable between the Contractor and the State. Operating personnel will be trained in the functional operations of the installed system, the procedures employed for system operation and the maintenance of DDC equipment.
      a) The first 2 days of training shall include:
         (1) General System Architecture.
         (2) Operation of Computer and Peripherals.
         (3) Command Line Mnemonics.
         (4) Report Generation.
         (5) Operation Control Functions.
         (6) Graphics Generation.
         (7) Input Function and Identification.
         (8) Point Naming Convention.
         (9) Point Logs.
         (10) Trending.
         (11) Alarms.
         (12) Executing Commands.
      b) The third day of training shall include:
         (1) General equipment layout.
         (2) Troubleshooting of DDC components.
         (3) Preventive Maintenance of DDC components.
         (4) Sensor maintenance and calibration.
      c) Three neatly bound vinyl notebooks shall be provided containing a summary of each topic discussed during the three phases of training.

f. The training room shall be clean, well-lit, well ventilated and isolated from noise (including HVAC noise) and other distractions. The Contractor shall arrange, via delamping, covering fixtures or by light switches, for there to be adequate contrast lighting to take notes and fend off drowsiness.

g. Instructor shall employ an LCD or LED panel, video projector or other suitable device to project large images of the EMS software and/or other training images.

h. Printed training materials shall be tailored to the task at hand and shall be well illustrated. Materials shall take students through the steps of learning the EMS and its software and shall provide sample exercises for the trainees to perform on the computers.

i. Training must steer clear of jargon and other confusing terminology and focus instead on learning how to use the system. Specific jargon may be addressed after the trainees have demonstrated a basic understanding of system operation.

j. Training shall involve actual field-type equipment using a training demonstration package that simulates real-time temperatures, settings, alarms, etc. Training shall also spend substantial time observing the site's actual system, include point logs, graphics, and alarms. In addition, a brief field visit shall be included to familiarize trainees with the equipment installed at their site.

k. Training must include quizzes, tests, and exercises that compel trainees to demonstrate understanding of the system's most important concepts. These concepts shall include, but not be limited to, the elements of a monitoring checklist developed by the site.

l. The overall training approach shall be interactive and encourage students to discuss concepts, ask questions of the instructor and share experiences among one another.

6. Explain available service programs to facility supervisory personnel for their consideration.

F. Company Field Advisor (Existing Sub-Systems): Secure the services of a Company Field Advisor from the Company of each sub-system for a minimum of 8 working hours for the following:

1. Render advice and witness test of existing sub-systems.
2. Render advice on the interconnection of existing sub-systems with the new system.
3. Witness the final test of the combined new system and existing sub-systems.

1.09 MAINTENANCE

A. Service Availability: A fully equipped service organization capable of guaranteeing response time within 8 hours to service call shall be available 24 hours a day, 7 days a week to service the completed Work.

B. Spare Parts:

1. 10 percent spare of each type I/O board.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Control diagrams shown on the drawings, in general, indicate the equipment required for the control sequences specified. Variations in the selection of temperature control equipment, which will produce the required control sequences may be submitted for approval.
   2. All equipment shall be the standard product of one manufacturer, unless otherwise specified.
   3. Components and system capacity parameters specified are minimum and shall be increased as required by the Company producing the system to enable the system to perform the functions specified and indicated on the drawings.

B. Standard utility grade power will be available for operation of the system. If power conditioning is required for proper operation of the system, all equipment and labor required to provide conditioned power shall be provided as part of the system.

2.02 DISTRIBUTED CONTROL PROCESSORS (DCPs)

A. For LonMark System Architectures DCPs shall be LonMark certified devices.

B. Microprocessor based, with operating system (OS) and energy management system (EMS) programs, data file and control programs, 72 hour battery backed real time clock.

C. DCPs shall operate stand alone and independent of a central computer for all specified control applications.

D. DCPs not utilizing “Smart Devices” shall be modular and configured to accommodate analog and digital input and output boards to meet specific application requirements, including spares as specified.

E. The DCPs including accessory devices such as relay, power supplies, etc., shall be factory mounted, wired and housed in a steel enclosure with a hinged door panel. LEDs and switches shall be visible without opening the panel door, but not accessible without opening the panel door.

F. DCPs shall be equipped with LEDs for indication of power and operational status, status of each input and output, and diagnostic LED indicators.

G. Separate discreet DCPs shall be provided to support each major HVAC system. In all cases where primary and back-up systems are specified, a single DCP shall not be used to control both primary and secondary systems. In addition, a single DCP shall not be used to control two or more major HVAC systems (i.e., chillers and heat exchangers controlled by one single panel.)

2.03 TERMINAL EQUIPMENT CONTROLLERS (TECs)

A. TEC Controller types shall support fan coil, unit ventilator, heat pump, remote I/O modules, and air handler applications.
   1. For LonMark System Architectures: BAS/EMS Vendor Terminal Equipment Controllers (TECs) will operate on a LonMark certified LonWorks Free Topology Transceiver (FTT) peer-to-peer open protocol communication network.

B. TECs shall be modular, field modifiable, expandable, and configured with an array of analog and digital inputs and outputs, and pulse counting totalizers to meet the application requirements.
   1. For LonMark System Architectures: TECs shall support any LonMark Functional Profile as shall be in existence at the time of architectural submittal.

C. The TECs shall be factory mounted on the equipment, wired, and housed in a steel enclosure.

D. TECs shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shut-down below 80 percent. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 watts at 3 feet.

2.04 ROUTER AND GATEWAYS

A. Provide certified Router and/or Gateway devices which connect two or more physical LonTalk or BACnet compatible equipment as required.

B. Routers or Gateways if required, shall be a microprocessor based communication device designed to provide seamless, two-way translation between two or more standard or non-standard network layer protocols.

C. UL Listing: UL 916 required as a minimum.

2.05 DCP AND TEC SOFTWARE

A. Energy Management Application Programs:
   1. Optimum Start, Night Cycling and Night Purge for economizing shall address the unique requirement of each systems Unoccupied Period, which may include one or more of the following as specified:
      a. Optimum start program shall delay equipment start-up based on global outdoor temperature, and system response to assure that comfort conditions are reached at scheduled occupancy time (occupancy schedules are defined under time programs), and operate in both heating and cooling cycles. In all cases, the optimum start program shall operate fully stand-alone in the local DCP.
      b. Night Cycle program shall apply to heating cycle only (or both heating and cooling cycle) with the outdoor air dampers closed. The space temperature shall be used to determine the “fan on” and/or “supply heat” command to maintain a low limit of 50-55

degrees for the heating cycle and the "fan on" and "supply cooling" command to maintain 82 degrees for the cooling cycle.

c. Night Purge program shall apply to cooling cycle only. Night Purge shall introduce 100 percent outdoor air any time the outdoor air is above 50 degrees F, the space temperature is above 75 degrees F, and the outdoor air dewpoint is less than 60 degrees. Purging shall stop when outdoor air is below 50 degrees F, or space temperature is below 75 degrees F, or outdoor temperature is less than 5 degrees cooler than space temperature, or outdoor air dewpoint, is greater than 60 degrees.

2. A load reset program shall be provided to assure that only the minimum amount of heating, cooling, and electrical energy is supplied to satisfy zone temperature requirements. The program shall be applicable where specified to hot decks, cold decks, chilled water supply, and AHU static pressure. Individual programs are to be provided each sensing the worst case zone requirements and providing only the minimum energy source media to satisfy the need.

B. Control Software:

1. Each DCP shall contain up to 20 unique user modifiable time programs (TP):
   a. Each TP shall consist of daily, weekly, and annual programs plus a "TODAY" temporary function.
   b. DAILY programs shall be definable for day types such as working day, half day, holiday, weekend, etc. Each daily program shall allow a list of tome based (or optimum time based analog and digital commands to be issued to user selected plant elements and points.
   c. WEEKLY programs shall allow a user selected set of daily programs to be defined for each day of the week, Monday through Sunday.
   d. The ANNUAL program shall initially be an automatic compilation of 52 weekly programs. Selecting a date of the ANNUAL program shall allow modification of the daily selection entered into the weekly program, such as changing Dec. 25 from a working day to a holiday.
2. Control Application Software shall be customized strictly to meet the detailed requirements of the "Sequence of Operation" specified in PART 3. DCPs shall be fully programmable. Initial software shall be fully modifiable, and not restricted by vendor's specific configuration guidelines.

C. Management Software:

1. Each DCP shall be provided with a trend archive of at least the last 200 events, digital transitions or analog value changes, of any user selected group of points. A stored event shall include date and time, and value or status. Events occurring in excess of 200 shall overwrite the oldest events, except where a modem module is specified, events shall be uploaded to the modem module. Point events shall be displayable at the POS as trend logs for evaluation of control system performance.

2. Each DCP shall monitor all analog input points and specified digital points for off-normal conditions. Each alarm shall have an "alarm delay" attribute which shall determine how long, in seconds, a point must be in an off-normal state prior to being considered in an alarm state. Alarms shall be displayable at the POS.
3. DCPs managing sub-networks of TECs shall report TEC alarms and shall be programmed to perform data reduction, sorting, and AHU DCP optimizing routines. In no case shall mass TEC optimizing data be allowed on the peer bus.

D. Communications Software:
1. LonTalk, BACnet, Arcnet, or Ethernet shall be used for communication between DCPs, and between operator interfaces. Each DCP shall have a full master peer-to-peer communications module to support all global data sharing, hierarchical control, and global control strategies specified. In addition, certain DCPs shall have hardware and software to support manage a secondary 9600 baud minimum bus of TECs, including hierarchical control specified, management, alarm processing and prioritization.

E. TEC Software:
1. BAS/EMS Vendor Terminal Equipment Controllers (TECs) will operate on a peer-to-peer communications network. TEC Software shall be configured to meet the detailed requirements of the Sequence of Operation, and shall be field reconfigurable if required to accommodate future functional or additional I/O requirements. TEC software shall be compatible with all the requirements set forth in the POT specification regarding TEC data display and modification. TEC software shall support full PID control.
   a. For LonMark System Architectures: BAS/EMS Vendor Terminal Equipment Controllers (TECs) will operate on a LonMark Certified LonWorks Free Topology Transceiver (FTT) peer-to-peer protocol communication network.

2.06 DATA COMMUNICATIONS

A. POS and DCPs shall directly reside on a primary peer communication bus such that communications may be executed directly between POS and DCPs, and directly between DCPs on a peer to peer basis, via fiber optic cable or via electronic cable, and routers as needed.

B. TECs shall be connected together via peer-to-peer secondary communication network managed by the DCPs.
1. For LonMark System Architectures: TECs shall be connected together via LonMark certified LonWorks Free Topology Transceiver (FTT) peer-to-peer open protocol communication network.

C. Protect communication lines against incorrect wiring, static transients and induced magnetic interference.

1. Provide static, transient, and short circuit protection on all inputs and outputs.
2. AC couple, or optically isolate bus connected devices so that any single device failure will not disrupt or halt bus communication.

D. Provide Modem telephone software for equipment used for point-to-point (PTP) applications for all dialup telephone connections as specified.

E. Provide Radio Frequency (RF) software-for remote (WAN) site communications applications as specified.

F. Provide Internet Protocol Access (IP) software for Internet access for remote (WAN) site communications applications as specified.

2.07 OPERATOR INTERFACE SOFTWARE

A. Operator station software shall include as a minimum the Operating System (OS), Data Base Manager, Communications Control, Operator Interface (OI), Trend and History Files, Report Generator, Support Utilities, Scheduler and Time and Event Support Programs. Utilize existing workstations and software. Provide additional software if required.

B. Provide a hierarchical linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. The interface shall utilize a mouse, pull-down menus, dialog boxes, zoom, coloration and animation to facilitate operator understanding of the system. A minimum of 20 levels of graphic penetration shall be provided with the hierarchy operator assignable (for example, area, building, wing, floor, air handler, sequence of operation pages, dynamic program display, point group). Dynamic system data points shall be assignable to each penetration level. Descriptors for graphics, points, alarms, etc. shall be modified through the operator's station under password control.
   1. Operator access to the system is to be under password and personal ID control. Operators shall be able to access data from any operator's station in the system by entry of proper password and ID. Sign off from an operator's station shall be a manual operation. If no mouse or keyboard activity takes place, within an assignable time period an automatic Sign Off shall occur. All sign on/sign off activity is to be recorded on the system printer.

C. A graphics mode of operation shall be provided allowing full color displays of building floor plan, HVAC systems, and equipment configuration.
   1. All graphic displays shall be online programmable via keyboard, trackball, or mouse selection of graphic library stored symbols and system profiles. Provide, in addition, the capability to create custom symbols, system profiles, floor plans, etc. and to store them in the graphics library.
   2. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding. A backtrack shall permit the operator to move upward in the hierarchy by

mouse click on the backtrack. The backtrack shall show at least the previous 4 penetration levels. The operator shall be provided the option of showing each graphic full screen size with the backtrack as the horizontal header or by showing a stack of graphics, each with a backtrack.

3. All operator accessed data shall be displayed on the color monitor. The operator shall select further penetration via mouse click on an area, building, floor, fan, etc. The defined linked graphic below that selection shall then be displayed. Dynamic data shall be assignable to any and all graphics.
4. The operator shall be provided with means to directly access any graphic or any point without going through the penetration path.
    a. Direct access to graphics shall be menu selectable wherein the operator may optionally enter the name of the graphic system desired or select the desired graphic via cursor positioning on a scroll bar listing of all graphics, or may be selected via keyboard entry.
5. Points (physical and pseudo) shall be displayed with dynamic data provided by the system with appropriate text descriptors, status or value, and engineering unit. Coloration shall be used to denote status and alarm states. Coloration conventions shall be variable for each class of points. In addition, there shall be clear indication of latest status (e.g., fan rotation, damper position, fluid flow, etc.) where specified. All points shall be dynamic with update rates user adjustable on a per point basis from 20 seconds to 120 seconds depending upon the process dynamics.
6. For operators with the appropriate privilege(s), points shall be commanded directly from the color monitor via mouse selection. For a digital command point such as a state (e.g., CLOSED) and the operator could select OPEN via mouse click. For most operations, a keyboard equivalent shall be available for those operators with that preference. Upon selection of analog commandable points (such as discharge air static pressure), a dialog box shall appear containing the following:
    a. The decimal value of the set point with adjacent up-down arrows.
    b. The operator shall be afforded three methods of analog commanding from which to choose as follows:
        1) Click the cursor on the decimal set point value, and enter a new set point value via the keyboard decimal keypad.
        2) Drive the decimal value up or down via the up-down arrows.
        3) “Drag” the set point arrow up or down by moving the cursor to the desired position and clicking.
    c. The bar chart shall also have an associated colored scale showing the current position (scaled value) of the alarm limits.
7. An operator shall be permitted to split or resize the viewing screen to show one graphic on the left half of the screen and another graphic, spreadsheet, bar chart, word processing, curve plot, etc., on the right half screen, to allow real time monitoring of one part of the system while

displaying other parts of the system or data from the system to facilitate system operation.

8. An on-line context-sensitive "help" utility shall be provided to facilitate operator training and understanding. The document shall contain text and graphics to clarify system operation. At a minimum, help shall be available for every menu item and dialog box.

D. Site Specific Customizing Software:

1. Provide all hardware and software required for complete system programming including system schematic development, I/O hardware point definition, hardware and software text point descriptors, DDC algorithmic development, and a controller software loading utility. Color conventions shall be used throughout to support ready recognition of inputs, outputs, plant heating/cooling devices, control function modules, etc. Provide all hardware and software required for the modification of existing graphics and for the construction of new graphics.
2. Provide software which will allow the user to modify and tailor the DDC system to the specific and unique requirements of the equipment installed, the programs implemented, and to staffing and operational practices. Online modification of system configuration, program parameters, and data base shall be provided via menu selection and keyboard entry of data into preformatted self-prompting templates. As a minimum, the following modification capability shall be provided.
    a. Operator assignment capability shall include designation of operator passwords, privilege(s), starting graphic and auto sign off duration.
    b. Peripheral assignment capability shall include assignment of segregation groups to consoles and printers, and designation of backup printers.
    c. System configuration/diagnostic capability shall include communications and peripheral port assignments, DCP enable/disable, assignment of command trace to points and initiation of diagnostics.
    d. System text add/change capability shall include action messages for alarms and run time, and trouble condition messages.
    e. Time/Schedule change capability shall include time/date set, time/occupancy schedules, holiday schedules, and daylight savings time schedules. All time and calendar scheduling and schedule modification shall be accomplished graphically via color bars and calendars in a hardware independent manner.
    f. Points shall be uniquely defined as to coloration, animation (when used), flashing rate and duration, audible rate and duration, point descriptors, operator messages (480 characters minimum), printer options, alarm archival option, alarm and warning limits, and engineering units. All messages specified and all physical and pseudo point descriptors shall be entered by the Company producing the system.
    g. Point related change capability shall include system/point enable/disable; run time enable/disable; assignment of points to

point classes, analog value offset, lockout, run time limits, and setting a fixed input value or output status.

h. All adjustable set points shall be resettable from a graphic.

E. Alarm handler software shall respond to alarm conditions sensed and transmitted from DCPs and TECs. First in, first out handling of alarms in accordance with alarm priority ranking is required with buffer storage for a minimum of 20 alarms in case of simultaneous multiple alarms. Alarm handler shall be active in both the Signed On and Signed Off modes to assure that alarm will be processed even though and operator is not currently signed on.

1. Alarms shall be displayed in a dialog box of the color monitor. Display shall include as a minimum:
   a. Indication of alarm condition; i.e., ABNORMAL Off, HI ALARM/LO ALARM, analog value or status, and English point identification.
   b. A unique per point alarm action message; i.e., "The fan has shut down due to an excessively high discharge duct pressure, There is a strong indication of a system malfunction such as an inlet vane drive failure, or major fire damper closure. The switch should not be manually reset until a thorough check of the cause is conducted" of up to 480 characters.
2. Alarms are to be directed to appropriate operators, operator stations, and printers for segregation assignments as specified in previous sections of this specification.
3. Alarm silencing shall be by selecting the "silence" button or by authorized operator's acknowledgment. In all cases, alarm acknowledgment shall only be allowed by operators authorized to acknowledge a point in alarm.
4. Each point shall be assigned to an alarm class, with no limit to the quantity of alarm classes. Each alarm class shall be uniquely assignable to any combination of the following alarm processing attributes:
   a. Audible beep duration: none, 10 seconds, 20 seconds, continuous.
   b. Audible beep rate (slow-medium-fast).
   c. Alarm historically archived (yes or no).
   d. Alarm printed, with printer ID.
   e. Associated coloration with any of 256 colors with separate brightness control, assignable to each alarm state (high alarm, etc.) and similarly be distinguished with different colors for each possible state.
5. Alarms shall be displayed and/or printed at each peripheral to which its segregation allows, but only those operators having proper privilege level will be allowed to acknowledge alarms.
6. An unacknowledged alarm indicator shall be provided on the color monitor display to alert the operator that there are unacknowledged alarms in the system.
7. Symbols for points in a graphic display that are in an unacknowledged alarm state shall flash red; when in an acknowledged state, the symbol shall be non-flashing-red.

8. Run time limit messages shall be presented and processed as alarm messages except the action message shall be of a maintenance directive nature.

F. Standard reports shall be provided which shall be operator selectable to appear on the operator station, any selected printer or both. A "terminate report" command shall be available to allow the operator to stop any report in the process of being printed. In the event of failure of any printer, subsequent reports directed to that printer shall be automatically redirected to an operator preassigned backup printer dedicated at the operator station. The following standard pre-formatted reports shall include:

1. Point summary reports may be requested at any penetration level (building, area, system) and shall include only points at and below that level. Point summary reports shall include the current value/status and condition, English system and point descriptors for all points. Point summary reports shall be selectable for all points, only those points in alarm, fixed points, disabled points, locked out points, locked out and in alarm points, analog input or output points, digital input or output points. All reports shall be capable of being scheduled to run at a specific time and/or interval via an operator function supported by necessary data entry templates and interactive prompts.
2. Dynamic trends shall show real time activity of the associated points. This information shall be printed and/or displayed in numeric, bar chart, curve plot, pie chart, etc., as selected by the operator. Graphic plots shall allow a unique color for each point. As new point values are sampled, they shall be processed, scaled, and dynamically appended to any plot being displayed. Sample interval of points selected for dynamic trend shall by user selectable from five seconds to sixty minutes.
3. Alarm and run time reports shall be automatically issued to assigned printers immediately upon occurrence, and shall consist of the point descriptor, the status or value of the point with engineering unit, the time and date, and an action taking alarm message.
4. The user shall be provided with a command trace feature selectable on a per point basis allowing the archiving of all commands issued to each point. The archived trace shall include the command, the command source, the point ID, and the time and date. Command trace reports shall be output upon operator demand.
5. A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only. Custom reports may be scheduled or requested manually. A spreadsheet program similar to Microsoft Excel shall be provided fully integrated with the DDC system data base, and available to the user. Spreadsheet packages which require offline execution or manual translation of data files from one program format to another are not acceptable.

G. Trend reports shall allow the operator to randomly select logical arrays of points to be recorded at selectable time intervals.

1. Trend point archival - Each DCP trend point system (hardware and software) shall be assignable to PC archive files at user definable time

intervals. Trend data sample resolution shall be a minimum of one degree or one percent of the points range, whichever is smaller. Each point trend file shall have a user assignable selectable archive duration of a day, a week, a month, or a year. For any duration period selected, the file shall retain one full duration period while it collects another (i.e., after collecting data for May, May is retained in total as June data is accumulated).

2. Trend display points shall be subsequently printed/ displayed individually or in logical groups of up to any eight points in any group. Points may be assignable to multiple trend groups. The system shall have up to 500 trend groups which may be predetermined by the user for a unique set of logical points and display characteristics.
   a. Single Point Displays: Single point trend reports shall be displayable by selecting the desired point from any system graphic upon which it is displayed or by entering its keyname. Display characteristics shall be user predeterminable for any desired display range (X-Axis period) and any desired data manipulation within the selected range.
   b. Template-selectable display range options shall be “current”, “previous”, or “date range” with range and appropriate data intervals. “Current” ranges shall be time periods of one hour, two hours, etc., up to one year. Starting at the beginning of the range (i.e., a display of the “current” month shall start at 00:01AM the first day of the month and display selected values up to the present time). Data intervals within the selected ranges shall be selectable from ten seconds to one month, dependent upon the sample intervals. The X-Axis resolution shall accommodate up to 100 data values. “Previous” ranges shall be similar to current ranges, except that a full “range” of data (such as a full seven days of data for the past week, up to the Present time) shall be provided. Selectable range, data intervals, and X-Axis resolution shall be as specified for the “current” display range. “Date range” selection shall provide templated for the entry of year, month, date, hour, and minute for the beginning and the end of X-Axis data. Selectable data intervals and X-Axis resolution shall be as specified for the “current” range.
   c. Data Manipulation: Within the selected X-Axis intervals of the selected A-Axis range of data, data manipulation options shall be template selectable as the actual, last, highest, lowest, or average of the actual data samples within each interval. For example, for data sampled every five minutes one might select the highest value within every two hours for the past week. From that display, noting the two hour period with the peak value, the operator may subsequently request a display of actual values every five minutes for the related two hour period.
   d. Point Group Displays: Point group displays shall be set-up by selecting each point desired to be displayed in a logical trend group and either setting up a new group with appropriate group name (such as AHU RETURN AIR TEMPS) or selecting an existing group from a drop-down menu. Group displays shall

then be initiated by selecting a top-level menu-bar option trend, and selecting a trend group from a subsequent drop-down menu. From this point, template selectable display options shall be as specified for single point displays (i.e., current, previous, date range, actual, highest, lowest, average).

3. Trend Presentation Options: After defining a desired trend display as above, selectable presentation options of display, print, or spreadsheet shall be available.
   a. Display: Selecting "Print" shall initiate an immediate printout of the same data values used to construct the above curve plot. Print format shall include a header with a time column and eight eight-digit value columns of data. The appropriate engineering unit shall be at the head of each column. The print header shall include a column point descriptor legend and an English description of the trend display set-up options as specified for the "display" option.
   b. Spreadsheet: Selecting the spreadsheet option shall present the display values (after data manipulation) in a spreadsheet (Microsoft Excel) format. From this screen, the user may edit the values to correct problems (missing data, failed sensors, errors). After editing, display or print options specified above may be executed, or any other standard spreadsheet data manipulation options may be exercised.

2.08 DATA AND CONTROL (D/C) SUMMARY

A. Each analog point shall have unique DCP and TEC resident dual high and dual low limit alarm thresholds set in engineering units. Where specified, floating (a band above and below a set point) alarm limits shall be provided.

B. Each digital output shall have a software-associated monitored input. Any time the monitored input does not track its associated command output within a programmable time interval, a "command failed" alarm shall be reported.

C. Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups. The respective unconditioned raw data (such as logarithmic differential pressure) points shall also be grouped into a special group for display and observation independent of the logical groups.

2.09 VARIABLE SPEED FAN CONTROL

A. Temperature Transmitter: Selectable span to meet the individual application requirements.

B. Optical Loop Isolator: To provide protection against RFI and signal line spike interference.

C. Power Supply: 120 V ac to a maximum of 35 V dc while supplying the current necessary for the transmitter, receiver, and indicator.

D. Receiver Controller: Input of 4 to 20 mA, adjustable output zero and span; proportional direct or reverse acting output of a signal level and type as required as an input to the fan speed controller; grounded or ungrounded output as needed by the drive, capable of PID control.

E. Signal Selection: Low signal discrimination so that the drive is operated from the point in the hydronic system with the greatest offset below the set point temperature.

F. Indication: The temperature at each transmitter shall be indicated at the receiver controller.

G. Operation: Each noted point in the system shall have a receiver controller and a separate set point. The fan drive, speed, shall be automatically adjusted to maintain the temperature to satisfy the controlling set point. The speed of the drive shall ramp in the direction of large changes and shall soft start the fan.

H. Signal Wire, 20 gauge shielded twisted pair: Provide signal wire as recommended by the Company producing the system. Soft ground the wire shield.

2.10 MISCELLANEOUS ELECTRIC/ELECTRONIC AND MECHANICAL DEVICES

A. Input/output sensors and devices shall be closely matched to the requirements of the DCP for accurate, response, noise free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.
   1. In no case shall computer inputs be derived from pneumatic sensors or thermocouples.

B. All electric switch devices shall be selected for the applied load and UL listed for the application.

C. Provide NEMA 1 enclosures for all switching devices.

D. Unless otherwise specified or indicated, the following features are required for the equipment specified:
   1. Temperature sensors shall be Resistance Temperature Detector (RTD) type with 500 ohm balco, 100 or 3000 ohm platinum.
      a. Resistance shall be 100 ohms at 32 degree F with a minimum accuracy of 0.5 degree F through the range of 32 degree F to 212 degree F.
      b. Space temperature sensors shall be provided with vandal resistant type locking covers.
      c. Duct temperature sensors shall be averaging type elements for sensing mixed air temperatures in ductwork, with sufficient length or sufficient number of elements, so as to efficiently measure the air temperature through the entire cross section of duct.

d. Water temperature sensors shall be provided with a separable copper, monel or stainless steel well.
e. Outside air wall mounted sensors shall be provided with a sun shield.

2. Thermistors:
   a. Precision thermistors may be used in temperature sensing applications below 200 degrees F, as identified on the project drawings or where allowed in this specification.
   b. Sensor accuracy over the application range shall be 0.36 degrees F or less between the range of 32 degrees F to 150 degrees F. Sensor manufacturer shall utilize 100 percent screening to verify accuracy. Thermistors shall be pre-aged, and inherently stable. Stability error of the thermistor over five years shall not exceed 0.25 degrees F cumulative.
   c. Sensor element and leads shall be encapsulated. Bead thermistors shall not be allowed. A/D conversion resolution error shall be kept to 0.1 degrees F. Total error for a thermistor circuit shall not exceed 0.5 degrees F, which includes sensor error and Control Unit A/D conversion resolution error.
   d. Provide thermistor and Control Unit manufacturer documentation including Contractor's engineering calculations, which support the proposed thermistor input circuit will have a total error of 0.5 degrees F or less.
3. Temperature or humidity control equipment with sensing elements or probes for insertion in insulated equipment or insulated ductwork. Provide flanges or sockets of the extension neck type, so as to finish flush with final insulated surface.
4. Current Sensor for Fan or Pump:
   a. Unit Status: Solid-State Status Sensor.
      1) Output rating: 0.2 A at 30 Vdc.
      2) Input rating: 0 to 135 ampere continuous.
      3) Sensor supply current induced from monitored conductor. Minimum conductor current required 1A. Maximum rating 135.
      4) Isolation: 600 Vac RMS.
      5) Trip set-point: Adjustable to +1 percent.
      6) Temperature range: -15 degrees C to 85 degrees C.
      7) Humidity range: 0 to 95 percent non-condensing.
5. Humidity Sensor: Model 534636 by Landis and Staefa, Inc.

2.11 AUTOMATICALLY OPERATED DAMPERS

A. Dampers:
   1. Size dampers for linear flow output, with a maximum damper leakage of 30 cfm per square foot of projected area at 3 inch static pressure.
   2. Provide dampers and seals suitable for service from -40 degrees F to 200 degrees F, with closed cell neoprene edging seals, spring loaded stainless steel side seals and adjustable baffles for full size adjustment.

3. Provide dampers in 2 inch size increments from 8 inches horizontal and vertical to 48 inches. For requirements over 48 inches in size provide standard modules with interconnecting hardware.
4. Dampers shall be of the multiple interlocking V-grooved blade type with nylon or oil impregnated bronze bearings, zinc plated steel shafts and hardware with a corrosion resistant finish. Provide blades a maximum of 8 inches in width with the overall construction designed to prevent leakage in the closed position, complete with solid stops.
5. Fabricate frames in steel ductwork from No. 13 USS gage galvanized steel and blades of No. 16 USS gage galvanized steel, with a factory baked black enamel finish.
6. Fabricate frames in aluminum ductwork from No. 14 B & S gage extruded aluminum and blades of No. 14 B & S gage aluminum.
7. Proportional control dampers shall be rated by the manufacturer as suitable for use at 3000 fpm face velocity.
8. Equipped with required type of actuator, electric/electronic.

2.12 ACTUATORS

A. Type: All actuators shall be electric/electronic.

B. Actuators shall be factory selected, mounted and tested for proper operation based on unit size, type, and torque requirements.

C. Electric/Electronic Actuators:
   1. Damper Actuators:
      a. Electric/Electronic, positive positioning, spring return, sized to stroke damper smoothly throughout its range.
         1) All outdoor air dampers shall fail closed upon electric power loss.
      b. Actuator response shall be linear in response to sensed load.
      c. Voltage to suit system voltage.

2.13 MARKERS AND NAMEPLATES

A. Markers: Premarked self-adhesive; W.H. Brady Co.'s B940, Thomas and Betts Co.'s E-Z Code WSL self-laminating, Ideal Industries' Mylar/Cloth wire markers, or Markwick Corp.'s permanent wire markers.

B. Nameplates: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.
   1. Phenolic: Two color laminated engraver's stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).
   2. Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.
   3. Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

2.14 ACCESSORIES

A. Include accessories required to perform the functions specified and indicated on the drawings.

2.15 WIRING

A. See Section 260502.

2.16 THERMOSTAT/TEMPERATURE SENSOR GUARDS

A. Model TG Series 16 by Shaw Perkins:
   1. Cover: Top, front and bottom, 16 gauge perforated steel, 1/8 inch perforations on 3/16 inch centers.
   2. Sides and mounting frame: 14 gauge steel.
   3. Fastener: 1/4x3/8 inch tamper resistant torx or allen head center post.
   4. Finish: Baked enamel finish.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

A. Testing Existing Sub-Systems:
   1. Prior to installing the new system, test the existing sub-systems to ascertain their operating condition.
   2. Conduct tests that are disruptive to facility personnel after normal working hours as directed.
   3. Prepare a written report for the Director's Representative indicating the repairs required, if any, to make the existing sub-systems function properly.
   4. Repairs to the existing sub-systems are not included in the Work unless requested by Order on Contract.

B. Interruptions to Existing Sub-Systems:
   1. Maintain the existing sub-systems in their present condition to the extent possible while installing new Work.
   2. Prior to making changes or removals relative to the existing sub-systems, notify the Director's Representative and have procedures approved.

3.02 INSTALLATION

A. Install system in accordance with the Company's printed instructions unless otherwise indicated.

B. Temperature or humidity control equipment installed on insulated surfaces: Provide extension pieces or rigid insulating mounting back plates, of depth as required, so that equipment backs finish flush with final insulated surface.

C. Identification, Labeling, Marking:

1. Identification of Circuits: Identify wires and cables by system and function in interconnection cabinets, POSs and DCPs to which they connect with premarked, self-adhesive, wraparound type markers. Designations shall correspond with point to point wiring diagrams.
2. Battery Data: Insert a copy of the battery warranty in each battery compartment and mark on batteries the date placed in service.

D. Provide at least one DCP for each air handling or air conditioning system and for each mechanical equipment room. Separate discreet DCPs shall be provided to support each major HVAC system. In all cases where primary and back-up systems are specified, a single DCP shall not be used to control both primary and secondary systems. In addition, a single DCP shall not be used to control two or more major HVAC systems (i.e., chillers and heat exchanger controlled by one single panel).

3.03 FIELD QUALITY CONTROL

A. Preliminary System Test:
   l. Preparation: Have the Company Field Advisor adjust the completed system and then operate it long enough to assure that it is performing properly.
   2. Run a preliminary test for the purpose of:
      a. Determining whether the system is in a suitable condition to conduct an acceptance test.
      b. Checking and adjusting equipment.
      c. Training facility personnel.
   3. Also perform a witnessed validation demonstration consisting of:
      a. Running each specified report.
      b. Display and demonstrate each data entry template to show site specific customizing capability. Demonstrate parameter changes.
      c. Execute menu tree.
      d. Display graphics, demo update.
      e. Execute digital and analog commands in English and graphic mode.
      f. Demonstrate freeform address assignments and commands.
      g. Demonstrate all specified diagnostics.
      h. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs (6 loops minimum).
      i. Demonstrate scan, update, and alarm responsiveness.

B. System Acceptance Test:
   l. Preparation: Notify the Director's Representative at least 3 working days prior to the test so arrangements can be made to have a Facility Representative witness the test.
   2. Make the following tests:
      a. Test system operational functions step by step as summarized in the detailed description of system operation.
      b. Test monitor and control devices.

c. For Lon Mark System Architectures: Demonstrate that each device meets Functional Profile for each application specified.
d. Test all remote devices such as valve and damper actuators to demonstrate full range of motion in the "controllable range".

3. Supply all equipment necessary for system adjustment and testing.
4. Submit written report of test results signed by Company Field Advisor and the Director's Representative. Mount a copy of the written report and in a Plexiglas enclosed frame assembly adjacent to the POS.

3.04 POINT DESCRIPTION, PROGRAM LIST, AND SEQUENCES

A. General:

1. Points listed are the minimum number of points to be provided. Points are identified on the contract drawings. Provide additional points as required to satisfy the sequence and operational requirements.
2. Provide spare points. After the system has been completed and tested, the following minimum quantity of spare points shall be available for future connection at each DCP:
   a. Binary inputs: 2.
   b. Binary outputs: 2.
   c. Analog inputs: 1.
   d. Analog outputs: 1.
3. Provide proportional-integral-derivative algorithms for all control programs.
4. Determine, through operation of the system, proportional bands, interval time, integral periods, adjustment rates, and any other input information required to provide stable operation of the control programs.
6. Provide proof of flow for fans. Fan proof-of-flow switches shall be adjustable set point and differential pressure type. Switches shall be piped to fan discharge except where fans operate at less than one inch W.C., they shall be piped across the fan. For fractional horsepower and non-ducted fans, relays or auxiliary contacts may be used. Maximum pressure rating shall be at least 10 inches W.C.
8. The system-wide outdoor air temperature and outdoor air humidity signals shall each consist of the average of 1 sensor. The sensor shall be located outside the building.
9. The following definitions apply to the letter descriptors used in the point lists:
   a. RT - Run time of a piece of equipment. This shall be the total operating time since initial start-up of a piece of equipment.
   b. T - Indicates the point shall be trendable.
   c. A - Indicates the system shall alarm when the point is outside its range, or upon contact closure or opening.
10. All alarms shall be trendable. All equipment start/stops shall be trendable.
11. At a minimum, each sequence and accompanying point list shall be represented by an individual graphic. Each point listed shall appear on the graphic. Where appropriate and approved, multiple sequences and point lists may be combined into a single graphic.

a. For analog outputs, display on the graphic the percent of full signal (percent open for valves and dampers, percent of speed for variable speed drives, percent open for vortex dampers, etc.).
b. For analog outputs controlled by analog inputs, provide a probe at the graphic to redefine the proportional, integral, and derivative gains.
c. Alarm set points and ranges shall be resettable from the graphic. Control set points and ranges shall be resettable from the graphic.
d. Where average point values are called for in the sequence, the average value shall be displayed on the graphic. In response to a probe on the graphic, the individual sensor values and sensor locations shall be displayed.

12. Where dampers operate in conjunction with fan operation, the damper open signal shall precede the fan start signal by 10-15 seconds. The damper close signal shall be delayed 10-15 seconds after the fan stop signal.

END OF SECTION