SECTION 15900

BUILDING MANAGEMENT AND CONTROL SYSTEM

PART 1- GENERAL

1.01 WORK INCLUDED

A. Extend and integrate the existing Honeywell District Wide Enterprise Buildings Integrator (EBI) Building Management and Control System (BMCS) incorporating Direct Digital Control (DDC), equipment monitoring, and control consisting of a PC based Operator Work Station (OWS) with color graphic data displays; microcomputer based General Purpose DDC Controllers (GPCs) interfacing directly with sensors, actuators and environmental delivery systems (i.e., AHU units, Gas Absorption Chillers, Cooling Towers, VAV systems, etc.); electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels, a primary communication network to allow data exchange from GPC to GPC; microcomputer based Unitary DDC Controllers (UCs) interfacing with sensors, actuators, and terminal equipment control devices; and a secondary Echelon communication network interfacing UCs to GPC network devices.

The proposed BMCSsystem have the capability built and designed into it to fully be interoperable ,must directly extend and integrate with the existing EBI district wide supervisor front end located in Kearny Board of Education building. The BMCS shall be capable of total integration of the school district wide BMCS infrastructure systems. The BMCS System shall communicate through the existing school district LAN Fiber Bus; all XL5000 Panels must communicate directly to EBI Front End. Modification offy the existing Honeywell EBI BMCS System must include; a points license expansion, re-programming and and updating of front end graphics to allow the Building Operator to view, operate and program the new DDC Panels from the BMCS EBI Front End. All portions of the Honeywell EBI System must be designed, furnished, installed, commissioned and serviced by the manufacturer's branch office with factory certified employees. The BMCS Contractor must demonstrate that this capability is built into the proposed (BMCS) System.

B. Submittals, data entry and electrical installation, programming, start up, test and validation acceptance documentation and system warranty.

C. All dedicated 120V/60Hz circuit in an outlet box near eachpower to DDC panels and unitary controllers shall be provided by the electrical contractor for the BMCS system. The BMCS contractor shall be responsible for coordination of panel locations with the electrical contractor. for all electrical power and control wiring from the outlet box to the DDC panel and downstream of DDC panels to all equipment and devices. Contractor shall provide all points as specified in these specifications and as shown on drawings.

D. The contractor shall be responsible for all control wiring. Failure of this contractor to coordinate requirements with other trades shall result in this contractor to be responsible for control wiring of any and all non coordinated items.

E. All conduits in connection with the controls and instrumentation system shall be furnished and installed by this contractor.

F. The BMCS contractor shall complete all sensing and control installation including electrical and electronic components.

1.02 WORK BY OTHERS

Access doors and setting in place of valves, power wiring, flow meters, water pressure and differential taps, flow switches, thermal wells, dampers, air-flow stations, and current transformers.

1.03 QUALITY ASSURANCE

A. Codes and Approvals:

1. The complete BMCS installation shall be in strict compliance to the national, state and local mechanical and electrical codes and the electrical section of these specifications. All devices shall be UL or FM listed and labeled for the specific use, application and environment to which they are applied.

2. The system shall comply with NFPA 90A Air Conditioning and 90B Warm Air Heating, Air conditioning.

3. System shall be designed and manufactured to ISO 9001 quality standard and all electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled and European CE rating for electromagnetic emissions standards.

4. System devices required for the smoke evacuation sequence shall have UL864 (UUKL smoke control) and CSA approval and shall be so certified at time of bid.

B. Remote Monitoring. Throughout the warranty period, the contractor shall provide continuous around-the-clock monitoring of any five user selected critical analog or digital alarm points. Upon detection of alarm, the system shall initiate an immediate dial-out to a continuously contractor-staffed monitoring station with the definition of the unique point in alarm.

The dial-out monitoring panel shall be UL listed for Central Station Grade A Burglary Alarm and installed in strict accordance to UL681 and NFPA 74 instructions. The panel shall be battery backed for no less than four hours and shall also initiate a descriptive dial-out upon

local power failure. The dial-out module shall not require a dedicated phone line, and shall share any user-selected line such that upon alarm detection, the dialer automatically seizes the line.

For each unique alarm point, the user shall provide ten additive or alternative action communication responses that the contractor shall output upon the receipt of an alarm. The responses shall be dial-out in nature to user defined phone numbers and persons, with each response message up to 100 words in length. The contractor shall magnetically record all phone call responses and retain the recordings for one month. The contractor shall also submit to the user a monthly written summary of all alarm activity.

C. Provide the services of branch control manufacturer's representative to be on site during the entire time that the start up, testing and balancing procedures of this specification. Representative shall be part of 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.

1.04 IN WARRANTY SERVICE (AFTER OWNERS ACCEPTANCE OF CONTROL SYSTEMS)

A. Emergency Service with 4 hour response

B. Contractor shall provide minimum of 2 complete checkouts (40 hours each) of the entire system including:
1. System control loop tuning and calibration.
2. System diagnostics
3. Software backup
4. Verify software applications to the building (change as required)
5. Documentation of above maintenance tasks as defined in “minimum service qualifications” section of this specification.

1.05 MINIMUM SERVICE QUALIFICATIONS

A. Contractor shall have a branch office within **50** miles of Customers location

B. Contractor shall have minimum of twenty (20) factory-trained certified and authorized personnel with the ability to maintain, troubleshoot and provide training for customer personnel on a variety of Automation Systems.

D. Contractor shall maintain a UL monitoring center manned 24 hours a day / 7 days a week / 365 days a year by company personnel, (cannot be an answering service) capable of continuous monitoring of environmental conditions in various areas throughout the building. Must have certified energy managers and HVAC experts on the monitoring staff.

E. Base bid shall include hardware, software and installation for monitoring and control of owner selected critical points. Critical points, as a minimum shall consist of all freeze stats,

gas absorption system alarms, and general fire conditions, building temperature alarms including water systems and space temperatures and building occupancy schedules. Remote monitoring shall have the ability to override building occupancy schedules based on an authorized phone call to the central monitor station.

F. Contractor shall provide 100% of all services with company personnel. No portion of services can be subcontracted to others without express written permission of the customer, and that with such permission, all specifications, terms, and conditions specified herein shall be the responsibility of the prime contractor.

G. Contractor must be in the temperature control service business for over 20 years.

H. Contractor shall be of known reputation and shall have a minimum of twenty (20) qualified personnel and associated equipment to adequately service and/or repair the district heating, ventilation, air conditioning, controls and automation equipment.

I. Contractor will maintain complete and detailed service and maintenance records for each piece of equipment in a secure central database and are provided upon request.

J. Contractor will have the ability to provide verification of completed work order or preventive maintenance form within one (1) hour of the completion of that service or maintenance action. A paperless version is preferred and may be required.

K. Contractor will have the ability to receive service requests via an Internet web site or a centralized call center. E-mail requests are <u>not</u> acceptable.

L. Contractor will have the ability to digitally capture customer signature for authorization of work and work completed; that signature is digitally recorded for verification reasons but will not be used again for any other purpose.

M. Contractor will provide work orders that are legible and contain sufficient information about the work performed.

N. Contractor must have certified quality processes (i.e., ISO 9002 certification) that ensure

1. Equipment is serviced and work actions recorded in a uniform manner every time, regardless of the assigned technician.

2. Service requests and preventive maintenance activities are tracked to completion in a timely manner

3. Information and data is properly and securely controlled

1.06 UTILITY MONITORING AND REPORTING

The vendor should be able to provide a comprehensive energy use and cost report on a quarterly basis. The report should document monthly consumption and cost associated with all major energy and fuel types compared against a recent baseline. All current consumption and cost data should be normalized for weather and days per month when compared to the baseline data. The report should include graphs and data that identify use pattern anomalies when they occur. The report should include detailed analysis of observed patterns and recommendations for energy savings. The report should include budget analysis graphs and tools for forecasting current and future year budgets. The report should include tools for identifying utility billing errors.

1.07 ACCEPTABLE BIDDERS AND BID PROCEDURES

A. Bids by Wholesalers, Contractors, Franchised Dealers, Independent Honeywell Authorized Control Integrator (ACI) Contractors or must come from the manufacturer's branch office, any firm whose principal business is not that of manufacturing and installing automatic temperature control systems shall not be acceptable.

B. The system shall be engineered, programmed, and installed by personnel trained and regularly employed by the BMCS manufacturer.

C. Supplier shall have an in-place support facility within 30 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

D. Acceptable manufacturer/Installers and System.

i. Honeywell International (Branch Office)
101 Columbia Road
Morristown NJ 07962
856- 596-4912

ii. Invensys (Branch Office)

iii. Siemens (Branch Office)

E. All named manufactures must meet all requirements of the specifications and drawings. Naming the manufacturer does not eliminate the requirement to meet all requirements. The Bidders shall note that the integrity and functionality of the school district's BMCS is maintained upon installation of the new BMCS system and integrating it with the existing Honeywell BMCS System.

PART 2 - PRODUCTS

2.01 BMCS COMPUTER HARDWARE

A. Central Hardware. The central BMCS system shall be located where shown on the plans and shall meet the following minimum criteria:

B. The BMCS shall be listed by Underwriters Laboratories Inc (ULI) for use in energy management (category PAZX), critical process (category QVAX), security (category APOU), and as the primary control and monitoring device for smoke control (category UUKL) and fire alarm systems (category UOJZ). In addition the above listings the SMS shall have the ability to integrate all open communication protocols standards including BACnet, LonMark, ODBE, OPC, AdvanceDDE and Modbus. The SMS shall have the ability to simultaneously allow open integration and control of stand-alone systems (HVAC, fire, security, lighting, asset tracking/monitoring, closed circuit television systems and digital video systems), allowing the owner the ability to have each subsystem work together to form a complete building automation system. The system shall have the ability to allow communication between open communication protocols including BACnet, LonMark, AdvanceDDE, Modbus and OPC.

1. Printers shall be provided for recording alarms, operator transactions, and system reports. Alarm and report printers shall be 80 column/160 character per second print speed; 9 x 9 dot matrix character structure switchable to 9 x 18 dot matrix for letter quality output with 96 ASCII upper/lower case character set; bi-directional printing; and shall include 1000 sheets of fan-fold paper per printer.

2. Printers are to be furnished as follows:
   i. One printer at the central location shall be dedicated to the recording of alarm traffic only.
   ii. A hard copy multi-color graphics printer shall also be provided for recording graphic displays and associated dynamic data. Printer shall be HP Desk Jet 560C.

C. General Purpose DDC Controllers shall be minimum 16 bit microprocessor based with EPROM operating system. The devices shall be programmable and capable of taking extensive measuring, control and monitoring functions. As a back up, store DDC programs and data files on non-volatile EEPROM or flash memory to allow simple and reliable additions and changes. Each GPC shall have 30 day battery backed real-time clock. GPCs shall be provided where shown and specified with capacity to accommodate input/output (I/O) points required for the application plus spare points specified. Each panel shall be provided with a socket for a Portable Operators Terminal (POT), and a port for network communications at no less than 78K baud. Each panel shall have optional port available for modem remote to central communications. GPC outputs shall be binary for On-Off control, and true variable voltage (0-10v) for driving analog or pneumatic transducer devices. Analog outputs shall have a minimum incremental resolution of one percent of the operating range of the controlled device. GPCs shall have LEDs for continuous indication of all bus communications, power, and operational status. All panel electronics shall be installed in NEMA enclosures suitable for the environment in which they are located.

D. Unitary DDC Controllers (UCs) shall be standalone EEPROM based configured to perform the sequences specified, and with I/O selected for the application. All Unitary DDC

Controllers (UCs) shall be LonMark BTL listed BACnet Advanced Application Controllers (B-AAC) approved products and shall support the LonMark Functional Profile for the given application. UCs shall be tested and listed under both UL916 for computing devices and UUKL smoke control applications.. UC enclosures shall be flame retardant compact plastic conforming to UL94-V5 for plenum mounting or plated steel. Each UC shall be provided with face mounted LED type annunciation to continually display its operational mode; power, and normal., or in an alarm state. As an alternative to the face mounted integral LED, the control contractor shall provide relay driven pilot lights mounted at the UC location which shall provide the specified annunciation. UCs shall be configured for DIN rail mounting using industry standard clip on adapters or direct panel mounted. Each controller shall be designed with on-board jacks for quick commissioning and troubleshooting with a portable programming tool. 384009600 baud UC networks shall be grouped with no more than 20 30 UCs per primary bus connected device., except for UC networks operating over 50,000 baud, up to 100 UCs may be so grouped.

The control contractor shall furnish and ship damper actuators and Unitary DDC Controllers to the zone VAV equipment manufacturer for factory installation. See section 15851 and plans for coordination details. (Note: Zone equipment manufacturer furnishes transformers, relays, airflow rings, and enclosures.) The control contractor shall provide the zone equipment manufacturer with necessary wiring and mounting instructions.

1. VAV Terminal Unit Controller
   Provide a standalone DDC VAV terminal unit controller for factory mounting featuring preprogrammed heating and cooling control algorithms. Controller shall be designed to work with pressure independent units and pressure dependent units. Pressure independent units shall contain a default algorithm to revert to pressure dependent mode on failure of the flow sensor. Controller shall use Echelon LonWorksBACnet MSTP communication technology for field busbus and shall utilize the LonMark VAV communication profile for Interoperability with third party LonMark devices in network applications.. Controller application software shall include; set point reset for energy demand limit control or outdoor air compensation, optimum start, night purge and morning warm-up. A standby feature shall be provided to reset the occupied temperature set point back to a user definable limit based on status from an auxiliary device, such as an occupancy sensor or window contact. Controller shall include a temperature wall module connection, which may be used in any applications where the wall module must: sense temperature, control set point temperature, controls Occ/Unocc control fan speed. In addition to internal I/O selected for the application, controller shall also support distributed I/O from the network.

2. Input/Output Module
   Provide a remote input/output module, which connects sensors and actuators onto the Echelon field bus network for use with Zone Manager and Unitary DDC Controllers. Zone Manager shall be configured to read and command these points as required or specified. I/O Device shall use Echelon LonWorks communication technology for

network and controller-to controller communications and hall conform to LonMark specification. I/O Device shall have extended operating temperature rating from -40F to +150F so Device can be mounted directly in wiring cabinet of monitored appliances. I/O Device shall include a temperature wall module connection, which may be used in any applications where the wall module must: sense temperature, control set point temperature, controls Occ/Unocc control fan speed.

2.02 OPERATOR STATION SOFTWARE

A. Operator Station (OWS) software shall be compatible with the existing plant (OWS) include as a minimum. The Operating System, Data Base Manager, Communications Control, Operator Interface (OI), Trend and History Files, Report Generator, and Support Utilities.

1. Real time operating system shall be true multi-tasking providing concurrent execution of multiple real time programs and custom program development. "Switching" from foreground applications to background applications where the background applications are suspended is NOT acceptable.

2. The system shall support a minimum of three full performance stand-alone OWSs capable of connection anywhere on the primary bus without system modifications.

B. Operator Interface Software. Provide a hierarchical linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation from the local and remote BMCS workstations. The interface shall utilize pull-down menus, tool bar, dialog boxes, zoom, pan, scroll boxes, coloration and animation to facilitate operator understanding of the system. An operator-unique personalized tool bar as specified hereinafter shall be provided for day-to-day repetitive operations. A minimum of twenty (20) levels of graphic penetration shall be provided. Descriptors for graphics, points, alarms, etc., shall be modified through the operator station under password control. 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.

1. Operator access to the system is to be under personal ID and password control for up to 100 unique operators. Up to 16 alphanumeric characters for personal ID and up to 16 alphanumeric characters for password shall be assigned to each operator. The operators shall be permitted to change their own password without permitting access to any other password. Sign-off from a station shall be a manual operation or, if no mouse or keyboard activity takes place within an assigned time period, shall be automatic.

2. The OWS shall support a minimum of three languages for all menu’s dialog boxes, messages, and on line help. Each operator shall be able to select one of three languages for their screen displays. The OWS automatically displays selected language when the operator signs on and reverts to the default language when the

operator signs off. Alarm printing shall use the default language while application printing shall use the language of the operator signed on.

3. Each operator shall be assigned an access level from 1 to 5 with controlled privileges. Levels assigned as follows (5) define new operators, (4) modify high level data such as control parameters, (3) modify intermediate level data such as setpoints and alarm limits, (2) modify time programs, and (1) view data. All operators shall have privileges at their assigned level and below.

4. The OWS and software shall be configured to accommodate two printers. Printers shall through menu assignment receive any of three types of outputs; alarms, data application reports, and print screen outputs. When two printers are required, the applications printer backs up the alarm printer.

5. Data to be displayed within a graphic shall be assigned regardless of physical hardware address. Graphics are to be on-line programmable. Points may be assigned to multiple graphics and shall also contain calculated or pseudo points. Points (physical and pseudo) shall be displayed with dynamic data values with optional text descriptors, status or value, and engineering unit. Coloration shall be used to denote status and alarm states. In addition, animation shall be used where specified, to confirm operator commands (e.g., fan and pump rotation, graphical motion). All points shall be dynamic and shall continuously update anytime their field status or value changes. Points shall be commanded from any graphic directly via mouse selection.

6. Penetration within a graphic hierarchy shall display each graphic name as they are stacked to facilitate operator understanding. The "backtrace" of names shall permit the operator to move upward on the hierarchy by mouse click on the stacked backtrace. The backtrace shall show at least the previous four penetration levels. The operator shall be provided the option of showing each graphic full screen size with the backtrace as a horizontal header or by showing a stack of graphics.

7. The operator shall be provided with a means to directly access any graphic or any point without going through the penetration path. Direct access to graphics shall be by menu selection 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. Graphics shall also be selected by entering, or selecting via scroll bar of all system points, the user address of any point within the graphic. Graphics shall also be assigned to any tool bar icon for single stroke selection at any time.

8. In addition to dynamic graphic system wide multi level data and functional penetration procedures, each operator shall be provided with a unique eighteen-button tool bar selector. Upon operator sign-on, the operator’s unique tool bar shall display across the screen top above the top-level graphic. The system shall allow

each operator to easily assign multi step operator functions to any tool bar button. Buttons shall be operator-programmable as follows:

i. Button icon-pictures shall permit copying (such as a button intended to enable Microsoft word would have the standard "Word" icon copied onto the button) or may be custom designed.

ii. Buttons shall initially be provided and programmed to select third-party programs/utilities of Microsoft Word, Microsoft Excel, Micrografx Designer, Windows Calendar, Windows Card File, and the button bar designer/configuration.

In addition to third party buttons/selectors specified above, buttons shall be provided for operator assignment to Dynamic Plot 1, Dynamic Plot 2, Dynamic Plot 3, Trend Graph 1, Trend Graph 2, Trend Print 1, AHU A, AHU B and the Gas Absorption CHILLER. Operator selection of any button via mouse driven cursor selection and single click shall display, print, or command the selected operation.

9. By partial data entry, a wild card search utility shall be provided. For example, by entering "Room," all points with the word "Room" in their name shall be listed. The wild card search utility shall be used for point data access by point name or by point attribute, when searching alarm history files by date range or for critical alarms only, and by searching the operator activity files by date range.

10. An on-line context-sensitive help utility shall be provided to facilitate operator training and understanding. Help shall be available for every top-level menu bar item and dialog box.

11. To enable operators to view graphics in greater detail, a zoom/pan display feature shall be provided via a diagonal click-and-drag mouse operation.

C. General Customizing Software.

1. Provide software which will allow the user to modify and tailor the remote and local BMCS to the specific and unique requirements of the equipment installed, the programs implemented, and to staffing and operational practices. On-line modification of system configuration, program parameters, and database shall be provided via menu selection and keyboard entry of data into formatted self-prompting templates. As a minimum, the following modification capability shall be provided.

i. Operator and password assignment including designation of operator names, access levels, auto sign-off, and peripheral assignment capability including segregation of printers.

ii. System text changes shall include English descriptors for graphic systems and points, and action messages. Points shall be definable as to coloration,

animation, critical or non-critical alarm, alarm and warning limits, and engineering units, alarm suppression, run time assignment, and setting a fixed input value.

iii. Time program change capability shall include time and date set, time and occupancy schedules, holiday schedules, and daylight savings time schedules.

iv. Graphic Creation. An on-line graphic development facility shall be provided to allow the user to develop or modify graphic displays and assign and position any array of points within each graphic. All graphic displays shall be created on line via OWS graphics package. It shall not require taking the OWS off-line or interfere with point archiving and alarms. Graphics shall be created via mouse and keyboard selection of graphic library stored symbols and system templates. Provide the capability to create custom symbols, system templates, floor plans, buildings, etc., and to store them in the graphic library. The number and type of graphics to be provided is as noted in the Data Control and Graphics summary. The system shall provide expansion to a minimum of 1000 graphics per site and up to 99 live data points per graphic.

D. Alarm Processing Software.

1. A discrete per point-detailed alarm and run time limit action taking message shall be user definable; i.e., "The fan has shutdown 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 investigation of the cause is conducted" of up to 480 characters.

2. Point alarms shall be classifiable as critical or non-critical. Critical alarms shall be immediately displayed in a dialog box of the color monitor. All alarms shall be directed to the user selected alarm printer and OWS disk. Display shall include as a minimum time and date of occurrence, indication of alarm condition, analog value or status, user address, and alarm message. Symbols for critical points in a graphic display that are in an alarm state shall flash red for alarm and yellow for warning. Upon alarm acknowledgment, flashing shall cease.

3. Alarm silencing shall be by selecting the "silence" button of the dialog box or by authorized operator's acknowledgment. In all cases, alarm acknowledgment shall only be allowed by operators of access level 2 or better.

4. An unacknowledged alarm indicator shall be provided on the color monitor display to alert the operator how many unacknowledged alarms are in the system.

E. Dynamic Trend System. Dynamic trends shall be provided with up to eight users selected points per trend. This information shall be printed and displayed in numeric, bar chart, curve plot, pie chart 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 attached to the plot being displayed. Sample interval shall be user selected from five seconds to sixty minutes.

F. Reports. Reports shall be provided which shall be output onto the selected application printer, video screen or user defined file using the Borland Report Smith engine. Each physical point or pseudo point shall be assigned an English descriptor for use in reports. The following standard pre-formatted reports shall be provided.

1. Alarm History. The last 4000 alarm events shall be disk archived. Viewing or printing shall be by entering a date range (from-to). The display printout may be selectively limited to critical alarms only. Alarm history data shall include time and date of occurrence, point name, alarm type, value and status, alarm message, name of operator acknowledging the point alarm, and time and date of acknowledgment. In a LAN system, the Alarm History Report shall include alarms from the local site and all remote sites.

2. Operator Activity. All operator activity shall be archived. Viewing or printing shall be by entering a desired date range. Activity displays and printouts shall include the time and date of activity, and nature of activity (log on, attempted log on, data point changed notation with point name).

3. Controller Alarm History. Alarm event history within a GPC alarm buffer shall be displayable including the point name, time and date, alarm condition, status, value, and alarm message.

4. Controller Current Alarms. Points within each controller currently in an alarm state shall also be displayed and printed including data noted for controller alarm history.

5. Standard Reports. The 14 pre-defined reports shall include as a minimum All Point, Alarm Summary, Alarm Suppressed, Manual Mode, Device Status, Alarm Limit, Schedule Download Status, Command List Definition (all), Command List (selected), Command List Initiators, Command List Names, Event Definition, Global Data Transfer, and Run Time reports.

6. Custom Reports. An integrated Custom Report Writer capability shall be provided to allow the user to format reports of any mix of text, points with status, value and descriptors, and perform calculations, or add graphs. The user shall have the capability to modify the defined reports or design unique reports that collect and disperse different combinations of data from the system and to modify or add to the BMCS Custom Report Writer macro's which control the data collection process. A custom report drop down item under the report bar item displays a report dialog box

that allows you to schedule, run and view these reports. Spreadsheet packages which require off-line execution or manual translation of date files from one program format to another are not acceptable.

7. Database Reports. Reports shall be provided for time programs (per controller), each time control schedule command (sorted by time or by point name), time programs overridden (for following 365 days), text descriptors (per controller), parameter files and parameters (per controller), listing of all operators, listing of all customer PC programs and custom reports, listing of "Quick Access" points with status/value, multiple point group display (per HVAC System), point data record {each point; listing point name, related graphic, point description, enable/disable, analog alarm limits (4), alarm text, fixed value/status, alarm delay time, fixed mode status, alarm status, trend status, alarm lockout status, digital run time, last change (date/time), and alarm delay time}.

G Trend Reports. OWS shall allow the operator to randomly select point archival. Each system point (hardware and software) shall be assigned to PC archive files for display at user-selected intervals of 10 seconds to 24 hours. Trend data sample resolution shall be a minimum of the greater of 0.2 or one percent of the points value. Each point trend file shall have a user assigned 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).

Multipoint, multicolor trend data shall be displayed in curve plot, spread sheet, or columnar format and can be output to screen, file or to a printer.

H. Controller Support. The OWS shall provide complete utilities necessary for management of the network of digital controllers and devices. Each controller shall be provided with a user definable 16-character name. Provide software to execute and observe diagnostics of any remote device connected to the primary bus and the ability to deactivate and restart the device.

2.03 GPC SOFTWARE

A. Control Software:

1. Time Programs. Each GPC shall contain up to 20 unique user modifiable time programs (TP). Each TP shall consist of daily, weekly, and annual programs plus a "TODAY" temporary function. 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 time based (or optimum time based) analog and digital commands to be issued to user selected plant elements and points. WEEKLY programs shall allow a user selected set of daily programs to be defined for each day of the week (Monday through Sunday). 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 to meet the detailed requirements of the "Sequence of Operation". GPCs and UC network management devices shall be programmable. All GPC control software shall be designed via a graphic programming facility, the flow chart output of which shall be provided as system documentation.

3. In addition to Proportional, Proportional-Plus-Integral (PI), and Proportional-Plus-Integral-Plus-Derivative (PID) algorithms, an HVAC enhanced Adaptive Neural PID (ANPID) real time auto tuning algorithm shall be provided and implemented where specified. The ANPID shall be a full PID, but modified and enhanced to perform as follows:

   The loop performance is modeled for various loads and PID gains. The performance results of the model are entered into the ANPID as a training function. Subsequently the trained ANPID is applied to the loop. The ANPID then monitors the PID (error, PI and D gains; and output) and continuously auto adjusts the final output to prevent repeating the error learned during the training process.

B. Management Software:

1. Trending. In addition to supporting OWS trending specified elsewhere, each GPC 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 up to 20 points. A stored event shall include date and time, and value or status. Events occurring in excess of 200 shall overwrite the oldest events.

2. Alarms. Each GPC shall monitor and report 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 off-normal prior to being considered in an alarm state.

3. Alarms-Limits For each analogue input or pseudo analog point, two maximum limits and two minimum limits (alarm and prealarm) shall be set for a particular value. Each time this limit value is reached an alarm shall be triggered.

4. Zone Equipment Support. GPCs and devices managing sub-networks of UCs shall report UC alarms and shall be programmed to perform data reduction, trending, data sharing, and AHU GPC optimizing routines. In no case shall mass UC optimizing data be allowed on the primary bus.

2.04 ZONE EQUIPMENT CONTROLLERS SOFTWARE

A. UC Software shall be configured to meet the requirements of the "Sequence of Operation" specified and shall be field configurable. UC software shall support full PID control, and shall utilize separate PID gains for heating and cooling. Where UC space sensors are provided with temperature setpoint knobs, UCs shall be provided with unique software setpoint limits. Each UC shall have continuously running hardware diagnostics to detect malfunctions of the flow sensor, the temperature sensor, the remote setpoint sensor, and the A to D converter.

B. UCs shall have configured airflow calibration software to assist the test and balance (T&B) Contractor in final calibrations. Using the UC contractors calibration tool, the T&B contractor shall be provided with a display allowing a simple command entry to place the UC in zero, minimum, and maximum CFM control modes. At each mode, a display field shall be provided for the T&B contractor to enter the actual measured value in CFM. Upon completion of entering the three values, the UC shall automatically recalibrate based upon the actual values.

2.05 PORTABLE OPERATOR'S TERMINAL

A. Portable Operators Terminals (POT) shall be provided for use at all plant controllers. POTs shall be hand held and shall be plug-compatible with GPCs and UC network management devices. POTs shall display points with English language descriptions. The POTs shall be complete with command keys, data entry keys, cursor control keys, and a liquid crystal alphanumeric display. Access is to be via self-prompting menu with next menu and previous menu and step forward and step backward selection within a given menu. Connection of a POT to a panel shall not interrupt nor interfere with normal network operation , prevent alarms from being transmitted, or preclude remote initiated commands. Use of a POT at GPCs or UC network management devices shall allow the user to display software information; and, via password control, modify software. Two levels of user controlled passwords shall be provided. The first level shall allow the user to modify, create, or delete time programs; and the second level shall allow the user to modify data point text descriptors, reset totalizers, modify set points and parameters, set the system clock, and view trend logs and alarms. POTs shall have read-write-command capability for all time and calendar program functions, data point access including viewing display of historical trend values in curve plot format, alarm limits and control settings, alarm monitoring including time of occurrence, and system clock. POT shall have English access to all respective UC points noted in the section DATA CONTROL (D/C) AND GRAPHICS SUMMARY herein.

B. Furnish POTs at the gas absorption chiller plant controller and one air handling unit plant controller for use at all GPCs and UC network management devices.

2.06 DATA COMMUNICATIONS.

A. The design of the BMCS communications Network consists of three layers. The enterprise layer shall be based on standard LAN protocols for TCP/IP communications over Ethernet

and token Ring. The second layer shall consist of OWSs and GPCs and UC Network Management Devices interconnected via a Primary peer-to-peer communication network. UCs shall be connected together on the third layer via Secondary peer-to-peer network managed by GPCs or UC network management devices to provide data concentration and parallel processing for Unitary DDC Controllers such that system expansion does not noticeably affect system response. Zone network shall utilize Echelon LonWorks communications technology for true openness and Interoperability with third party devices or equal communications standard.

B. Enterprise Network

The system shall be capable of communicating over a non-dedicated Ethernet LAN. When connected to the LAN each OWS shall be able to access data residing in any primary communications bus that is connected. Graphics anywhere in the connected architecture shall be viewable and fully functional, i.e. view a system, read an analog value, command a point, change a set point, from any connected OWS. A minimum of 20 XBS OWSs shall be capable of interconnection on the LAN. Standard advanced technologies shall be supported including:

1. Client/server architecture with industry standard LAN operating systems.
2. Standard LAN protocols for TCP/IP communications over Ethernet and Token Ring.
3. Variety of industry standard wiring configurations including unshielded twisted pair thinnet, token ring, and fiber optics.

C. Primary Peer-To-Peer Network Layer

OWSs and GPCs controllers shall directly reside on single or multiple networks such that communications shall be executed directly between controllers and OWSs on a peer-to-peer basis at a selectable speed from 9,600 baud up to 1 Megabit.

D. Secondary Peer-to-Peer Network Layer

Unitary DDC Controllers shall reside directly on a peer-to-peer open protocol Echelon LonWorks communications (or equal) bus using a minimum transmission speed of 76K baud. This network shall be supported by a twisted pair cable utilizing T-Taps, star and mixed topologies on the same network. The Free Topology Transceiver (FTT) network shall not be polarity sensitive. Network media shall be Level IV, 22AWG, twisted pair wire and must conform to UL Category 4 for high-speed networks. Cable shall be supplied in plenum and non-plenum rated versions. Network length shall not exceed 1640 ft without the addition of Echelon LonWorks repeater achieving an additional length of 3280ft. For lengths in excess of 3280ft a daisy chain wiring scheme can be employed and using a repeater this length can be extended to 10,000ft. Lengths in excess of 10,000ft will not be allowed. Repeater Bus topologies shall include bus segments of 60 nodes unless routers are utilized. Systems communicating at slower speeds shall not exceed 30 nodes per segment to insure adequate global data and alarm response times.

2.07 TELECOMMUNICATIONS

A. OWSs shall be capable of auto dial / auto answer from the host system to a remote system and or remote standalone DDC panels via ISDN (64K baud to 128K) or modem (9600 baud to 28.8 K) or wireless networks. The OWS when connected to a remote site shall be capable of complete control and monitoring of all the points at the remote site as described for OWSs connected to the network. Points on the remote site that change state from normal to alarm or other significant event shall also initiate a AutoDial out sequence to establish a connection and transmit it's alarm condition to the host location.

2.08 ELECTRIC AND MECHANICAL DEVICES

A. All electric switch devices shall be selected for the applied load and UL listed and labeled for the application and environment to which they are applied. Miscellaneous, electric, pneumatic, and mechanical devices shall include:

1. Airflow measuring stations required to accomplish the specified control sequence shall be furnished under this section but installed under the sheet metal section. Airflow measuring stations shall be of heavy gauge metal construction, and shall be furnished with an air straightening section with an open face area of not less than 97%.
   i. Each airflow measuring station shall measure airflow by means of a network of static and total pressure sensors factory positioned and connected in parallel to produce an averaged velocity pressure. The measured velocity pressure converted to airflow (CFM) shall have accuracy within 2% of the full scale throughout the velocity range from 700 to 4,000 fpm when measured under ideal laboratory conditions. The location of stations shall meet manufacturer's guidelines.

   ii. The maximum resistance to airflow shall not exceed 0.6 times the velocity head. The unit shall be suitable to withstand temperatures up to 250F.

2. Any automatic control dampers not specified to be integral with other equipment. Frames shall not be less than 13-gauge galvanized steel. Blades shall not be over 8 inches wide nor less than 16-gauge galvanized steel roll formed. Bearings shall be oilite, ball-bearing or nylon with steel shafts. Side seals shall be stainless steel of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of -40 to 200F.

   i. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.

ii. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6".

iii. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all control dampers with the temperature control submittal. Maximum leakage for dampers in excess of sixteen inches square shall be 30 CFM per square foot at static pressure of 1 inch of WC.

iv. Where ultra-low leakage dampers are specified the blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 6 CFM per square foot for dampers in excess of sixteen inches square at 1 inch of WC.

3. Smoke dampers where indicated on the plans shall conform to the UL555S Leakage Class specified.

4. Automatic control valves 2 1/2 " and smaller shall be screwed type, and valves 3" and larger shall be flanged. Valves shall be ANSI-rated to withstand the pressures and temperatures encountered. Valves shall have stainless-steel stems and spring loaded Teflon packaging with replaceable discs.

i. All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs. All three-way valves shall be provided with linear throttling plugs such that the total flow through the valve shall remain constant regardless of the valve's position. Valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 5 psi.

ii. Unitary valves shall be straight-through or three-way type as specified in the sequence of operation. Stems shall be polished stainless-steel and packing shall be ethylene-propylene suitable for both chilled water and 250 degree hot water service. Pressure ratings shall be as required for the intended service.

5. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with pneumatic actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off.

6. Safety low limit shall be manual reset twenty foot limited fill type responsive to the coolest section of its length.

2.08 DATA INPUTS AND OUTPUTS

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

B. Temperature sensors shall be Resistance Temperature Detector (RTD) type of 100, 1000, or 3,000 ohm platinum, 500 ohm Balco, or 20,000 ohm. Sensors shall have + or - 1.0 degrees F accuracy between 32 degrees and 212 degrees.

1. UC Space Temperature Digital Wall Modules Honeywell type T7560 shall be provided where shown on plans and shall be mounted 48" above finished floor with blank commercial type locking covers with the following features:
   i. Set point control
   ii. Occ/Unocc override
   iii. Absolute/Relative scale
   iv. LCD display

2. Duct temperature sensors shall be rigid stem or averaging type as specified in the sequence of operation. Water sensors shall be provided with a separable copper, monel or stainless-steel well.

3. Dew point sensors shall employ a non-reactive organic bobbin material to give precise dew point readings with error of no more than + or - 1.5 degrees. The dew point sensor shall incorporate an integral draft shield as part of the instrument for air velocities in excess of 50 feet per minute.

C. Water flow analog sensors shall be provided complete with flow element and shall be an all solid state precision industrial type with stainless-steel meter body, maximum error of no more than .5% of span, and 4 to 20 ma output. Sensor shall be rated for 250 psi minimum and installed in strict accordance to the manufacturer's instructions complete with three-valve manifold for calibration and maintenance.

D. Kilowatt transducers shall be the integrated electronic type with accuracy of .2% of scale. For balanced (such as motors) three phase loads, two current transformers (CTs) shall be provided and for unbalanced loads, three CTs shall be provided. Two or three potential transformers (PTs) shall be provided as recommended by the manufacturer for the application.

E. Unless specified otherwise elsewhere, relative humidity sensors shall be capacitance type with 10% to 90% ranges. Duct mounted humidity sensors shall be provided with a sampling chamber.

F. Outside air relative humidity sensor used for enthalpy economizer decision shall be Vaisala model HMD 50U.

G. Current sensing relays used for proof-of-loading for fans and pumps shall be suitable for 2 to 200 amperes and shall have adjustable trip thresholds of plus or minus two percent of range. Each relay shall be provided with an LED to allow ready observation of the relay status.

H. 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 WC, 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 WC.

I. Pump proof-of-flow switches shall be adjustable differential pressure or flow type as specified in the sequence of operation or data point summary. Devices shall be 150 psi rated except chilled water flow switches shall be provided with totally sealed vapor tight switch enclosure on 300 psi body. Differential pressure switches shall have valved manifold for servicing.

J. Carbon Dioxide (CO2) sensors used for demand control ventilation (DCV) shall be of the analog output type 2-10 vdc output with automatic background calibration algorithm based on long term evaluation. Non-dispersive infrared (NDIR) with accuracy 5% full range 0 to 2000ppm. Shall be Honeywell model C7232B1014.

K. Mechanical Equipment Room Gas Monitoring System

i. Provide a Mechanical Equipment Room (MER) gas monitoring system as shown on the drawings. MER monitoring panel shall be located as shown on drawings to alert the user in the event of occurrences of hazardous conditions in the MER.

ii. The MER monitoring panel shall incorporate remote mounted CO and Methane monitoring sensors. Sensors shall be electrochemical type. Sensors shall have the ability to be field replaced without shutting down the controller or setting off alarms at the monitoring system.

iii. Central panel shall include a local audible alarm, visual indication of each connect gas sensor and alarm relay outputs for connecting to the BMCS system.

iv. Sensor accuracy shall be 1%

v. Gas sensor shall be MSA Model Tri Gard with dual sensors or approved equal.

PART 3-EXECUTION

3.01 GENERAL

The BMCS shall be designed, installed, and commissioned in a turnkey operational manner; including all labor not noted in Work by Others paragraph of PART I of this section of these specifications, and not noted in other sections of these specifications.

3.02 DATA CONTROL (D/C) AND GRAPHICS SUMMARY

A. All hardware, custom software, application software, graphics, etc., necessary to accomplish the control sequences and display the graphics specified shall be provided as part of this contract. Provide all controllers, inputs, outputs, valves, dampers, actuators and flow meters required to provide the control and graphic data described. Provide software set points required for display in logical groups and graphics.

B. Each digital output shall have a software-associated monitored input. Any time the monitored input does not track it's 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.

D. Unless otherwise specified or approved prior to bidding, the primary analog input and the analog output of each DDC loop shall be resident in a single remote panel containing the DDC algorithm, and shall function independent of any primary or UC communication links. Secondary (reset type) analog inputs may be received from the primary network, but approved default values and/or procedures shall be substituted in the DDC algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

E. In addition to the Unitary DDC Controller data points specified to be presented on colorgraphic displays, technical data for each zone mechanical apparatus shall be presented to operators on the OWS in full English menu text displays including the apparatus name; heating and cooling PID loop P, I and D gains; primary CFM airflow (if measured); damper position (% open); reheat status/value; cooling set point; heating dead-band; minimum and maximum CFM set points; reheat CFM set point; unoccupied temperature set point; temperature sensor calibration offset; bypass push button time, in minutes; smoke purge mode damper position; smoke pressurization mode damper position; smoke depressurization mode damper position; and morning warm-up mode damper position. All such points shall be presented in complete and direct read-write (command) format, unless they are provided in commandable colorgraphic displays.

F. In addition to Graphics of building systems with dynamic data points as noted in the following Data and Control and Graphic Summary, the following additional graphics shall be provided:
   i. Absorption Chillers
   ii. Individual building layouts or isometrics
   iii. Chilled & Hot Water System

iv. HVAC system graphics

3.03 SUBMITTALS

A. Provide 8 copies of submittal data within 30 days of contract award.

B. Submittal shall consist of:

1. System architecture showing existing campus and new LAN bus connections.

2. Equipment lists of all proposed devices and equipment including data sheets of all products.

3. Valve, damper, and well and tap schedules showing size, configuration, capacity and location of all equipment.

4. Data entry forms for initial parameters. Contractor shall provide English listing of all analog points with columnar blanks for high and low warning limits and high and low alarm limits, and a listing of all fan systems with columnar blanks for beginning and end of occupancy periods; and samples of proposed text for points and messages (for at least two systems of at least 15 points total) including sample 480 character alarm message. All text shall be approved prior to data entry.

5. Wiring and piping interconnection diagrams including panel and device power and sources.

6. Sketches of all graphics.

7. Software design data including flowchart of each DDC program showing interrelationship between inputs, PID functions, all other functions, outputs, etc. and sequence of operation relating to all flowchart functions.

3.04 INSTALLATION

A. All wiring and tubing shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All wiring shall be in accordance with all local and national codes. All line voltage wiring, all wiring exposed, and all wiring in equipment rooms shall be installed in conduit in accordance to the electrical specifications. All electronic wiring shall be #18 AWG minimum THHN and shielded if required, except standard network (Ethernet, LonWorks, etc.) cabling shall be as tested and recommended in lieu of #18 gauge twisted, #22 or #24 gauge is acceptable if used as a part of an engineered structured cabling system. The control manufacturer must submit technical and application documentation demonstrating that this cabling system has been tested and

approved for use by the manufacturer of both the control system and the engineered structured cabling system. All wiring in the central control room shall be concealed in an approved manner.

B. This contractor shall provide all sensing, control, and interlock wiring for the following unless shown or specified elsewhere by others.

i. BMCS inputs and outputs
ii. BMCS communications
iii. Gas Fired Absorption Chiller system control
iv. Cooling Tower System
v. VAV box communication bus and wall digital modules\sensors
vi. Miscellaneous exhaust fan interlocks
vii. Unit heater controls
viii. AHU unit controls
ix. Chemical Treatment Unit
x. A\C units
xi. Air Cooled Condenser Unit
xii. Freeze Protection Pumps
xiii. Smoke Dampers
xiv. Sand Filters
xv. Fume Hood Controls
xvi. Heating and Ventilation Units
xvii. Gas Monitoring System
xviii. Power and Control Wiring Downstream of all DDC Panels

C. The BMCS contractor shall enter all computer data into the related computers including all graphics, control programs, initial approved parameters and settings, and English descriptors. The BMCS contractor shall maintain diskette copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the owner during training sessions, and one copy shall be archived in the BMCS contractor's local software vault.

3.05 ACCEPTANCE

A. The BMCS contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequences of operations approved.

B. Witnessed acceptance demonstration shall display and demonstrate each type of data entry to show site specific customizing capability; demonstrate parameter changes; execute digital and analog commands; and demonstrate DDC loop stability via trend of inputs and outputs.

C. The control contractor shall furnish a portable UC programming tool with preloaded software and necessary interface cable to the balancing contractor for use during system balancing. The balancing contractor shall be responsible for proper use and care of this tool, and shall return it to the control contractor immediately upon balancing completion. The control contractor shall provide the balancing contractor up to four hours training on the use of this tool in order to exercise actuators and enter calibration and balancing parameters. Additional training or assistance required by the balancing contractor shall be contracted directly with the control contractor by the balancing contractor.

3.06 MANUALS

A. The following manuals will be provided:

1. An Operators Manual shall be provided with graphic explanations of keyboard use for all operator functions specified under Operator Training.

2. Computerized printouts of all GPC data file including all point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, etc.

3. A manual shall be provided including revised as-built documents of all materials required under the paragraph "SUBMITTALS" on this specification.

4. Two Operators Manuals and two As-Built Manuals shall be provided to the owner.

3.07 TRAINING

A. All training shall be by the BMCS contractor and shall utilize operator's manuals and as-built documentation.

B. Operator training shall include two twelve-hour sessions encompassing modifying text and graphics, sequence of operation review, selection of all displays and reports, use of all specified OWS functions, use of Portable Operators Terminals, troubleshooting of sensors (determining bad sensors), and password assignment and modification. One training session shall be conducted at system completion, and the other shall be conducted forty-five days after system completion.

C. Training shall be videotaped and submit (2) copies of Training CD and Presentation to the Owner.

3.08 WARRANTY

A. All components, system software, and parts supplied by the BMCS contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date. Labor to repair, reprogram, or replace components shall be furnished by the BMCS

contractor at no charge during the warranty period. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks.

3.09 SEQUENCE OF OPERATION

A. CENTRAL PLANT - The central plant for the two-pipe dual temperature system includes the following equipment:

1. GFA-1 & GFA-2 Dual Fuel (Natural gas and # 20 Oil) Gas Fired Absorbers.
2. P-1, P-2 & P-3 Primary Dual Temperature Pumps with VFD pump control.
3. P-4, P-5 & P-6 Secondary Dual Temperature Pumps with VFD pump control.
4. P-7 & P-8 Summer Reheat Hot Water Pumps
5. CT-1 Two cell Cooling Tower with VFD fan control.
6. CWP-1, CWP-2 & CWP-3 Condenser Water Pumps with VFD pump control.

B. CENTRAL PLANT SYSTEM CONTROL AND SEQUENCE

1. Provide a network interface with the specified absorbers to provide total monitoring of the absorber at the EBI Work Station. The BMCS contractor shall study and be familiar with the absorber manufacturer-provided integral controls as per approved shop drawings to provide network interface coordination. The BMCS contractor shall provide all control devices not provided by the equipment manufacturer but as required by the contract documents. Provide a DDC control panel with portable operator's station mounted on face of the panel to be located in the mechanical equipment room.

2. The absorbers operate under the following conditions in summer:
   i. BMCS Cooling Demand.
   ii. BMCS Operator Manual Command.

3. In the summer mode the dual temperature water system shall be enabled as follows:

   i. The isolation supply and return two way control valves serving the reheat control valves and the cabinet unit heater control valves on each floor shall be automatically closed through the EBI work station.

   ii. The absorption chiller hot water supply and return manual valves shall be closed by the operating personnel.

   iii. The absorption chilled water supply and return manual valves shall be opened by the operating personnel.

iv. The selected hot water P-7 or P-8 summer reheat hot water pumps shall be energized. Provide for each P-7 & P-8 summer reheat hot water pumps a current sensing device. The switch shall after a thirty second time delay and upon a loss of current energize the respective standby pump and provide an alarm condition at the EBI Work Station.

v. The cooling tower shall be placed into summer operation by the operating personnel. Once the cooling tower is placed into summer operation, the operating personnel shall acknowledge through the EBI Work Station that cooling system is ready for summer start-up operation before chiller system can be placed into summer mode of operation.

4. The absorbers operate under the following conditions in winter:

i. BMCS Heating Demand.
ii. BMCS Operator Manual Command.

5. In the winter mode the dual temperature water system shall be enabled as follows:

i. The isolation supply and return two way control valves serving the reheat control valves and the cabinet unit heater control valves on each floor shall be automatically opened through the EBI work station. The absorber hot water supply and return manual valves shall be opened by the operating personnel. The absorber chilled water supply and return manual valves shall be closed by the operating personnel.

ii. P-7 & P-8 summer reheat hot water pumps shall remain off.

iii. The cooling towers shall be placed into winter operation by the operating personnel. To prevent freezing of cooling tower pipes and cooling tower sump pan the cooling towers are drained and placed into winter operation, the operating personnel shall acknowledge through the EBI Work Station that heating system is ready for winter operation before heating system can be placed into operation. The cooling water make-up valve shall be manually closed. Cooling tower fans and condenser water pumps shall remain off during winter mode of operation.

6. The primary pumps shall be programmed to run at predetermined constant speeds during summer and winter operation. The selected active two primary dual temperature pumps shall be energized to run continuously.

7. The selected two secondary dual temperature pumps through its respective variable frequency drive (VFD) shall be energized to run continuously.

8. The selected condenser water pumps through their respective variable frequency drives shall be energized to run continuously. Once chilled water and condenser water flow are proven and after a five minute delay, the selected GFA-1 or GFA-2 lead absorber shall be energized to run through its integral operating and safety controls. The absorbers shall be energized only when the two primary dual temperature pumps are energized and proved. The absorber will be on all the time. The second absorber will be staged on when the chilled water temperature at the return header rises above 58F (adj.) for 20 minutes. Once the cooling demand reduces, the return water temperature will drop below 54F. The absorber will be staged off sequentially with a delay of 20 minutes.

9. Whenever the absorbers are de-energized the dual temperature and condenser water pumps shall continue to run for a minimum of 10 minutes and as per the signal command of the absorber operating control. The absorber leaving supply water temperature shall be controlled through its integral operating and safety controls as provided by the absorber manufacturer.

10. Provide for each dual temperature water pump and condenser pump a current sensing device. The switch shall after a thirty second time delay and upon a loss of current energize the respective standby pump and provide an alarm condition at the EBI Work Station.

11. For the secondary dual temperature water pumps, provide dual temperature water pressure transmitters in the supply piping and return piping. The pressure transmitters shall through the control panel modulate the output of the variable frequency drive to maintain dual temperature system pressure. The BMCS system shall provide a 2 to 10 vdc. control signal to the (VFD`s). Provide a differential pressure reducing control valve on the bypass line between the supply and return dual temperature system water mains. Provide a GPM (gallons per minute) flow meter on the common dual temperature water supply pipe in the North Building Basement MER. The flow meter shall proportionately modulate the bypass reducing control valve to maintain minimum GPM.

12. Upon energizing the condenser water pumps and proof of flow in the condenser water system, the condenser water supply temperature sensor shall sense the condenser water supply temperature and if the temperature is below 65 deg F (adj.) the three way valve in the condenser water loop shall modulate to bypass the water till the condenser water supply temperature reaches 75 deg F (adj.). During this period the cooling tower shall not be energized. When the condenser water supply temperature reaches 75 deg. F (adj.) the three way valve shall allow full flow of condenser water to the cooling tower and the cooling tower shall be automatically energized.

13. The cooling tower control shall operate as follows: The two cells of the cooling tower shall be operated in sequence to maintain condenser water temperature as follows: As condenser water rises above set point, the first cooling tower fan motor shall be

energized to its low speed operation through the VFD. As temperature continues to rise, the additional cooling towers shall be energized in sequence to maintain condenser water temperature to the absorbers. If condenser water continues to rise above set point due to cooling demand, the cooling tower fans shall then in sequence, begin to run in their high speed mode of operation. Provide current sensors for each of the cooling tower fans VFD. Provide in each cooling tower sump basin an immersion sensor. The sensor shall through the cooling tower manufacturer's control panel energize the cooling towers respective sump basin electric heaters to prevent a sump freeze condition. Provide at the EBI Work Station temperature status and alarm condition.

14. Provide condenser water return and supply sensors located in the common supply and return header of the cooling towers. The sensors shall provide temperature indication and high/low temperature alarm status to the EBI Work Station. Provide supply and return water temperatures for each of the absorption chillers and cooling towers. Provide BMCS status and failure of all of the above listed devices.

15. Provide on the dual temperature water common supply and return sensors on piping serving the AHU units. The sensors shall provide temperature indication and high/low temperature alarm status to the EBI Work Station. The absorption chillers shall be prevented from running in the summer mode until temperature falls below 70F (adj.).

16. Interlock the operation of Sand Filter with the operation of Condenser water Pumps.

C. AIR HANDLING UNIT SYSTEM CONTROL AND SEQUENCE (AHU-1N, AHU-2N, AHU-3N, AHU-4N, AHU-5N, AHU-6N, AHU-7N, AHU-8N, AHU-9N, AHU-1S, AHU-2S, AHU-3S, AHU-4S AND AHU-5S.)

1. FIRE ALARM CONNECTION: The fire alarm contractor shall provide in the fire alarm system a set of dry contacts, which shall signal the control center to shut down all AHU units and exhaust fans, switch on the smoke purge exhaust fans and open the motorized dampers associated with the smoke purge exhaust fans, whenever the fire alarm panel is in an alarm condition.

2. MANUAL EMERGENCY SHUTDOWN: Provide by the electrical contractor is an emergency shut down switch which shall to shut down all AHU units and respective exhaust fans. Provide an alarm status to the central work-station when the manual switch is in the shut down mode.

3. SMOKE DETECTORS: The electrical contractor shall provide duct mounted smoke detectors for the supply and return air ducts for the roof top air handling unit. The mechanical contractor as part of his contract shall mount the smoke detectors in the supply and return air ducts of the unit below the roof line.

NOTES

- Air Handling Units AHU-8N, AHU-2S, AND AHU-5S is provided with supply fans only.
- Air Handling Unit AHU-8N supply fan is a constant volume fan without VFD.
- Air Handling Unit AHU-9N is equipped with Energy Recovery Wheel (ERW).

4. When the air-handling unit (AHU) is in the occupied cooling mode, the supply fan and return fan will operate continuously, the variable frequency drive (VFD) will modulate to maintain the duct static pressure and the chilled water control valve will modulate to maintain discharge air temperature.

5. When the AHU is in the unoccupied mode, the supply air and return air fan will be off, outdoor air damper, relief damper and chilled water control valve will be closed.

6. When the AHU is in the night setback / morning warm-up heating mode, the supply fan and return fan will operate continuously, the (VFD) will modulate to maintain the duct static pressure, the outdoor air damper and relief damper will be closed, the return damper will be fully open and the heating control valve will modulate to maintain 65F (adj.) heating discharge air temperature set point 85F (adj.) for AHU-8N. The unit shall signal all variable air volume (VAV) terminal units to full flow with the associated heating control valve in full open position until the morning warm-up set point is reached and the AHU returns to occupied mode.

7. The supply fan will operate continuously whenever the AHU is in either the occupied cooling mode or in the night setback / morning warm-up heating mode. The supply fan will be off whenever the AHU is unoccupied mode, the mixed air low limit is tripped, or the supply fan status indicates a failure (after a two minute delay). the low limit and fan failure require a manual reset.

8. When the return fan starts, the return fan (VFD) shall modulate from the signals of a transmitter in the supply fan outlet ductwork, to maintain a constant difference between supply air and return airflow rates. When the supply fan and return fan is on, the (VFD) will slowly ramp (adjustable) up to set point and modulate to maintain the proper duct static pressure.

9. When the outdoor air temperature is less than the changeover set point, the mixed air dampers will modulate between the adjustable minimum position and full open to maintain the discharge air temperature at the economizer set point. Mixed air dampers will modulate closed as required (overriding the minimum position) to maintain the mixed air set point. A manual reset mixed air low limit will turn the supply fan off if any 12 inches of its sensing element is below its set point.

10. The mixed air dampers will be set to its adjustable minimum position if the economizer function is disabled or the discharge air temperature sensor has failed. If the AHU is in the morning warm-up mode, the supply fan is off, or the mixed air temperature sensor has failed, then the outdoor air damper will be closed.

11. The heating control valve will modulate to maintain the discharge air temperature at the discharge heating set point. If the AHU is in the heating mode, the unit will control to the heating discharge air set point. The heating control valve will modulate to maintain an AHU temperature not exceeding 85F (adj.) if the supply fan is off.

12. Carbon Dioxide sensors are located in the return air ducts of each AHU. Provide one carbon dioxide sensor for measuring the CO2 level for the outdoor air. The carbon dioxide sensors shall provide demand-controlled ventilation (DVC). Whenever the return air exceeds the ppm range the mixed air dampers shall modulate open to maintain CO2 level in the return air duct. Measurement of the outside air, outdoor CO2 and the return air CO2 levels shall be determined to allow adequate ventilation rates. Provide an Airflow Measuring Station at the outdoor air intake of each AHU to indicate OA intake.

13. De-Humidification Control: In the summer mode the return air relative humidity sensor will override control of the discharge air temperature and open the cooling coil control valve when the need for de-humidification arises. After sub-cooling the air to de-humidify, the reheat coil will maintain discharge air temperature setpoint to avoid over-cooling.

14. The BMCS shall monitor the AHU discharge air cooling set point, and a duct static pressure set point. The BMCS shall also send start-up, occupied, unoccupied, morning warm-up, heating / cooling, economizer enable, timed override, startup, coastdown, demand limit, duty cycle, night setback, purge, and priority shutdown commands.

15. If communication with the BMCS is lost, the AHU uses its default set points and operates in the occupied mode. The economizer function is enabled based on the AHU outdoor air temperature sensor.

16. Provide a differential pressure switch at the pre-filter banks. The switch shall be set as per the filter manufacturer's rating for a dirty filter. Whenever the filter exceeds this rating, the filter switch shall indicate a dirty filter alarm to the BMCS system. Provide a differential pressure switch or a current sensor at each supply and return/exhaust fan. The switch/sensor shall provide fan flow status and fan failure to the BMCS system.

17. SEQUENCE OF OPERATION FOR ENERGY RECOVERY WHELL (ERW) OF AHU-9N

NOTE: The following sequence is in addition to the sequence for Air Handling Units above.

i. ENERGY RECOVERY WHEEL:
The mechanical contractor shall coordinate between the AHU manufacturer, the energy recovery wheel manufacturer, and the BMCS contractor for the controls to provide a complete integrated system. This includes but is not limited to wiring diagrams and contact inputs such as: unit start/stop, supply fan start/stop, and wheel start/stop, heating and cooling stages and alarms.

ii. ENERGY RECOVERY OCCUPIED MODE:
Energy recovery unit shall be on and under control of recovery air temperature transmitter when the associated AHU is on and in the occupied mode.

iii. ENERGY RECOVERY MAXIMUM COOLING:
Based on summer design day, energy recovery wheel shall be rotating to absorb maximum energy from the exhaust air into the outdoor intake air. Recovery air temperature transmitter shall signal energy recovery wheel to rotate at maximum speed (or speed as required by the energy recovery until manufacturer), with recovery air temperature setpoint at 55F (adj.).

iv. ENERGY RECOVERY MINIMUM COOLING:
Same as the "maximum cooling" sequence above, because it is assumed that the energy recovery wheel is in a 100% outdoor air stream. With 55F (adj.) supply air requirement per recovery air temperature transmitter, maximum cooling is needed until outdoor air temperature via outdoor air temperature transmitter drops to within 5F (adj.) of exhaust air via exhaust air temperature transmitter (adjustable based on energy recovery wheel selections.) At this point, energy equilibrium (no heat transfer) shall be reached and energy recovery wheel shall shut off to save electric wheel motor energy. Also at this point, the "free cooling" benefit of 100% outdoor air will provide recover air temperature transmitter with the coolest temperature upstream of the roof top unit cooling coil, versus energy recovery cooling cycle.

v. NO ENERGY RECOVERY:
An outdoor air temperature transmitter dead band of 5F (adj.) above the exhaust air temperature transmitter, and 5F (adj.) below exhaust air temperature transmitter, shall prevent energy recovery wheel from operating.

18. ADDITIONAL SEQUENCE OF OPERATION FOR AHU-8N

i. Air handling unit AHU-8N serves the multi purpose room and kitchen areas. The air-handling unit shall be interlocked with the kitchen exhaust hoods such that whenever the air-handling unit is in occupied mode all the kitchen

exhaust hood fans shall automatically be switched on. Also, whenever the kitchen hood fans are locally energized, AHU-8N shall automatically go on occupied mode.

19. HEATING COIL CIRCULATING / FREEZE PROTECTION PUMP FOR ALL AHUs.

i. During unoccupied mode of operation in winter, the hot water control valve shall modulate to maintain AHU temperature of 65F (adj.) If however, the temperature falls to 38F (adj.) the freeze protection pump shall be energized and an alarm shall indicate on the BMCS host computer station.

ii. If the temperature falls further down to 35F (adj.) the freeze protection pump shall be de-energized, the heating coil control valve shall go to full open condition, the heating system shall be energized, and the dual temperature pumps shall run to provide hot water to the heating coil of the affected Air Handling Unit. An alarm shall also be indicated on the BMCS host computer station.

D. VARIABLE AIR VOLUME (VAV) BOXES CONTROL SEQUENCE

1. The supply air damper is controlled with user defined separate heating and cooling maximum and minimum supply air volume settings (0 to 100% adjustable). An air velocity sensor is used to determine CFM values.

2. The terminal box controller monitors the room temperature sensor and air velocity sensor. The terminal box controller modulates the supply air damper and the reheat valve to maintain desired room temperature.

3. During the occupied cooling mode, the VAV box will function as follows: The room temperature is compared to the cooling set point. The terminal box controller will modulate the supply air damper to maintain the cooling set point (78 degrees F. adjustable). The supply air volume will be limited by the cooling minimum and maximum supply air volume settings. The reheat control valves are closed.

4. During the occupied heating mode, the VAV box will function as follows: The room temperature is compared to the heating set point. During the heating operation, the supply air volume is at heating minimum flow. The controller will modulate the reheat control valve to maintain heating set point (70 degrees F. adjustable).

5. During the unoccupied mode, the VAV box will function as follows: Upon command from the corresponding air handling unit's control panel to changeover to unoccupied mode, the terminal box controller will control using the unoccupied heating and cooling set points (55F and 85F adjustable).

6. The terminal box controller may be reset to the occupied mode for a predetermined time period upon a signal from the control system or manually at the room sensor push button.

7. The terminal boxes shall function in concert with the corresponding air handling unit's direct digital controller to perform system operations such as morning warm-up, individual room schedule control, and central alarm and monitoring capabilities.

E. HEATING AND VENTILATION UNIT HV-1N.

1. The heating and ventilation unit provides combustion air to the absorbers. The heating and ventilation unit shall be interlocked with the absorber controls and associated motorized OA damper. Whenever the absorber gets a command to energize, the heating and ventilation unit shall be energized first and upon proof of air flow as sensed by an airflow switch installed downstream of the supply air fan the control circuit of the absorber shall be energized. A supply air temperature sensor installed downstream of the supply air fan shall energize the gas furnace in the heating and ventilating unit whenever the supply air temperature falls below 65F (adj.) The heating and ventilation unit shall be off, the motorized OA damper shall be closed whenever the absorber is not in operation.

F. PACKAGED ROOFTOP AIR CONDITIONING UNITS AC-2 and AC-3 SERVING ADMINISTRATION AREAS.

1. Whenever AHU-1N and AHU-2N are in the occupied mode AC-2 and AC-3 shall remain off and the motorized supply air dampers shall be closed. The supply air damper on the VAV box serving the administration area shall be open.

2. Whenever the AHU-2N is in the unoccupied mode and the occupied switch located in the administration area is depressed the supply damper on AC-2 shall open and the supply air damper on the VAV box serving the administration area shall be closed. The AC-2 shall run for a minimum of 4 hours (adj).

3. The AC-2 rooftop unit shall be furnished with a conventional thermostat option by the rooftop unit manufacturer is required for interface by an external direct digital control system. The rooftop units shall be provided with RTU manufacturer mounted economizer control.

4. During the occupied mode of operation, the unit's supply air fan shall run continuously. When space temperature rises above the cooling set point of 76 degrees F. (adjustable), the cooling controls (economizer cycle or mechanical cooling) shall be energized to maintain space temperature.

5. If outside air temperature shall be below the set point of the outdoor air changeover thermostat, the unit's outside air and return air dampers shall be proportionately positioned from minimum to full outside air (economizer) to maintain mixed air temperature set point.

6. If outside air temperature shall be above the set point of the outdoor air changeover thermostat, the unit's outside air and return air dampers shall be positioned to the minimum outside air position. The unit's mechanical cooling shall be cycled to maintain space air temperature.

7. Provide an override push-button on the face of the space thermostat, that when manually depressed, shall return the unit to the occupied mode of operation for up to 4 hours (adjustable). After the time duration, the unit shall return to the unoccupied mode of operation.

G. EXHAUST FANS

1. The exhaust fans shall be indexed for occupied - unoccupied modes of operation through the BMCS system. During the occupied cycle, the respective exhaust fans shall run continuously. During the unoccupied cycle, the respective exhaust fans shall remain off. The exhaust fans shall be interlocked with their respective AHU units' occupied - unoccupied modes of operation.

2. Provide a differential pressure switch or current sensor at each of the exhaust fans. The switch/sensor shall provide fan flow status and fan failure to the BMCS system.

H. LABORATORY FUME HOOD EXHAUST FANS

1. The laboratory fume hood exhaust fans shall be interlocked with their respective AHU units' occupied - unoccupied modes of operation. The laboratory fume hood exhaust fans shall run continuously when its associated AHU is in the occupied mode.

2. Provide a differential pressure switch or current sensor at each of the laboratory fume hood exhaust fan. The switch/sensor shall provide fan flow status and fan failure to the BMCS system.

I. EXISTING HEATING AND VENTILATION UNITS FOR THE LOCKER ROOMS AND GYMNASIUM.

1. There are three existing heating and ventilation units serving the locker rooms and the gymnasium. These units shall remain. Existing controls for the units are pneumatic type. The BMCS contractor shall replace all existing pneumatic controls and devices and provide DDC controls and integrate the controls with the EBI Building Management System. Check with Tom Macfie.

J. SMOKE EVACUATION FANS CONTROL

1. The BMCS contractor shall provide controls to automatically open the motorized outdoor air dampers of the smoke evacuation system and automatically enable the exhaust fans associated with smoke evacuation system upon a signal from the fire alarm system.

2. The BMCS contractor shall provide a Gas Monitoring System located in the MER. The system shall consist of a natural gas sensor located above the gas fired absorber units and a carbon monoxide sensor. The sensors shall sound an alarm in the MER and at the EBI Workstation whenever their set points are exceeded.

K. INPUT/OUTPUT SUMMARY

1. Refer to Attachment No. 1 to 6 for the input/output summary.

END OF SECTION 15900

INPUT/OUTPUT SUMMARY TABLE

	HARDWARE																						SOFTWARE																									
	OUTPUTS									INPUTS													ALARMS							Energy Management Control Strategies																		
	Digital				Analog					Digital						Analog							Digital			Analog																						
Point Description:	Control Relay	Solenoid	Contactor		Pneumatic Transducer	Electrical Transducer	0-10 V	Pneumatic		Pressure Switch	Flow Switch	Switch Closure	Current Sensor	KW		Temperature	Relative Humidity	PSIG / INW	Position	Flow	CO2/O2		Equipment Status	Maintenance	Run Time	High Limit	Low Limit			Start/Stop	Optimum Start/Stop	Timeclock	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Enthalpy	Hot/Cold Deck Reset	Steam Boiler Optimization	H.W.Boiler Optimization	Hot Water O.A. Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	DDC Adjustable	System Graphic
All AHU's Except AHU-9N																																																
Supply Fan VFD	x						x						x										x	x	x					x	x																x	x
Return Air																x	x				x																										x	x
Outside Air																x				x						x	x						x															x
Mixed Air																x																			x	x											x	x
OA,RA & EA Dampers							x																								x	x			x	x	x	x									x	x
Filter Alarm										x													x	x																								x
Heating Coil Valve							x																														x										x	x
Cooling Coil Valve							x																														x										x	x
Heating Coil Supply Air																x										x	x										x										x	x
Freeze Alarm												x															x																				x	x
Cooling Coil Supply Air																x										x	x										x											x
Return Fan VFD	x						x						x										x	x	x					x	x																x	x
Return Air Humidity																x										x	x											x									x	x
Summer Reheat Coil Valve							x																			x	x										x										x	x
Summer Reheat Supply Air																x										x	x										x										x	x
Smoke Damper End Sw																																																
Humidifier																																																
Sum-Win Valve	x																						x																									x
Bldg Fire Alarm Panel												x											x																									x
Fire Command Station																																																
Freeze Protection Pump	x												x										x	x	x					x																	x	x
Static Pressure Sensor																		x								x	x																				x	x
Communication Bus																							x																									

INPUT/OUTPUT SUMMARY TABLE

	HARDWARE																						SOFTWARE																									
	OUTPUTS									INPUTS													ALARMS							Energy Management Control Strategies																		
	Digital				Analog					Digital						Analog							Digital			Analog																						
Point Description:	Control Relay	Solenoid	Contactor		Pneumatic Transducer	Electrical Transducer	0-10 V	Pneumatic		Pressure Switch	Flow Switch	Switch Closure	Current Sensor	KW		Temperature	Relative Humidity	PSIG / INW	Position	Flow	CO2/O2		Equipment Status	Maintenance	Run Time	High Limit	Low Limit			Start/Stop	Optimum Start/Stop	Timeclock	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Enthalpy	Hot/Cold Deck Reset	Steam Boiler Optimization	H.W.Boiler Optimization	Hot Water O.A. Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	DDC Adjustable	System Graphic
AHU-9N																																																
Supply Fan VFD	x						x						x										x	x	x					x	x																x	x
Return Air																x	x				x																										x	x
Mixed Air																x																			x	x											x	x
Outside Air																x				x						x	x						x															x
OA,RA & EA Dampers							x																								x	x			x	x	x	x									x	x
Filter Alarm										x													x	x																								x
Heating Coil Valve							x																														x										x	x
Cooling Coil Valve							x																														x										x	x
Heating Coil Supply Air																x										x	x										x										x	x
Freeze Alarm												x															x																				x	x
Cooling Coil Supply Air																x										x	x										x											x
Return Fan VFD	x						x						x										x	x	x					x	x																x	x
Return Air Humidity																x										x	x											x									x	x
Summer Reheat Coil Valve							x																			x	x										x										x	x
Summer Reheat Supply Air																x										x	x										x										x	x
Smoke Damper End Sw																																																
Typical Exhaust Fans	x																						x	x	x					x	x																x	x
Space Sensor																x										x	x				x						x										x	x
Energy Recovery Wheel	x																						x	x		x				x							x											x
Bldg Fire Alarm Panel												x											x																									x
Fire Command Station																																																
Freeze Protection Pump	x												x										x	x	x					x																	x	x
Static Pressure Sensor																																																
Communication Bus																							x																									

INPUT/OUTPUT SUMMARY TABLE

	HARDWARE																						SOFTWARE																									
	OUTPUTS									INPUTS													ALARMS							Energy Management Control Strategies																		
	Digital				Analog					Digital						Analog							Digital			Analog																						
Point Description:	Control Relay	Solenoid	Contactor		Pneumatic Transducer	Electrical Transducer	0-10 V	Pneumatic		Pressure Switch	Flow Switch	Switch Closure	Auxiliary Contact	KW		Temperature	Relative Humidity	PSIG / INW	Position	Flow	CO2/O2	Gas Detection	Equipment Status	Maintenance	Run Time	High Limit	Low Limit			Start/Stop	Optimum Start/Stop	Timeclock	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Enthalpy	System Pressure Bypass	Steam Boiler Optimization	System Pressue psig	Hot Water O.A. Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	DDC Adjustable	System Graphic
MER																																																X
O. A. Carbon Dioxide																					X																										X	X
O. A. Temperature																X																															X	X
Outdoor Air Humidity																	X																					X									X	X
Absorber # 1 CHWS Sensor																X										X	X										X										X	X
Absorber # 2 CHWS Sensor																X										X	X										X										X	X
Absorber Common.CHWS																X										X	X										X									X	X	X
Absorber#1 HWS Supply																X										X	X										X										X	X
Absorber#2 HWS Supply																X										X	X										X										X	X
Absorber Common.HWR																X										X	X										X									X	X	X
Absorber #1 SHWS Sensor																X										X	X										X										X	X
Absorber#2 SHWS Sensor																X										X	X										X										X	X
Absorber Common.SHWR																X										X	X										X									X	X	X
P7\P8 CHWS Common																X										X	X										X									X	X	X
CT-1 Pan Sensor																X											X																					X
CT-2 Pan Sensor																X											X																					X
CT-1 Water Level												X											X			X	X																					X
CT-2 Water Level												X											X			X	X																					X
CT Common Return																X										X	X																				X	X
CT Common Supply																X										X	X																				X	X
MER GasDetectorCo2																					X	X				X																						X
Electric Utility KW Meter														X									X	X																								X
Dual Temp Diff Sensor										X																X	X																				X	X
Dual Temp Bypass Valve							X																																X		X							X
Elevator Sump Pump												X												X		X																						X

INPUT/OUTPUT SUMMARY TABLE

	HARDWARE																						SOFTWARE																									
	OUTPUTS									INPUTS													ALARMS							Energy Management Control Strategies																					
	Digital				Analog					Digital						Analog							Digital			Analog																										
Point Description:	Control Relay	Solenoid	Contactor		Pneumatic Transducer	Electrical Transducer	0-10 V	Pneumatic		Vibration Switch Switch	Flow Switch	Switch Closure	Current Sensor	KW	CT Valve End Switch	Temperature	Relative Humidity	PSIG / INW	Position	GPM Flow	CO2/O2	Gas Detection	Equipment Status	Maintenance	Run Time	High Limit	Low Limit			Start/Stop	Optimum Changeover	Timeclock	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Enthalpy	System Pressure Bypass	Dual Temp.Changeover	System Pressue psig	Hot Water O.A. Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	DDC Adjustable	System Graphic
MER																																																
P-1 Dual Temp Pump	X												X										X	X					X															X	X
P-2 Dual Temp Pump	X												X			X							X	X					X															X	X
P-3 Dual Temp Pump	X												X				X						X	X					X															X	X
P-4 Dual Temp Pump	X						X						X			X							X	X					X						X									X	X
P-5 Dual Temp Pump	X						X						X			X							X	X					X						X									X	X
P-6 Dual Temp Pump	X						X						X			X							X	X					X						X								X	X	X
P-7 HW Reheat Pump	X												X			X							X	X					X						X									X	X
P-8 HW Reheat Pump	X												X			X							X	X					X						X									X	X
CT-1 Cell-1 Fan	X						X			X			X			X							X	X					X						X								X	X	X
CT-2 Cell-2 Fan	X						X			X			X			X							X	X					X						X									X	X
CWP-1 Cond. Pump	X												X			X							X	X					X						X									X	X
CWP-2 Cond. Pump	X												X			X							X	X					X						X								X	X	X
CWP-3 Cond.Pump	X												X			X							X	X					X						X								X	X	X
CWS/R 3 Way Control Valve													X										X						X						X									X	X
Condenser Water Flow																				X			X			X	X																	X	X
Sand Filter Alarm												X																																		X	
Sand Filter Status												X																																		X	
MER Exhaust Fan	X												X										X	X					X															X	X
HVAC Shutdown												X											X			X	X																		X	
DualTemp GPM Meter																				X			X			X	X																	X	X
3 Way. SHWS Valve																								X															X					X	X
Absorber # 1	X						X					X		X									X	X	X				X	X										X				X	X
Absorber # 2	X						X					X		X									X	X	X				X	X										X				X	X

INPUT/OUTPUT SUMMARY TABLE

	HARDWARE																													SOFTWARE																		
	OUTPUTS									INPUTS													ALARMS							Energy Management Control Strategies																		
	Digital				Analog					Digital						Analog							Digital			Analog																						
Point Description:	Control Relay	Solenoid	Contactor		Pneumatic Transducer	Electrical Transducer	0-10 V	Pneumatic		Vibration Switch Switch	Flow Switch	Switch Closure	Current Sensor	KW	CT Valve End Switch	Temperature	Relative Humidity	PSIG / INW	Position	GPM Flow	CO2/O2	Gas Detection	Equipment Status	Maintenance	Run Time	High Limit	Low Limit			Start/Stop	Optimum Changeover	Timeclock	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Enthalpy	System Pressure Bypass	Dual Temp.Changeover	System Pressue psig	Hot Water O.A. Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	DDC Adjustable	System Graphic
VAV BOXES (TYP.)																																																X
Space Temperature																X																					X										X	X
Reheat Coil Actuator							X																														X										X	X
Supply CFM Airflow																		X					X																								X	X
VAV Damper Actuator							X																														X										X	X
EXHAUST FANS (Typ. For General Exahust & Kitchen Exhaust Fans)	X																						X	X	X					X	X																X	X
FUME HOODS																																																
Exhaust Fan	X											X	X										X	X	X					X																	X	X
Fume Hood Alarm												X											X	X																								X
VAV ISOLATION																																																
HW Isolation Valves	X																						X	X													X										X	X
AC-1 UNITS																																																
Space Temperature																X										X	X																					X
AC-2\AC-3 UNITS																																															X	X
Space Temperature																X										X	X																					X
AC Unit	X											X	X										X	X	X					X		X					X										X	X
Supply Air Dampers (4)	X																						X							X	X																X	X
SMOKEDAMPERS																																																
Smoke Dampers Act.												X																																				

INPUT/OUTPUT SUMMARY TABLE

	HARDWARE																						SOFTWARE																									
	OUTPUTS								INPUTS														ALARMS						Energy Management Control Strategies																		
	Digital				Analog					Digital						Analog							Digital			Analog																					
Point Description:	Control Relay	Solenoid	Contactor		Pneumatic Transducer	Electrical Transducer	0-10 V	Pneumatic		Pressure Switch	Flow Switch	Switch Closure	Current Sensor	KW		Temperature	Relative Humidity	PSIG / INW	Position	Flow	CO2/O2		Equipment Status	Maintenance	Run Time	High Limit	Low Limit			Start/Stop	Optimum Start/Stop	Timeclock	Demand Limiting	Day/Night Setback	Economizer	Ventilation/Recirculation	Temperature Control	Enthalpy	Hot/Cold Deck Reset	Steam Boiler Optimization	H.W.Boiler Optimization	Hot Water O.A. Reset	Chiller Optimization	Chilled Water Reset	Condenser Water Reset	Chiller Demand Limit	DDC Adjustable	System Graphic
Existing H&V Units																																																
HV Supply Fans	x											x	x										x	x	x					x	x																x	x
Return/Exhaust Fan	x											x	x										x	x	x					x	x																x	x
Return Air Temperature																x										x	x																				x	x
Mixed Air Temperature																x										x	x								x	x											x	x
OA & Return Air Dampers							x																								x				x	x	x	x									x	x
Filter Alarm										x													x	x																								x
Heating Coil Valve							x																														x										x	x
Heating Coil Supply Air																x										x	x										x										x	x
Freeze Alarm												x															x																					x
HV-1 Supply Fan	x											x	x										x	x	x					x	x																x	x
Supply Air Temp																x										x	x																				x	x
Outdoor Air Damper	x																						x																								x	x
Outdoor Air End Switch												x																																				x
Filter Alarm							x			x													x	x																								x
Outdoor Air Sensor																x																					x										x	x
Freeze Alarm												x															x																					x
Gas Control Panel	x																																															
Bldg Fire Alarm Panel												x											x																									
Cabinet Unit Heater	x																						x	x						x							x										x	x