DIVISION 25 INTEGRATED AUTOMATION

Section 25 00 00 Integrated Automation - General

1. Varying, or deviating from any item(s) indicated in this document must be approved by DTIR. DTIR will not grant a deviation from these requirements unless the deviation has been submitted in writing for review and approved prior to proceeding with the design.

Section 25 01 11 BAS: Start-up & Verification

1. Inspecting & Testing of Controls Equipment

   1.1 The mechanical design engineer shall reserve the right to use any piece of electrical equipment, device, or material for such reasonable lengths of time and at such times as he may require to make complete and thorough tests of same before the final completion and acceptance. The contractor shall be advised so that he may have a representative present. Such tests shall not be construed as evidence of acceptance of any part of the contract and it is understood that no claim for damage will be made by the contractor for any injury or breakage to any parts of the above due to the aforementioned tests where caused by weakness or inaccuracy of the parts or by defective materials of workmanship of any kind whatsoever.

   1.2 Tests shall be conducted until it has been demonstrated that the system performs as specified.

   1.3 The contractor shall provide full commissioning of the systems upon completion of field installation and when all equipment is in operation. Commissioning shall include a supervised, detailed calibration and function check of every separate point installed under the contract, together with a complete run-through of all functions on all building systems connected to ensure that all equipment, systems and circuits are functioning properly before completion of the contract. Commissioning shall be carried out by use of a commissioning point log sheet system, prepared jointly with designated personnel. After each point has been checked and confirmed to work, it shall be signed off by the contractor and designated personnel. The mechanical/controls design engineer shall verify that all equipment, systems and circuits have been fully tested, and are functioning properly as per the design. Refer to DTIR's Consultant Agreement for further details.

2. DTIR Performance Testing of Controls

   2.1 Testing of control hardware and software will be conducted by DTIR after the controls contractor has completed the work and fully verified the operation of the system. The test program by DTIR shall in no way be relied on by the controls contractor to determine the readiness of the control system.

2.2 For educational facilities, hospitals and buildings over 20,000 square feet, the contractor shall provide a controls representative on site for two days to assist DTIR testing and to be available to respond to telephone inquiries during the testing period. For other buildings, the controls representative is to be available to respond to telephone inquiries by DTIR during the test period.

2.3 Any additional time required to correct deficiencies identified during testing shall be the responsibility of the contractor.

Section 25 05 01 BAS: General Requirements

1. The building controls shall consist of either direct digital controls (DDC) or electric-electronic controls. DDC systems are required for educational facilities, hospitals and generally buildings over 20,000 square feet. For other buildings and renovation projects, the mechanical design engineer shall consult with DTIR on the size and type of control system required. This will be based on the size of the building, operational needs and economy.

2. For specific requirements related to DDC, refer to Section 25 30 01 Building Controllers.

3. Control systems shall utilize electric/electronic terminal devices. However, pneumatic actuators are acceptable on air handler dampers, on 3-way mixing valves for main circulation loops and on steam convertor control valves for existing buildings only, where pneumatic controls already exist.

4. Application specific controls for specific equipment shall have control features specified by the mechanical design engineer and shall be capable of interfacing with the overall building control system as needed for central monitoring and control of setpoints.

5. All control products (except equipment specific controls) shall be supplied by single vendor. Control devices serving similar functions shall be from the same manufacturer.

6. The controls must provide for all applicable control functions including those for space temperature control, humidity control, mechanical equipment operating schedules, building set back, hot water reset for space heating, air handler mixed air, cooling, heat recovery and heating, mechanical and electrical room ventilation, interlocks, critical alarm signals, freeze/fire shutdown where required and unoccupied shut down of air conditioning and ventilation to comply with the needs of the facility.

7. The control system is to be arranged to avoid simultaneous heating and cooling.

8. All panels and terminal devices are to be permanently identified as per Facility Services Subgroup - General requirements for Mechanical Identification.

9. Controls are to be started up, commissioned and fully adjusted prior to functional performance testing by DTIR or their representative.

10. The mechanical design engineer is to coordinate with the electrical design engineer the line voltage wiring of control panels and the placement of 120V receptacles within a reasonable distance (approximately10 feet) of DDC panels for powering PCs or laptops.

11. The mechanical design engineer is to ensure sensor well installation is coordinated with the piping specification.

12. The mechanical design engineer shall ensure that line voltage wiring for control devices such as freeze-stats, humidifier air flow cutouts, etc. is designated to be by the appropriate sections of Divisions 21-28 Arrange with the electrical engineer for all starters to be provided with necessary relays, and auxiliary relays to permit central indication of alarm conditions. The mechanical design engineer shall specify the control configuration for the 'hand' and 'auto' modes on the HVAC motor starters.

13. The control specification shall include all control wiring, and also interfacing between the main control system and the specialized terminal controls for equipment such as variable speed drives and humidifiers. Refer to electrical Division 26 for wiring and electrical equipment installation requirements. Note: All control wiring shall be Yellow.

14. Warranty

15. Warrant all controls equipment, parts and labour against defects and workmanship for one (1) year.

16. Service & Preventative Maintenance

    16.1 Service and preventative maintenance routines shall be performed by factory trained technicians and tradesmen a minimum of four times per year during the warranty period. During this period, components of the system are to be inspected and serviced. Reports shall be submitted to DTIR indicating the items checked and service work performed, and the condition of the equipment following each inspection. A minimum of 33% of all control panel hardware, control software, points, sensors, valves, thermostats, dampers, actuators, controllers, relays, transducers, equipment interfaces, etc. on the system shall be inspected on each trip. The contractor shall consult with the Owner's maintenance supervisor on each trip regarding the performance of the system and address any deficiencies that have occurred.

17. Maintainability and Reliability

    17.1 The equipment shall be designed in such a way that the time necessary for any repair or maintenance will be reduced to a minimum. All modules, components and test jacks shall be easily accessible.

17.2 Maintenance of any satellite panels or any peripheral device shall not affect the remainder of system.

17.3 Means must be provided for monitoring and locating component and system failures as quickly and easily.

17.4 The system shall be designed so that damage caused by the failure of one element or component of the system will be limited to the element or component which has failed.

Section 25 05 02 BAS: Submittals

1. Operational and Maintenance Manuals

1.1 Manuals shall be consistent with requirements of Division 01 and shall include: manufacturer's installation, operating and maintenance instructions; shop drawings including layouts and schematics (mechanical and electrical) showing location of key components; point description lists and verification point lists signed off by controls contractor and; software printouts and; name of spare part suppliers and their addresses for each piece of apparatus or system supplied.

2. Personnel Training

2.1 Provide practical training for up to four personnel designated by the Owner. Such training shall review manuals and available shop drawings. Emphasize how each control system is interfaced with the HVAC systems. Also cover control sequences, alarms, operators commands, operator overrides, listing point values, listing trend values, all non DDC controls and troubleshooting of common problems.

2.2 A minimum period of six hours shall be provided initially for on site training. A second six hour follow-up session shall be provided up to two months later. An additional ten hours of telephone consultation shall be provided for addressing operator questions during the first year of operation.

Section 25 05 53 Identification for Integrated Automation

1. Manufacturers Nameplates

1.1 Each piece of equipment shall have a metal nameplate mechanically fastened to equipment, with raised or recessed letters. Nameplates to be located so that they are easily read. Do not insulate or paint over plates.

1.2 Include registration plates (e.g. pressure vessel, Underwriters' Laboratories and CSA approval) as required by respective agency and as specified. The supplier shall indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.

2. System Nameplates

2.1 Major equipment to be identified with laminated plastic plates with white face and black center (lettering) of minimum size 89mm x 102mm x 2mm (3½" x 1½" x 3/32") nominal thickness, engraved with 13mm (½") high lettering.

2.2 Nameplates to be fastened securely with pop rivets or screws in conspicuous place. Where nameplates cannot be mounted, such as on cool surfaces, provide standoffs.

2.3 Unique mechanical identification tag shall follow naming system laid out on drawings and in specifications. Equipment type, number and service or areas or zone of building it serves to be identified.

3. Equipment Concealed by Ceiling

3.1 At valves, control dampers air vents and drains, and other similar pieces of mechanical equipment located above T-bar ceilings or access doors, install circular 19mm (¾") diameter self- adhesive identification discs on the underside of the ceiling, as close as possible to the location of the equipment.

3.2 Discs shall be coloured as scheduled in this section (see pipe primary and secondary colours table).

3.3 Where the item has a primary and secondary colour, provide a 19mm (¾") diameter primary colour disc with a 9.5mm (3/8") diameter secondary colour disc centered on the primary disc.

4. Electrical and Controls Equipment Identification.

4.1 Electrically fed equipment supplied by Division 21-28 (excluding that noted in .2 and .3, below) shall be identified as per Division 26 identification requirements.

4.2 Intermediate and end control devices including sensor, controllers, monitoring devices etc. shall be identified with laminated plastic plates or white polyolefin tags as noted for system nameplates above. The plates shall be fastened securely with pop rivets or screws. Where rivets or screws are not feasible, provide heavy duty plastic tie wraps. As a minimum, control device identification shall correspond to descriptors provided in the approved shop drawings with respect to panel designation or DDC point name.

4.3 Control devices located concealed by ceilings shall also be provided with a second identical plate installed on the underside of the ceiling grid or access door opening frame, as close as possible to the location of the device.

Section 25 10 02 BAS: Operator Work Station (OWS)

1. Facility Management Software

1.1 The DDC system shall be provided with standard and custom report generation functions that include:

1.1.1. Alarm Summaries

1.1.2. Motor Status Summaries

1.1.3. Point displays by type, system, status, overrides, failures, location, equipment and enabled/disabled.

1.1.4. Program Listings

1.1.5. Runtime logs

1.2 All reports shall be either displayed or printed by:

1.2.1 Operator Request

1.2.2 Time or Date

1.2.3 Event conditions (such as response to an alarm interlock, etc.)

1.3 All reports shall be time and date stamped.

1.4 An alarm processing program shall be provided to annunciate those points designated as alarmable. Alarm points shall, upon alarm occurrence, be displayed or printed at designated terminals.

1.5 Historical trend data shall be collected and stored at each DDCP or global supervisory network controller for later retrieval. Retrieval may be manual or automatic. Any point, physical or calculated, may be designated for trending. The system shall allow for two methods of trend collection; either by a pre-defined time interval sample or by a pre-defined change of value. Trend data shall be presented in a columnar format. Each sample shall be time stamped. Trend reports may be single point or may be a group of points up to a maximum of 8 points in any single group. Any point, regardless of physical location in the system, may become part of a multiple point group. The system shall be capable of storing a minimum of 1000 values in each trend log.

1.6 Each DDC network shall provide a point-monitoring function that can display single or multiple points in a continuous updated fashion for dynamic displays of point values.

1.7 A database and configuration report program shall be provided that allows the user to interrogate DDCP status. As a minimum the user shall be able to verify available RAM at

each DDCP, verify DDCP status (on-line, off-line failed) and set the system clock. Any invalid operator entry shall result in an error message.

1.8 DDCP's shall contain a password access routine that will assign an operator to one of at least three levels of access. As a minimum, Level 1 shall permit display function only, Level 2 shall additionally permit commanding of system points and Level 3 shall additionally permit full program and database editing.

1.9 DDCP's shall provide for the accumulation of totalized values for the purposes of run-time or energy totalization. Totalized values may be displayed or printed automatically or by operator request.

2. Energy Management Software

2.1 A Duty Cycle Control program shall provide user definable variable "on" and "off" times throughout the day once the mechanical or electric equipment is started by Time Program Commands, Optimum Start, or Manual Command.

2.2 The time of the overall cycle, as well as the length of time for each load during the cycle, shall be user selectable. Off time for different loads can be staggered within the cycle period and temperature compensation may be programmed to reduce the off portion of the cycle, as required.

2.3 The operator shall be able to read program data or to reprogram the system. Any of the program parameters, such as cycle time, off time, adding or deleting loads, auto adjust sensor assignments, input of compensation, etc., may be monitored or altered by a qualified operator through a connected operator terminal. A qualified operator shall be able to temporarily override the status or value of any point.

2.4 The DDC system shall be provided with an operator interactive time of day (TOD) program. TOD programming and modifying shall be accomplished in a calendar-like format that prompts the user in English language to specify month, year, day, time and associated point commands.

2.5 It shall be possible to assign single points or groups of points to any on or off time. Appropriate time delays shall be provided to "stagger" on times. TOD shall incorporate a holiday and special day schedule capability which will automatically bring up a pre-defined holiday or special day schedule of operation. Holidays or special days can be scheduled up to one year in advance. In addition to the time dependent two state control, TOD also provides time dependent setpoint control. This control provides the capability to output assignable, proportional setpoint values in accordance with the time of day and day of week. This program shall be used to accomplish night setback, morning warm-up and normal daily operating setpoints of all control system loops, controlled by the DDCP. As with the two state control, time dependent setpoint control shall be subject to the holiday schedule. The setpoints desired shall be user definable at any operator terminal. The operator shall be capable of reading and/or alternating all sorted data pertaining to time of

day, day of week, on/off times, setpoint values, and holiday designation. The TOD program shall also provide an override function that allows the user to conveniently change a start or stop time for any point up to one week in advance. The override command shall be temporary. Once executed the TOD program shall revert to its original schedule. The TOD program shall interface with the Optimal Start Program (OSP) such that stop times may be assigned by OSP.

2.6 In addition to the previously specified management functions, the DDC system shall be provided complete with the following programs:

2.6.1 Supply Air Reset

2.6.2 Hot Water Reset

2.6.3 Dead Band Control

2.7 All specified energy management programs, whether or not applicable shall be provided such that the programs may be enabled at a future date without the need to purchase or modify additional software.

3. Point Expansion Modules

3.1 Each DDCP shall be capable of extending its input/output capabilities via special purpose modules. Said modules may be mounted remote from the DDCP and shall communicate with the DDCP over a pair of twisted cables.

4. Graphic Display

4.1 System information (including all point values and status) shall be displayed dynamically in both text and graphics. Graphic displays shall utilize picture files of floor plans, elevations, system schematics, control panels, text, scanned images, etc. as background layers. The foreground layer shall contain real time data such as point values, time, set points, as well as control buttons. Data shall be placed on each graphic display and easily moved to its appropriate location. Graphic displays shall support minimum 16 bit colour and must be fully customizable to suit the users specific requirements. From the graphic display, the user shall monitor data, make changes as required and access other resources such as trend graphs and schedules directly by using the mouse.

5. On-Site Operator’s Work Station.

5.1 Provide a report and alarm printer adjacent to the video display terminal. Printer shall be an ink jet or laser printer. Provide one spare printer cartridge for each type the printer uses.

5.2 The printer shall be interfaced to the operator work station PC through a parallel or USB port and shall be supplied with all required cables and devices.

5.3 The personal computer shall have minimum system requirements as follows: Processor not less than 2 gigahertz (or equivalent), full function keyboard, 120 GB hard drive, 1 GB RAM, 17" SVGA monitor, dedicated graphics card with minimum 64 MB video memory, CD/DVD rom drive, 2 serial ports, optical mouse, Windows 7 c/w MS Internet Explorer and DDC system interface software.

5.4 For limited DDC applications where printers and computers are not required (as determined by consultation with DTIR), a display on the DDC panel shall be provided (where feasible) for programming and monitoring. As a minimum, a port shall be provided (complete with any required connectors and software for interfacing with a PC) for set-up and service.

Section 25 30 01 BAS: Building Controllers

1. Control Panels

1.1 Control panels shall be the steel unitized cabinet type with hinged door. Construct panels from 12 gauge furniture steel with baked enamel finish on exterior and rust inhibitive paint on interior. Panels shall have hinged key lock for full access. All controllers, thermometers, or temperature indicators, relays, switches, etc. shall be panel mounted. Control panels shall be provided for all air system and water system controls. One panel may accommodate more than one system in the same equipment room. Mount panels adjacent to their associated equipment on vibration free walls or on the closest column. Mount plastic enclosed, reduced size shop drawings of all systems in the cabinet or on an adjacent wall. Provide engraved plastic nameplates indicating panel identification and all instruments and controls inside the cabinet and on the cabinet face.

2. Pneumatic Piping for existing pneumatically controlled buildings

2.1 Copper pipe shall be hard drawn control instrumentation copper tubing. Plastic pipe shall be rodent resistant PVC, type FR. All piping shall be run in a neat and workmanlike manner parallel to surfaces and supported from the structure. Pipe shall be sized in accordance with manufacturer’s recommendations to handle the required air quantities. Piping shall be adequately supported. Soldered fittings shall be used on copper piping, except at valves, remote bulb controllers and at panel connections, where compression fittings shall be used. Copper pipe shall be used where tubing is run exposed, in all mechanical rooms and where subject to damage. Seal all openings between pipe and pipe sleeves. Plastic tube shall not be supported and/or hung from horizontal piping and/or conduits. Maximum spacing of supports on concrete structure shall be 61 cm (2”). Supports shall be anchored to concrete, adhesive stickers are not acceptable. Copper tubing shall be supported on maximum 183cm (6”) centers.

3. Direct Digital Control (DDC) Systems

3.1 The following DDC sections are applicable to educational facilities, hospitals and generally buildings over 20,000 square feet. For other buildings and also renovation projects, consult with DTIR on DDC design requirements and scope for specifying a more limited small scale DDC to suit the application. The need for features such as memory, graphics, trending, front-end hardware, remote access, etc. shall be closely examined, keeping in mind the cost, and benefits to be gained from using these features. Consult with DTIR regarding the requirements for BACnet features, building IT network interface, web based access to DDC system and communication or integration with other building systems (e.g. fire, security, etc.). See later items in this section for additional requirements related to these issues.

3.2 The DDC system shall consist of an information sharing network (control LAN) of stand alone Direct Digital Control Panels (DDCPs) to monitor and control equipment per the control sequence and the input/output summary. A DDCP may include directly connected point expansion modules. Global supervisory network control panels on the control LAN may be acceptable provided the control design requirements are met. All DDC field devices related to the following items shall be connected to highest level DDCPs (i.e. DDC terminal device controllers at the highest level of the control LAN architecture): air handling units, pumps, outdoor sensors, hydronic sensors, 1st priority alarms, boilers, chillers, mixing valves, critical space conditions, fans for controlling space temperature in critical location, humidifiers, variable speed drives, and other critical components. The highest level DDCPs and any global supervisory network controllers shall be individually connected to a common network. All points associated with each mechanical system shall be connected to the same DDCP (e.g. all DDC sensors, controls, relays, etc. associated with a specific air handler shall be connected to the same DDCP).

3.3 All Freeze, Fire, High limited and Low Limited alarms to be provided with DPDT electrical contacts or auxiliary relays to permit central indication of alarm conditions.

3.4 Additional temperature sensing wells, pressure taps and flow measuring sensors to be provided to allow for the addition of central monitoring sensors.

3.5 Ensure correct sensor is installed to match well.

3.6 Control System Communications Processing

3.6.1 All DDC control panels in a facility shall be connected to form a fully operational information sharing local communications network (control LAN). In smaller facilities with only one DDC control panel, the DDC panel system shall be capable of network operation with no additional upgrade. The DDC functions and point data resident on any DDCP plus any external point data required for control by that panel shall be operator accessible by connecting and logging on to the panel with a typical personal or laptop computer with a minimum of Windows 7 operating system. Include in the DDC system architecture a fully functional telephone modem (not

required if remote access is by internet/intranet) and a personal computer / operator workstation package connected to a highest level controller or to the highest level of the control LAN.

3.6.2 The communication speed between the highest level DDCPs on the control network shall be more than sufficient to efficiently pass full information sharing of all DDC point values, panel status, memory transfers and operational functions.

3.6.3 The failure of any DDCP on the network shall not affect the operation of other DDCPs. A DDCP failure shall be annunciated at the specified alarm printers or terminals. In the case where a failed DDCP is generating a global value, the remaining DDCPs shall continue using the last valid global value received from the failed panel.

3.6.4 In the event of a loss of communication with, or failure of a processing unit, the controlled equipment/system shall be left in a fail-safe mode.

3.7 DDCP Hardware

3.7.1 Each DDCP shall consist of a minimum 32 bit programmable microprocessor and controller, power supply, real time clock, input/output boards and communication board. All program and point data bases shall be stored in battery-backed or non-volatile on board memory. Provide a minimum of 256K RAM or an equivalent combination of RAM, ROM and EEPROM in each DDCP, sufficient to support all of the control, alarm, equipment schedules and communication functions specified and to allow for point expansion. Additional battery backed or non-volatile memory shall be provided as needed for supervisory, communication and trend data storage functions configured as needed on the control LAN.

3.7.2 All DDCPs shall have a personal computer interface port in addition to network ports. Connecting a PC to this interface port shall allow the user to communicate with and program any controller on the network. Memory contents of the DDCPs shall be transferable to and from the PC via this port.

3.7.3 Supply and install the hardware (and software) required so that at least one of the highest level standalone DDCPs is BACnet/IP ready and complete with a BACnet communications port ready for a connection to third party BACnet devices.

3.7.4 Each DDCP shall provide for input/output connections to field equipment. The following point types shall be supported:

3.7.4.1 Analog Inputs: for measuring sensed variable. Inputs shall be capable of accepting voltage, resistance, current or pressure signals.

3.7.4.2 Analog Outputs: For controlling end devices. Outputs shall be capable of producing voltage, resistance, current or pneumatic pressure signals.

Pneumatic outputs shall be provided with a manual override for adjusting outputs in the event of power loss at the DDCP.

3.7.4.3 Digital Inputs: for monitoring dry contacts such as relays, switches, pulses, etc.

3.7.4.4 Digital Outputs: To control two position devices such as starters, actuators, relays, etc.

3.7.5 DDCPs shall have a minimum of 10 percent spare capacity within each mechanical room for future point connection. The type of spares shall be in the same proportion as the implemented points in the DDCPs. In any case there shall be no less spares than two analogue inputs, two digital inputs, two analogue outputs and two digital outputs in each mechanical room and no less than one spare point of each type in any DDCP.

3.8 Programming Functions

3.8.1 Resident software in each DDCP shall provide for custom programming of control strategies, point database, operator interface, network communications, facilities and energy management functions. Use of a global supervisory network control panel for certain non-critical communications and facilities management functions may be acceptable.

3.8.2 Programming of control and energy management strategies shall be accomplished via a high level computer language. A standard math processor shall be part of the programming language. All analog control loops shall be capable of proportional (P), integral (I), and derivative (D)control in the form of P, PI or PID control with programmable loop constants.

3.8.3 Each DDCP shall incorporate an operator interface program (OIP) that provides an English language user interface. The OIP shall allow the user to program, interrogate, command and edit the DDCP via a self prompting method. Operator terminals, whether textual or graphical, shall be able to access the entire network from any DDCP. Full access shall be accomplished in a transparent fashion; that is, the operator shall not be required to address specific DDCPs in order to display or command system points.

Section 25 30 02 BAS: Field Devices

1. Space Control

1.1 Spaces subject to different loads must have separate controls. Each room requiring space control shall have an individual space sensor. Only one sensor may be installed in any room unless it is considered that there are separate zones within the room. A zone with

separate heating and cooling units must have the units sequentially controlled from a single sensor.

2. Hot Water Space Heating

2.1 Supply water temperature for general space heating shall be reset according to outside air temperature. Setpoints shall be predetermined by the design engineer.

3. Circulating Pump Control

3.1 The sequencing of heating pumps shall take into account load requirements, automatic back-up and run time equalization, however, it is assumed that all heating will be shut down when the ambient temperature rises above 18 deg. C (65 deg. F) and will not restart until the ambient temperature drops below 16 deg. C (60 deg. F). Circulation through the boilers must be maintained while the boilers are on-line by either primary circulators or bypass circulators. See also Heating Design Considerations in Facility Services Subgroup - General and related Section 23 52 00 - Boilers for additional information related to thermal shock prevention.

4. Actuators

4.1 Provide spring returns so that the damper's fail-safe mode is normally open or closed, as dictated by freeze, fire or over-temperature protection. Size operators to control dampers against the maximum fan pressure or dynamic closing pressure, whichever is greater, with sufficient reserve power to provide smooth modulating action or two position action as specified. For pneumatic actuators, pilot positioners shall be full relay type with an interconnecting linkage to provide mechanical feedback on mechanical damper operators and valves. Provide pilot positioners where more than two controlled components are sequenced, select spring ranges suitable for the control sequence specified.

5. Control Valves

5.1 Provide valves pressure-rated in accordance with general valve pressure ratings specified elsewhere.

5.2 2-way water valves shall have equal percentage characteristics for typical hot water applications and linear characteristics for chilled water or steam applications.

5.3 3-way water valves shall have linear characteristics.

5.4 All valves shall have stainless steel stems and spring loaded, self-adjusting Teflon or rubber packing. Except for sequenced valves, all valves shall have full range springs. Sequencing of coil valves shall be by positive sequencing relays to ensure no overlap of operation. Valves 51mm (2") and under shall be screwed, valves above 51mm (2") shall be flanged. Valve operators shall be sized to close the valves against the shut-off head of the associated pumps.

5.5 Size hydronic control valves for radiators and coils at 65% of the pressure drop between the supply and return, at design conditions.

5.6 Size hydronic 3-way mixing valves for the boiler bypass at a pressure drop equal to the design pressure drop from the bypass connection through the boiler to the 3-way valve inlet.

5.7 Pneumatically actuated 3-way valves shall have pilot positioners.

6. Supply Air Temperature Control

6.1 Air systems supplying air to a multiple room zone shall be controlled from a supply air sensor with its set point varied according to a schedule with outdoor temperature. Additional reset based on return air, exhaust air or room air temperatures shall be provided where overheating or underheating may occur, within maximum and minimum supply air temperature limits.

6.2 Operate mixing dampers, preheat, heat recovery, heating coils and cooling coils in sequence to maintain supply air set point.

6.3 DX cooling coils shall be staged based on space or return air temperature.

7. Outside Air Mixing

7.1 Dampers shall be selected as indicated under “Dampers” and “Mixing Dampers”. An adjustable minimum position control shall be provided on all fresh air dampers. Exhaust air and return air dampers may be modulated together from a common activating signal. Outside air damper control shall be from a separate signal. For systems with cooling, economizer control based on enthalpy control. The mixing dampers shall be controlled in sequence with heating and cooling to maintain supply air set point.

7.2 The normal mixed air damper control shall be overridden to maintain mixed air temperature at an adjustable minimum set point.

8. Dampers

8.1 Blades shall not exceed 15cm (6") wide or 122cm (4'-0") long. Modular maximum size is 122cm (4'-0") x 122cm (4'-0"). Multiple sections shall have stiffening mullions and jack shafts. Frames and blades shall be extruded aluminum. Bearings shall be oilite or nylon with 13mm (½”) shafts. Linkage and shafts shall be zinc plated steel. Vertical shafts shall have thrust bearings. Dampers shall have compressible seals and shall be suitable for temperature ranges of -40 deg. C (-40 deg. F) to 93 deg. C (200 deg. F). Local (shop) fabrication of dampers is not allowed. Dampers mixing cold and warm air shall be parallel blade mounted at right angles to each other with the blades opening to mix the air streams. Make allowance in damper sizing to equalize the pressure losses through the airstreams. All shut-off dampers in outside air intakes and exhaust air outlets shall be

insulated low leakage type with synthetic rubber seals on all blade edges and sides of frame.

9. Damper Sizing

9.1 Minimum size 15cm high x 30cm (6" high x 12") long with 15cm (6") increments up to 122cm x 122cm (48" x 48"). Use multiple section dampers for larger sizes.

9.2 The free air ratio of the damper, i.e. total open area of the damper between blades divided by the nominal area shall be approximately 0.7.

9.3 The resultant damper size may be smaller than the duct size. The blanking pieces required shall be the responsibility of the sheet metal contractor.

10. Mixing Dampers

10.1 The mechanical design engineer designer is to be responsible for the sizing of the outside air and return air dampers. This shall not be left to the equipment manufacturer. All dampers mixing cold and warm air shall be parallel blade with blades opening to mix the air streams. The mixing box must be arranged to give air mixing with fresh air drawn in horizontally and return air drawn in vertically, or vice versa. Make allowances in damper sizing to equalize the pressure losses through the entire fresh air intake and return air systems. Also provide blenders to promote mixing.

11. Face and Bypass Dampers

11.1 Use parallel blade dampers throughout.

11.2 Size bypass damper so that bypass system pressure loss is equal to the face damper and coil section loss. Where extreme temperature differences are encountered between air streams, coil face and bypass selections shall be multiple sections with each bypass not wider than 15cm (6"). For packaged equipment, check sizes and resistance to ensure that bypass resistance of open bypass damper is equal to coil and open face damper, by inserting plate after bypass to increase bypass exit velocity.

12. Variable Volume Dampers

12.1 Size dampers so that their operating characteristics are linear with respect to their associated system.

12.2 Where centrifugal prime mover is not controlled to maintain constant damper pressure loss, size dampers for equal percentage characteristics.

13. Glycol Preheat Coils

13.1 Preheat coils should normally not be needed as the air system coils shall be protected by glycol. For the exceptions where they are used, full flow of the heating media in the

preheat coil must be provided when the air entering the coil falls below 4 deg. C (40 deg. F). Where face and bypass control is used, dampers to be designed for complete mixing so that air below 4 deg. C (40 deg. F) does not strike any part of a freezable upstream coil. When the full heating media flow on a face and bypass damper coil may result in overheating when the entering air temperature is above 4 deg. C (40 deg. F), an additional modulating control valve must be provided.

14. Reheat Coils

14.1 Sequence reheat according to individual space requirements. All reheat coil valves shall close when the fan stops.

15. Cooling Coils

15.1 The recommended control for constant flow chilled water systems is mixing or bypass valves. In the case of variable flow chilled water systems having individual chiller pumps, or variable speed primary pumps with a common or decoupled piping configuration, use coil pumps, 2-way valves and mixing valves as needed for adequate control. Sequence chillers and secondary (i.e. system) flow to maintain optimum system pressure differential and chilled water supply temperature.

15.2 Cooling coils on individual supply air systems shall be controlled in sequence with mixed air dampers and main heating coils.

16. Humidity Control

16.1 Humidifier control shall be based on return air or space humidity with a provision for high limit supply air humidity override. On a demand for humidification, the control element shall modulate the humidifier. All humidifying valves to close or humidifier to shutdown when the fan stops.

17. Multizone Unit Control

17.1 Zone thermostat calling for most heat to control the hot deck coil. The preheat coil and mixing dampers are to be sequenced to follow the cold deck controls. The cold deck coil valve shall not open until the preheat coil is off and the preheat coil shall not come on until the outside air damper is in minimum position. In all cases, ensure that precooling and reheating, or vice versa, is not possible. Where reheat coils are used, the zone thermostat calling for the coolest air shall control the main system, where economically feasible. Where reheat coils are located remotely, the central system shall be controlled from its discharge air at a fixed set point as a completely independent system. Where zone loads are similar, the hot deck leaving temperature may be reset from outside temperature to reduce reheat.

18. Variable Volume Systems

18.1 To conserve horsepower and limit noise, the system static pressure shall preferably be controlled by a fan speed control or variable inlet vanes. For fan systems without volume regulators on terminal units, sensors shall be located near the static pressure midpoint of the duct run. Where volume regulators are installed, pressure controllers may be located at the end of the duct run with the highest static pressure loss. Separate controllers shall be used if a major variation in flow and pressure occurs in different zones with changes in load. High static limits are recommended at the fan discharge. Multiple point pitot tubes or flow measuring stations shall be used for sensing velocity pressures at supply and return fans on variable volume systems.

19. Freeze Protection for Air Systems

19.1 Outside air dampers must close completely when supply fan stops. Dampers are to be the low leakage type. Each coil bank is to be protected by a low limit control which responds to the lowest temperatures to which any one square foot portion is subjected. The low limit control shall shutdown the supply fan when temperatures less than 3 deg. C (38 deg. F) are sensed. In exceptional cases where an air supply has no heating coil, low limit controls should be provided as necessary to protect equipment downstream of the air handler. When an air supply system is shut down, control must be provided to bring on the heating coil if abnormally cold temperature are sensed in the air system.

20. Thermostats

20.1 Room thermostats shall be fully proportional with an adjustable throttling range not exceeding 30 deg. C (86 deg. F) with two dial stop pins to limit setpoint range. Thermostats shall be single or dual temperature direct or indirect acting as required. All thermostats shall be provided with bi-metallic dial thermometers. Thermostats to be mounted in accordance with barrier free requirements of the Nova Scotia Building Code Regulations Act.

20.2 Electric Thermostats

20.2.1 Shall be line voltage or low voltage type suitable for the application. Low voltage thermostats shall have heat anticipation. Ratings shall be adequate for the applied load. Guards shall be installed over adjustable thermostats in public areas.

21. Temperature Sensors

21.1 All master space temperature sensors and other space temperature indicating sensors shall be of the linear output type, with an appropriate range and blank stainless steel locking covers. Room return air sensors shall be of the linear output type with bi-metal sensing element and corrosion proof construction with an appropriate range. Seal opening to wall cavity. Vandal proof screws shall be used in public areas. Private areas shall have setpoint adjustment by user. Setpoint adjustment shall be limited to a 3 deg. C (37 deg. F) range.

22. Duct Mounted or Immersion Sensors

22.1 Averaging element sensors shall have a minimum 274 cm (9'-0") element. Temperature sensors shall be of rigid stem construction using bi-metallic sensing elements except where averaging is required. Duct mounted sensors shall be located to provide sensed temperature of maximum reliability as well as maximum possible ease of accessibility. Outside air temperature sensors shall be located on a north facing wall or shall be provided with an appropriate sun shield.

23. Low Limit Controllers and Safety Cutouts

23.1 Shall have elements providing adequate coverage of cross sectional area with control at the coolest point (6m (20') elements are normally preferred).

23.2 Safety low limits shall be line voltage type with bellows activated switches. Reset shall be manual or automatic to suit the application.

23.3 Freeze stats shall be located immediately after the heating coil. The element shall be constructed of rigid copper tubing arranged in a grid covering the complete face of the coil and shall be securely mounted to the coil.

24. Safety High Limit

24.1 Shall be manual reset, line voltage type with bi-metal actuated switches.

24.2 Switch shall have an adequate rating for the applied load.

25. Status Indicators

25.1 Provide status lights at motor starters.

25.2 With DDC controls, provide status indication for fans over 150 cfm, either by pressure differential switches or current sensors (set to detect fan belt breakage). Status is not required for recycle room fans which run continuously, assistive care washroom fans, range hood exhaust fans and laundry exhaust fans.

25.3 With DDC controls, provide status indication for pumps over 1/5 hp using current sensors (set/programmed to signal impeller problem, coupling failure or cavitation where possible). Status is not required for domestic hot water recirculation pumps.

25.4 Coordinate with electrical discipline for necessary current sensors, relays, and auxiliary relays to permit central indication of alarm conditions. All current sensors, relays etc. for motor starters and motor control centres shall be factory installed with all components and assemblies CSA approved; field installation shall not be permitted. Refer also to Division 26 requirements.

26. Heating/Cooling System Changeover

26.1 System to be provided with safeties to prevent chilled water from being diverted to boiler and to prevent water hotter than 27 deg. C (80 deg. F). from being diverted to chiller.

27. Temperature Sensors (DDC)

27.1 Temperature sensors shall be thermistor or RTD type with the following characteristics where applicable:

27.1.1 RTD's shall be 3 wire platinum type having a resistance of 100 ohms at 177 deg. C (350 deg. F) with low strain construction and integrally anchored lead wires.

27.1.2 Sensing elements shall be sealed from moisture intrusion.

27.1.3 Sensors (as shipped) shall have fast response to temperature changes (i.e. less than 5 seconds to indicate ± -14 deg. C (6 deg. F) of a sudden -7 deg. C (20 deg. F) temperature change.

27.1.4 Sensors shall have a nearly linear resistance temperature relationship over the rated temperature range.

27.1.5 The rated sensor accuracy measured in accordance with a recognized standard shall be at least ± -17 deg. C (1.5 deg. F) from -46 deg. C (-50 deg. F) to 49 deg. C (+120 deg. F) for outdoor sensors; ± 1 deg. C (1.8 deg. F) from -1 deg. C (30 deg. F) to 104 deg. C (220 deg. F) for immersion sensors, ± 0.7 deg. C (1.3 deg. F) from -1 deg. C (30 deg. F) to 32 deg. C (90 deg. F) for duct sensors and ± 0.4 deg. C (0.7 deg. F) from 16 deg. C (60 deg. F) to 27 deg. C (80 deg. F) for space sensors.

27.1.6 Mixed air sensors shall be averaging type with an element length at least four times the cross section length of the mixed air plenum.

27.1.7 Duct sensors shall have stainless steel stems which extend into air flow by at least one third of the maximum duct width or diameter to a maximum of 46cm (18").

27.1.8 Immersion sensors shall have stainless steel stem with matching thermowells suitably sized for piping. Fill well with heat conducting compound when installing sensor.

28. Humidity Sensors (DDC)

28.1 Measuring Range: 0 to 100% RH

28.2 Accuracy at +20 deg. C (68 deg. F): +/-2% RH for 0-90% range. Temperature coefficient: +/- 0.05%RH/degree F and +/-0.018 degrees F/ degrees F. Stability better than +/-1% RH/year.

28.3 Polymer capacitive sensor for RH.

28.4 Outside Air

28.4.1 Non-corroding shield designed to minimize solar and wind effects.

29. Airflow Pressure Switches (DDC)

29.1 Pressure sensing elements to be Bourdon tube, bellows or diaphragm type, with adjustable setpoint and differential.

29.2 Operate automatically and reset automatically when condition returns to normal.

30. Damper End Switches (DDC)

30.1 Activated by damper blade movement and mounted securely on damper frame.

30.2 Rotary action steel slotted lever with plastic roller.

30.3 Two electrically isolated single pole changeover micro switches.

30.4 Contact rating of 10 amperes at 120 V AC.

30.5 CSA approved and bearing a ULC label.

31. Differential Pressure Switches (DDC)

31.1 Adjustable set point with range to match application.

31.2 SPDT contacts.

31.3 CSA approved.

31.4 Mount with diaphragms in a vertical plane.

32. Current Sensors (DDC)

32.1 Sensors must be certified to the applicable CSA standard.

32.2 Analog current sensors are preferred over current switches that provide on/off digital signal.

32.3 As noted in the Canadian Electrical Code, current sensors shall not be installed in motor control centres unless provided by manufacturer. Refer also to Division 26 requirements.

32.4 Refer to Division 26 for specifications related to the installation of alternating current transformers.

Section 25 30 03 BAS: Installation

1. Telecommunication Capabilities

1.1 A telecommunications interface shall be furnished as necessary to allow direct connection of DDCP's and networks to public and private phone lines. This device shall be capable of both automatic answer and automatic dial methods of call handling. Additionally, manual call initiation shall be done via a man-machine interface command. The unit shall be able to store a minimum five (5) phone numbers of at least 20 digits, and shall support communications at speeds of greater than 9600 baud (bits per second). Where a high speed communication line will serve the building, provide remote access and IT network interface similar to that noted below for educational facilities. Consult with DTIR on specific requirements.

1.2 As a result of a predefined event or command, the telecommunications interface shall automatically establish communications with specific PCs/workstations, mobile telephones or pagers. Consult with DTIR and, for educational facilities, school board maintenance personnel for specific requirements.

1.3 The telecommunications interface shall have automatic answer capabilities to allow it to be accessed remotely. The interface unit shall be able to allow the person calling access to any information on the network, provided that the standard log-on security screening is met.

2. Telephone Connection

2.1 A telephone line shall be provided to allow remote access to the DDC system for a period of one year from substantial completion of controls work. This is not required if remote access is by a high speed communication line.

3. DDC Point Requirements

3.1 DDC systems shall be designed with all the necessary input/output devices including, but not necessarily limited to the following:

3.1.1 Air Handlers (recirculation type with no heat recovery)

3.1.1.1 Outside air temperature (if not already provided for heating systems)
3.1.1.2 Return air temperature
3.1.1.3 Mixed air temperature
3.1.1.4 Supply air temperature
3.1.1.5 Return air humidity (where applicable)
3.1.1.6 Supply air humidity (where applicable)
3.1.1.7 Return fan start/stop
3.1.1.8 Supply fan start/stop
3.1.1.9 Return fan status

3.1.1.10 Supply fan status
3.1.1.11 Exhaust/return damper modulation
3.1.1.12 Outside air damper modulation
3.1.1.13 Freeze-stat status
3.1.1.14 Heating coil valve modulation
3.1.1.15 Cooling coil valve modulation
3.1.1.16 Humidifier modulation or staging (where applicable)
3.1.1.17 Remote override signal (e.g. to allow users to activate gym or kitchen/cafeteria ventilation)
3.1.1.18 Air Handlers (100% outside air type with heat recovery)
3.1.1.19 Outside air temperature (if not already provided for heating systems
3.1.1.20 Return air temperature
3.1.1.21 Exhaust air temperature
3.1.1.22 Heat recovery discharge temperature
3.1.1.23 Supply air temperature
3.1.1.24 Return air humidity (where applicable)
3.1.1.25 Supply air humidity (where applicable)
3.1.1.26 Return (exhaust) fan start/stop
3.1.1.27 Supply fan start/stop
3.1.1.28 Return (exhaust) fan status
3.1.1.29 Supply fan status
3.1.1.30 Exhaust damper open/close
3.1.1.31 Outside air damper open/close
3.1.1.32 Exhaust damper end switch
3.1.1.33 Outside air damper end switch
3.1.1.34 Freeze-stat status
3.1.1.35 Heat recovery modulation (if not integral)
3.1.1.36 Heat wheel start/stop (where applicable)
3.1.1.37 Heat Wheel modulation or staging (where applicable)
3.1.1.38 Heat Wheel Status
3.1.1.39 Heat recovery coil glycol entering temperature (if run-around type)
3.1.1.40 Heat recovery coil glycol leaving temperature (if run-around type)
3.1.1.41 Heating coil valve modulation
3.1.1.42 Cooling coil valve modulation
3.1.1.43 Humidifier modulation or staging (where applicable)
3.1.1.44 Remote override signal (e.g. to allow users to activate gym or kitchen/cafeteria ventilation)

3.1.2 Variable Frequency Fan Drives

3.1.2.1 VFD status

3.1.2.2 VFD control

3.1.2.3 Static air pressure in applicable duct

3.1.2.4 Differential pressure in applicable piping system

3.1.3 Ventilation Exhaust Fans

3.1.3.1 Fan start/stop and status requires for fans greater than 150 CFM. Start/stop is not required for recycle room fans which run continuously, range hood and dishwasher exhaust fans. Exhaust systems over 250 CFM shall be complete with motorized backdraft dampers except for recycle room fans which run continuously, range hood exhaust fans and where not permitted by code. All motorized backdraft dampers shall be c/w end switches which must be made before the exhaust fan operates.

3.1.4 Exhaust/Supply Fans for Space Cooling

3.1.4.1 Control fan(s) and dampers by electric cooling thermostat or by DDC. For rooms with fuel fired appliances (eg. boiler rooms), DDC control shall be provided. If DDC, then provide start/stop, status and room temperature points. Exhaust/supply systems over 250 CFM shall be complete with motorized backdraft dampers with end switches which must be made before the fans operate. For rooms with fuel fired appliances (eg. boiler rooms) provide control so that a fan cannot operated without proof that the other fan is operating properly.

3.1.4.2 If DDC, then provide start/stop, status and room temperature points

3.1.5 Pumps/circulators (including hydronic, fuel, DHW heating).

3.1.5.1 Pump start/stop and status (for pumps over 1/4 hp and over).

3.1.6 Humidifiers

3.1.6.1 DDC points as indicated under air handlers

3.1.6.2 Separate direct wired air flow proving switch to be provided

3.1.7 Room Heating

3.1.7.1 Room temperature

3.1.7.2 Heating control valve

3.1.8 Unit Heaters and Cabinet Heaters

3.1.8.1 Typically control by local thermostat

3.1.8.2 If DDC, then provide space temperature sensor and fan start/stop

3.1.9 Boilers

3.1.9.1 Header supply temperature

3.1.9.2 Burner enable/disable

3.1.9.3 Burner status (by current sensors)

3.1.9.4 Primary and shunt (bypass) circulation pumps status

3.1.9.5 Alarms

3.1.10 Secondary Hot Water or Hot Glycol Loops

3.1.10.1 Outside air temperature (on north wall or complete with shade to shield from direct sunlight when installed on exposures other then north)

3.1.10.2 Supply temperature

3.1.10.3 Return water temperature

3.1.10.4 Control valve modulation

3.1.11 Glycol Heat Exchange Coil

3.1.11.1 Leaving temperature on output side

3.1.11.2 Inlet temperature on output side

3.1.12 Domestic Hot Water (indirect type)

3.1.12.1 Provide DDC or aqua-stat temperature control for each tank

3.1.12.2 If DDC, then provide immersion temperature sensor for each tank

3.1.13 Trap Primer: Solenoid valve(s) on/off

3.1.14 Water Meter(s): Pulse input with controls programming to provide daily total flow and daily peak flow.

4. DDC Alarms

4.1 The DDC system shall be designed to provide the operator with all critical alarms. Suitable time delays are to be programmed to screen momentary false alarms. DDC alarms are to include but not necessarily be limited to the following:

4.1.1 Failure of any control panel

4.1.2 Failure of any fan linked to the DDC

4.1.3 Failure of any pump linked to the DDC

4.1.4 Failure of any heat wheel

4.1.5 Low pneumatic air pressure

4.1.6 Low boiler header temperature (if outside air temperature is less than 7 deg. C (45 deg. F))

4.1.7 Low room temperature (if any room on outside wall is less than 10 deg. C (50 deg. F))

4.1.8 High room temperature (if electrical, boiler, or communications room is greater than 31 deg. C (88 deg. F))

4.1.9 Air handler freeze-stat low limit status when activated

4.1.10 Supply air humidity greater than 80%

4.1.11 VFD failure

4.1.12 Low supply air temperature (if less than 8 deg. C (46 deg. F))

4.1.13 Boiler alarm.

5. Interlocks

5.1 The DDC system shall be designed and programmed with all applicable control interlocks required to maintain reasonable air balance, protect equipment and prevent unnecessary discomfort. The interlocks shall not allow short cycling of equipment. The interlocks shall include but not necessarily be limited to the following:

5.1.1 Supply and exhaust fans are to stay off until both dampers open (for 100% outside air type AHU)

5.1.2 Shutdown humidifier, exhaust and outside air dampers with air handler

5.1.3 Shutdown heat wheel or heat recovery pump with air handler

5.1.4 Shutdown AHU heating pump except to maintain low limit temperature

5.1.5 Schedule major ventilation exhaust fans with respective air handler

5.1.6 Shutdown Chemistry Lab general exhaust if fume hood exhaust turned on.

5.1.7 Shutdown Lab Storage/Prep Room general exhaust if fume hood exhaust turned on

5.1.8 Shutdown air handler supply and return fans on low supply air temperature

5.1.9 Shutdown humidifier on fan or supply humidity alarm until fan restarted

5.1.10 Shutdown supply and return fans on any air handler if either fan alarms

5.1.11 Start back-up pump when lead pump remains in alarm otherwise stop back-up.

5.1.12 Shutdown boiler if shunt (bypass) circulation pump alarms.

5.1.13 Enable backup boiler if header temperature in alarm (stop if alarm acknowledged)

5.1.14 Alternate lead boiler and pump assignments at appropriate intervals

5.1.15 Reset heat recovery control to prevent frost formation

5.1.16 Interlock DDC pump and fan control via ‘auto’ mode of HOA switches

5.1.17 Bypass switch to be provided for burner DDC start/ stop relay

5.1.18 Adjust cafeteria/kitchen AHU return/exhaust air according to range hood exhaust status

END