DDC Controls Upgrade

City of Vancouver

Kerrisdale Community Centre
5851 West Blvd
Vancouver, BC

Prism Project #: 2015026
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01 11 00 - SUMMARY OF WORK

1. OBJECTIVE

1.1. The objective of the work is to replace the existing DDC system and implement the recommended measures as per the April 2016 BC Hydro C Op Investigation Report prepared by Prism Engineering

1.2. The existing Reliable Controls DDC system comprises of one MACH-Pro controller installed in the electrical room, one MACH-Net controller with expansion cards installed in the pool boiler room, five MACH1/ MACH2 controllers, one MACH-Stat, twelve MACH-Air VAV controllers, and eleven obsolete LC500 controllers.

1.3. The existing controllers are to be replaced with controllers by Reliable Controls or by Delta Controls. If Reliable Control controllers are used, then the existing MACH-Pro controller could be retained and re-used. Otherwise all controllers shall be replaced.

1.4. The existing MACH1, MACH2, MACH-Air, and MACH-Stat controllers shall be handed over to the owner for used as spare parts. LC500 controllers and replaced end devices shall be removed and sent to an electronic recycle centre.

1.5. There are two boilers plants: one serving the Seniors Centre and the other serving the Pool and the new wing. A MACH-Pro controller, located in Electrical Room 006, is currently controlling the Seniors Centre boiler plant. A multiple conductor telephone cable connects the MACH Pro controller to a terminal strip box located in the Seniors Centre boiler mechanical room. This cable shall be removed and discarded and the MACH-Pro controller (or the new DDC controller) shall relocated to the boiler mechanical room and inputs reconnected to the controller.

1.6. Although the majority of the control points in this panel use the multiple conductor telephone cable, some few control points have the wiring running from the current controller location in the electrical room to the control devices. New control wirings shall be provided connecting new control panel location to the previous location in the electrical room. A terminal strip with wiring correctly identified in both sides shall be used for connecting the wiring.

1.7. Some of the I/O control wiring connected to the MACH-Pro controller panel is no longer in use or have been relocated to another controller. The wiring shall be end-to-end recommissioned to confirm which points are still in use. Wiring/cabling not in use shall be removed. Remaining points shall be re-arranged, re-tagged, or relocated to another controller as per this specification.

1.8. There are several re-heat coils, radiant panels, mixing and heating coil valves in the Seniors Centre with pneumatic actuators. All these valves shall be replaced with valves with electronic actuators selected for the same size and CV as listed in this specification.

1.9. CoV will provide Ethernet ports at all IP controller's location for communication between controllers. No switches or routers would be required by the DDC contractor.

2. SCOPE OF WORK

2.1. Major items of Work shall consist of but shall not be limited to the following:

Controls

- Act as the prime contractor - direct and schedule the work;
- Provide a new DDC system for the monitoring and control of the HVAC systems. The DDC system shall be designed and installed as per this specification including sequences of operation and points list;

- A BACnet Ethernet network shall be provided for communication between Building Controllers (B-BC). BACnet MSTP subnetworks shall be provided between Building Controllers (B-BC) and Advanced Application Controllers (B-AAC);
- Existing network communication cable between controllers as well as existing cabling between controllers and associated field controllers can be re-used, providing they are suitable for the new system, meet performance requirements and are fully tested by the contractor. All telephone type cable shall be removed and replace with adequate control cabling.
- The DDC system including controllers and communication with existing controllers shall be fully tested and commissioned to prove point functionality and communication after installation;
- The existing control cabinets can be re-used providing they meet the requirements of this specification such as hinged doors, single keyed, adequate space for controllers and panduits, etc. Existing panels can be retained for wiring termination if existing point I/O wiring is not long enough for wiring to the new DDC controllers;
- Provide all required hardware components necessary for a complete system, including network, communications devices, building and system controllers and field devices of all types (e.g. sensors, actuators, relays, contractors), transformers, wiring, conduit, raceways, and piping;
- All end devices such as duct and immersion temperature sensors, pressure transmitters, control valves, damper actuators can be re-used provided they are compatible with new DDC system and meet performance requirements;
- The existing room temperature sensors shall be replaced with new temperature sensors compatible with the new DDC system;
- Replace all existing pneumatic heating valves in the Seniors Centre with valves provided with electronic actuators.
- All re-used control devices shall be verified, tested, and calibrated as required. A list of defective devices including prices for replacement shall be prepared and presented to the Engineer and Owner's Representative;
- Remove and recycle all unused DDC controllers, DDC and pneumatic devices including valves, actuators, relays, transformers, interface components and wiring no longer utilized by the newly installed DDC system;
- Remove and discard all pneumatic tubing for the pneumatic devices being replaced with electronic/DDC devices. Confirm and inform of any pneumatic control or device still in use.
- Graphic screens shall be provided for all DDC system interfaced systems and miscellaneous equipment. Floor plans and system schematics, VAV and radiant heating tables as per this specification shall be provided for displaying all inputs, outputs and setpoints. Graphic screens shall be submitted and reviewed by Prism, and by the City of Vancouver DDC Technician;
- All critical alarms, as defined by the Senior Building Operator, shall be generated and forwarded to the operators e-mail, and as text messages to the operators' cellular phone;
- Provide all required devices and coordinate with IT personnel for remote access to the DDC system via Internet;
- Provide all engineering and documentation necessary to define details of the contractor's system for both shop drawing review and the Contractor's installation;

- Provide application programming, databases, graphics and other activities related to computer software or firmware, required to implement the defined sequences of operation, trends, logs and the graphics screens defined in this specification;
- Provide and coordinate the work of all associated trades necessary to install the system;
- Patch and touch up paint to match existing or provide cover plates where sensors were removed or replaced with new DDC sensors;
- Provide labour and supervision for the installation, calibration, adjustments, checkouts, commissioning of all components and devices provided;
- Commission the control system to prove point functionality and communication;
- Provide complete documentation of the installed system with commissioning reports and Operations and Maintenance manuals;
- Provide a complete demonstration of the control system capabilities as per this specification;
- Provide training on the system for the building operation and maintenance personnel; and
- Provide one year warranty as per this specification.

3. BRIEF DESCRIPTION OF BUILDING SYSTEMS

3.1. This section contains a brief description of the existing HVAC and controls systems. The information is intended to provide a general overview only.

Heating Systems

There are two heating plants for this facility. One heating plant has three 398,000 BTUH Burnham atmospheric boilers with dedicated boiler pumps. There are four secondary pumps serving the Gym (P2-8); Library (P2-5); South Wing (P2-6); and Pool (P2-9 ¾ hp). The pumps are ¼ hp except for P2-9 that is ¾ hp. The circuits serving Library and South Wing are provided with 3-way mixing valves.

Heating for the Library and South Wing is provided by baseboard heaters equipped with control valves.

The heating for the Gym is provided by four forced flow heaters installed on the ceiling and controlled by a manual switch.

A separate heating plant, with a 720,000 BTUH water tube Brian boiler, serves the Senior Centre. It has three circulating pumps serving: radiant panels (pump P-1, 1/3 hp); re-heat coils in the VAV boxes (pump P-2 ,3/4hp), and unit heaters (pump P-3, 1/6 hp).

Cooling Systems

Cooling for the building is provided by DX coils installed in the rooftop units..

Air Handling Systems

Fan system	Service Area	Description
AC-1	Auditorium	8,000 CFM (3,584 l/s) Engineered Air constant volume rooftop air unit with mixing dampers 2-stage 20 tons DX cooling, modulating gas fired burner, and 7.5 hp supply fan.
AC-2	Main and Basement Floors, Interior, Games, Offices, Programs.	4,000 CFM (1,900 l/s) Engineered Air constant volume rooftop air unit with mixing dampers 2-stage 12 tons DX cooling, gas fired burner, and 5 hp supply

		fan.
AC-3	Lobby	3,000 CFM constant volume rooftop air unit with mixing dampers, 7.5 ton (2 compressors) DX coil, 200 MBH gas burner and 1 hp supply fan.
AC-4	Room 007 - Fitness Room	2,000 CFM constant volume rooftop air unit with mixing dampers, 5 ton DX cooling, 90 MBH 2 stage gas burner and 3/4 hp supply fan
AC-5	Room 005 - Exercise Room	1,300 CFM constant volume rooftop air unit with mixing dampers, 3 ton DX cooling, 80 MBH 1 stage gas burner and 1/2 hp supply fan
AC-6	Room 109 – Multipurpose / Pre-School, Birthday Party	2,000 CFM constant volume rooftop air unit with mixing dampers, 5 ton DX cooling, 90 MBH 2 stage gas burner and 3/4 hp supply fan
AC-7	Room 222 - Activity	1,300 CFM constant volume rooftop air unit with mixing dampers, 3 ton DX cooling, 80 MBH 1 stage gas burner and 1/2 hp supply fan
AC-8	Room 226 - Multipurpose	1,200 CFM constant volume rooftop air unit with mixing dampers, 3 ton DX cooling, 80 MBH 1 stage gas burner and 1/2 hp supply fan
AC-9	Basement Room 015 – Activity (Karate), Stretch Room	2,000 CFM constant volume rooftop air unit with mixing dampers, 5 ton DX cooling, 90 MBH 2 stage gas heating and 3/4 hp supply fan
AC-10	Activity Rooms 217, 220, 221, Boardroom 218	2,000 CFM constant volume rooftop air unit with mixing dampers, 5 ton DX cooling, 120 MBH 2 stage gas heating and 3/4 hp supply fan
HV-I	Senior Centre	12,000 CFM air handling unit with mixing dampers, a 34 tons AAON air cooled condenser with variable speed compressors. Serving VAV boxes
HV-1	Pool Area	10,000 CFM Engineered Air 1,250 MBH gas fired ventilation air unit with mixing dampers, 7.5 hp supply fan, 5 hp return fan.
HV-2	Staff, Dressing, Control, Viewing Area	2,200 CFM Engineered air 158 MBH gas fired ventilation air unit with mixing dampers, 3 hp supply fan, 3 hp return fan.

There are several fractional HP exhaust fans. The larger exhaust fans are:

Fan system	Service Area	Description
EF-12	General Exhaust	750 CFM (3500 l/s) ¼ hp
EF-10	Fitness	820 CFM (390 l/s) ¼ hp
SF-1	Pottery	750 CFM (3500 l/s) ¼ hp w/ hot water coil
EF-1	Pool Exhaust	8,475 CFM 3 hp

Control System

The HVAC systems are controlled by a Reliable Controls DDC system. The original Burke DDC system was partially upgraded by Webir Automation in 1999 but left the Burke supervisory controllers in place. Although the Burke supervisory controller was later replaced by an up-to-date Reliable Mach-Pro-Sys, most of the existing controllers are obsolete Reliable Multinet LC500.

The DDC system has had several upgrades by different contractors (Webir, Fraser Valley, and Control Solutions) and there are no compiled as-built drawings.

There are no graphic screens currently provided by the DDC system. If graphic screens were provided in the past, they were lost during upgrades and changes in the DDC system. Remote access is available via internet.

END OF SECTION

25 05 01 - EMCS GENERAL REQUIREMENTS

4. GENERAL

4.1. This Project Specification, including all appendices, shall be deemed to cover the complete installation ready for operation. Consequently, minor details not necessarily shown or specified but necessary for the proper functioning of the installation, including equipment serviceability, shall be included in the Work, the same as if shown in the Project Specification.

5. INTENT

5.1. Work shall be in accordance with the specifications and their intent, complete with all necessary components, including those not normally shown or called for, and shall be ready for operation before acceptance.

5.2. Any reference to the “design authority” or "consultant" shall mean Prism Engineering Ltd.

5.3. The work "provide" shall mean "supply and install" unless otherwise indicated.

5.4. The new installation shall meet the existing building standards in all aspects.

6. CODES AND STANDARDS AND PERMITS

6.1. Obtain all required permits and pay all fees therefore and comply with all provincial, municipal and other legal regulations, codes and by-laws applicable to the work.

6.2. General contractor and all sub-contractors shall obtain security clearance as per each tenant requirements before perform any work inside the building.

6.3. The work under this Contract shall conform, but not be limited to, the requirements of the following codes, regulations and standards:

- the local Building Code;
- the B.C. Building Code;
- the Workers' Compensation Act;
- the Canadian Electrical Code;
- the Canadian Standards Association; and
- the National Fire Protection Association.

6.4. Electric equipment shall bear CSA labels and, where applicable, ULC label certifying compliance with test standards of these agencies.

7. LIABILITY

7.1. Assume responsibility for laying out work and for damage caused by improper execution of work.

7.2. Protect finished and unfinished work and owner equipment from damage.

7.3. Take responsibility for condition of materials and equipment supplied and protect until work is completed and accepted.

7.4. The owner shall have recourse in tort for any negligent action by the contractor or his representatives.

8. INSURANCE

8.1. The Contractor shall provide and show proof of, at his expense, insurance in accordance with City of Vancouver requirements.

8.2. The Contractor shall carry full employee's liability insurance for the whole of the work in accordance with the Workers' Compensation Act.

9. SECURITY AND SAFETY

9.1. The Contractor shall be responsible for the protection and security of the Work, plant, equipment and materials and the protection and safety of all persons performing the Work on the site. On a daily basis and in a manner acceptable to the Owner's Representative, the Contractor shall remove and dispose of all waste materials and on completion of the Work, shall leave the site in a safe condition. Provisions of security requirements of the Owner shall be at the contractors cost.

10. EXAMINATION OF SITE

10.1. A site visit is required for all the contractors before pricing the project. Examine all local and existing conditions on which the work is dependent. Site visit should be at the date and time as per the invitation for pricing.

10.2. No consideration will be granted for any misunderstanding of work to be done resulting from failure to visit the site.

10.3. When the contract documents do not contain sufficient information for the proper selection of equipment for bidding, notify the design authority during the tendering period. If clarification is not obtainable, allow for the most expensive arrangement. Failure to do this shall not relieve the contractor of responsibility to supply the intended equipment.

10.4. Check drawings of all trades and survey the site to verify space availability for the installation. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent without written approval.

10.5. Wall locations, ceiling layout, heights, and equipment locations shall be verified on site. Failure to do this shall not relieve the contractor of the responsibility for correct location of mechanical systems and equipment.

11. SIGNS AND PUBLICITY

11.1. Neither the Contractor nor anyone directly or indirectly employed by them, shall post any site signs, nor release any publicity reports, photographs, sketches, plans or other information, orally or in writing, concerning the work performed or to be performed, without the prior written acceptance of the Owner's Representative.

12. PROJECT MANAGER

12.1. The Contractor shall identify a Project Manager who will be responsible for all aspects of the project (including co-ordination of subcontractors and suppliers, permits, installation, commissioning and contract administration). The Owner's Representative reserves the right to interview the prospective project manager to evaluate their understanding and ability to complete the project.

13. WORKMANSHIP

13.1. Workmanship shall be in accordance with well-established practice and standards accepted and recognized by design authorities and the trade.

13.2. Employ only tradesmen holding valid provincial trade qualification certificates. Tradesmen shall perform only work that their certificate permits.

14. CONTROLS CONTRACTOR REQUIREMENTS

14.1. The Control System to be installed shall be Reliable Controls or Delta Controls.

14.2. The Controls Contractor shall have an established working relationship with the Control System Manufacturer of not less than three years.

14.3. The Control Contractor shall have a local office in Metro Vancouver for the past 5 years. The local Controls Contractor Office shall be staffed by trained personal capable of maintaining the system and training client staff. The local office shall have local availability of replacement parts

14.4. Controls Contractor shall demonstrate capacity to respond to emergency calls by a local contractor (or his representative) within a two hours period of the call.

14.5. The Controls Contractor shall provide 24-hour response in the event of a customer call.

15. WORK IN EXISTING BUILDING

15.1. Obtain approval from the Owner's Representative prior to penetrating any structural surfaces including floor slabs. Obtain from the Owner's Representative approval of locations of all penetrations prior to commencing work. Contractor shall replace/repair any building services that are damaged due to this construction (example: drilling through concrete floors) at no extra cost.

15.2. Carefully route new conduits and other new services so that they do not interfere with existing installation. Arrange and pay for any necessary relocation of existing conduit, cable tray, bus duct or any other services required for the proper installation of new Work.

15.3. Removed equipment and material shall become the property of the Contractor and shall be removed from site unless otherwise requested by the Owner's Representative.

15.4. After completion of work in ceiling space, arrange and pay for the repair of any damaged or dislodged fireproofing material.

15.5. In area with solid ceilings, electrical and systems junction boxes along with associated wire and conduit shall be relocated to areas where ceiling access is possible, or access panels may be provided with the approval of the Owner's Representative.

15.6. All Contractors shall exercise due care and diligence in working in the occupied areas. Keep the job reasonably clear of waste material and rubbish at all times during progress of the work. Clean up and restoration of the work area shall occur after each day's installation to ensure that no disruption to the work area takes place.

15.7. All work on site shall be co-ordinated with the Owner's Representative so as to minimize disruptions. Installation of equipment must take place outside of regular business hours. Work taking place outside of the occupied areas that does not involve power interruptions may occur during the day with prior approval from the Owner's Representative.

16. CONTINUITY OF EXISTING SERVICES

16.1. Keep existing buildings in operation at all times with minimum length of shutdown periods.

16.2. Obtain permission of the Owner before shutting down or disconnecting electrical and fire protection services. Co-operate with the Owner and other contractors on the job and provide necessary services so that existing building can be kept in operation at any time.

16.3. Shutdowns of systems are to be co-ordinated with the building operator Tony Wong, phone: (604) 861-1760 ; e-mail: tony.wong@vancouver.ca

16.4. Installation of equipment in occupied areas must take place outside of regular business hours. Desks, equipment and furniture must be covered when the work is taking place. Work taking place outside of the occupied areas that does not involve power interruptions may occur during the day with prior approval from the Owner's Representative.

16.5. Include in Price any overtime that may be required to tie-in services at night or on weekends.

16.6. Protect all existing services and make good any damage occasioned by the work in this contract.

16.7. The Owner reserves the right to complete and/or repair any work that is not in operating condition, beyond scheduled shut downs, in order to maintain the Owner's operation.

17. CUTTING AND PATCHING

17.1. The Contractor shall be responsible for all cutting, patching and refinishing of the existing structure required for the work of this Contract.

18. CLEANING

18.1. The Contractor shall be responsible to keep the building, site, and premises clean and tidy with respect to his work at all times.

18.2. On completion, all dirt and rubbish for which the Contractor is responsible shall be removed from the site and premises and the whole left clean and tidy. All soiling of finished walls, floors, ceilings, carpets, or other surfaces, caused by the Contractor shall be cleaned up or made good by the Contractor.

18.3. All control panels, etc., shall be thoroughly vacuum cleaned of dust, dirt, and debris before start-up and hand-over.

19. NEW PRODUCTS ONLY

19.1. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 1 year. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 7 years after completion of this contract.

20. SHOP DRAWINGS

20.1. The Contractor shall submit an electronic copy of the Shop Drawings in Adobe PDF format to the Owner's Representative (Prism) for acceptance, prior to commencement of the installation.

20.2. When Shop Drawings are accepted, the said acceptance does not in any way relieve the Contractor of his responsibility or the necessity of furnishing materials and software or performing work as required by the Contract Documents.

20.3. No factory or field fabrication work shall commence, nor shall any materials be delivered to the site(s) until the Shop Drawings have been reviewed by the Owner's Representative for conformity with the plan and specifications.

20.4. Note each shop drawing with the following information:

- Manufacturer's and Supplier's name;
- Catalogue model number;
- Project identification number; and
- Number identifying item on Contract Drawings and/or in Specifications.

20.5. The location of all devices shall be reviewed with the Owner's Representative prior to installation.

20.6. Shop Drawings for each controlled system shall consist of detailed descriptions of the system(s) including:

- Network drawing showing the system configuration, for the new and existing controllers; operator workstation(s); modem/ hub/switches; external access devices; including name, model, address, location, type of network and cabling, etc.;
- Points Lists for all controllers including controller name, controller address, system name, point name, point description, point type (AI, AO, DI, DO), device type and part number. Spare points shall be shown for each controller;
- Schematic diagrams containing the system name, description and location; name and panel/point address of all monitored and controlled devices; all required field and factory terminations and cable/wire identifiers;
- Sequence of operation. The written sequence shall be specific for the use of the Control System being provided for this project;
- Identically controlled subsystems (i.e. VAV boxes, reheats, fan coil units, etc.) shall be grouped by system and indexed;
- Sample of the proposed graphic screen(s) including all navigational links, points, variables and labels;
- Control valve schedule including valve size, model number (including pattern and connections), flow, CV, pressure rating, and location;
- Complete bill of materials of equipment to be used indicating quantity, manufacturer and model number; and
- System capacity and expansion limits including the type and size of memory.

20.7. Provide manufacturers cut sheets for all system components including controllers, sensors, valves, dampers, actuators, relays and auxiliary control devices. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.

20.8. Each shop drawing shall be checked and stamped as being correct by the Contractor, before drawing is submitted.

20.9. Provide the Owner's Representative and Owner, with any additional information or data that is deemed necessary to determine compliance with these specifications or which is deemed valuable in documenting the system to be installed.

20.10. Wiring diagrams with cable type and identification including terminal numbers shall be included in the as built drawings.

21. AS-BUILT DRAWINGS

21.1. Changes made to the Work during installation and before completion of the Work shall be documented by the Contractor to ensure that the changes are recorded as they occur.

21.2. The Contractor shall submit for review, an electronic version of the as-built set of drawings to the Owner's Representative after completely incorporating the revisions as above. These drawings shall be clearly identified with the notation "Revised As-built" imprinted adjacent to the title block.

21.3. A copy of the as-built drawings shall be provided on a CD or DVD media and a copy saved on the Operator Workstation and be accessible via an icon on the main graphic screen.

22. OPERATING AND MAINTENANCE MANUALS

22.1. Operating and Maintenance manual shall be provided and form a complete document for the Owner.

22.2. All existing documentation for the re-used control devices such as valve and damper schedules, applicable technical information, wiring diagrams, parts and bill of materials revised as applicable, shall be incorporated to the O&M manual to form a complete and comprehensive document.

22.3. One copy of the Operating and Maintenance manual shall be submitted in draft form to the Owner's Representative for acceptance before Substantial Performance Testing.

22.4. Following acceptance by the Owner's Representative, submit three (3) complete sets of operating and maintenance instructions, bound in vinyl covered hard backed binder, 8 1/2" x 11 size, three-ring covers at completion, and before Substantial Completion of the Work. Contents of binder shall not include hand-written data.

22.5. The title sheet shall be labelled "DDC System Manual" and shall bear the following: Project Name, Date, Name and Address of closest service organization, List of Contents.

22.6. The binder shall contain numbered dividers separating the manual into the following sections: Operating and Maintenance (O & M) Manual; Operators Manual; and Engineering, Installation and Maintenance Manual(s),

22.7. The O & M manual shall include:

- As-built versions of the submittal product data;
- Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each;
- A listing and documentation of all custom software created using the programming language including the point database;
- One set of CD/DVD's containing updated back-up files of all program code; as-built control drawings (pdf); all updated graphic screens files created for the project;
- Complete original issue CD/DVD for all software provided including operating systems, programming language, operator workstation software, and graphics software;
- Licenses, Guarantee, and Warrantee documents for all equipment and systems;
- Testing and Commissioning Reports and Checklists including the End-to-End Checkout Sheet for each control panel;

- Customized description of graphic interface with instructions on how to start the graphics package, make setpoint changes, add or modify schedules, add or modify a trend, add, modify or acknowledge alarms;
- Panel riser and panel-by-panel points list;
- Reduced floor plans showing equipment and sensor locations;
- Record of Training; and
- Review manual with the Owner's operating staff or representatives to ensure a thorough understanding of each item of equipment and its operation.

22.8. Operators Manual shall include Procedures for operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.

22.9. Engineering, Installation and Maintenance Manual(s) shall include descriptions on how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

22.10. Should the Contractor thereafter amend the manuals, he shall promptly provide one copy of any such amendments to the Owner's Representative for acceptance. Upon acceptance by the Owner's Representative, the Contractor shall provide three copies of such amendments.

23. COMMISSIONING

23.1. The control system must be commissioned and tested at the end of the work to be completely operational including the following:

- every point shall be end to end checked to ensure accuracy and integrity of systems. Provide check-out data sheet signed off by the DDC Contractor;
- DDC Program Code shall successfully control the systems;
- time schedules shall be built and in control of time-controlled equipment;
- graphic displays must be installed and each graphic screen shall be fully operational;
- all specified trends covering a Seventy-Two (72) hour continuous period to confirm system operation must be created and operational;
- Runtime totalizer shall be set on all digital outputs;
- all features of system shall have been exercised;
- operator shall have been briefed on operation of system;
- all alarms shall be operational;
- all sensors shall have been calibrated; and
- results of all tests shall be documented by the Contractor and a signed hard copy of the commissioning sheets, sensors calibration, and trends submitted to the Owner's Representative (Prism) for review.

24. DEMONSTRATION

24.1. A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 4 hours on-site with the Owner and his representatives for a complete functional demonstration of all the system requirements.

24.2. This demonstration constitutes a joint acceptance inspection, and acceptance of the delivered system for on-line operation.

25. TRAINING

25.1. Train the designated staff of Owner's representative and Owner to enable them to proficiently operate the system.

25.2. The training shall be divided into two logical groupings; participants may attend one or more of these, depending on level of knowledge required:

Day-to-day Operators

System Manager

25.3. Provide a minimum of 4 training sessions of 4 hours each, throughout the contract period for personnel designated by the Owner.

26. WARRANTY

26.1. Labour & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures of upgrade components during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during customary business hours.

26.2. At the end of the final start-up/testing and commissioning, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.

26.3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period, other than those items that are specifically exempted. Written authorization by Owner must, however, be granted prior to the installation of such changes.

26.4. The warranty shall provide all material, parts and labour, including labour provided on an emergency response basis outside of normal working hours. Labour shall include any related travel time and other related costs associated with providing the warranty service.

26.5. The warranty shall cover all aspects of the control system upgrade provided under this contract, including: transmission equipment and links, all DDC panels and micro panel chip upgrades, and devices, transducers, and software.

26.6. A detailed service report must be filed with the Owner after each warranty visit, detailing the work performed, time spent, devices replaced or repaired, and the personnel involved.

26.7. Emergency calls during the warranty period shall be addressed by the Contractor within four (4) hours of notification. Service shall be available 24 hours per day, seven days a week. The Owner shall be provided an emergency phone number for contacting service personnel. The service call shall only be chargeable if inspection reveals any defect not directly covered under the terms of the specification.

27. OWNERSHIP OF PROPRIETARY MATERIAL

27.1. All project developed hardware and software shall become the property of the Owner. These include but are not limited to:

- record drawings;
- project database;
- job-specific application programming code; and

- all documentation.

28. ACCEPTANCE

28.1. The control systems will not be accepted as meeting the requirements of completion until all tests and documentation described in this specification have been provided to the satisfaction of both the Owner's Representative and Owner.

28.2. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.

29. SUBSTANTIAL PERFORMANCE

29.1. Once the above basic requirements are met and all other features of the system are complete and acceptable, Substantial Performance shall be granted. A deficiency list shall be prepared and holdbacks applied. All deficiencies shall be corrected prior to Total Performance.

30. TOTAL PERFORMANCE

30.1. The Owner's Representative shall issue a letter of Total Performance when all of the deficiencies have been rectified.

30.2. The date of this letter shall be the date of Total Performance of the Contract. Warranty shall start from the date of Total Performance of the work.

30.3. The following shall be submitted before final acceptance will be issued:

- Electrical permit and inspectors report;
- As Built Drawings;
- O & M Manuals;
- Commissioning Report; and
- Controls Verification and documentation.

END OF SECTION

25 30 01 - EMCS HARDWARE REQUIREMENTS

31. OPERATOR INTERFACE

31.1. There will be no site operator interface. Technicians would access the DDC system via remote access or direct connecting to the supervisory controller Ethernet port.

32. CONTROLLERS

32.1. The following requirements shall apply to Building Controllers (B-BC), Advanced Application Controllers (B-AAC) and Application Specific Controllers (B-ASC):

32.2. Controllers shall be BACnet Testing Laboratories (BTL) marked. No translation software shall be used internal to the controller to convert from a proprietary protocol to BACnet Standard Object Types, Standard Application Services and Devices.

32.3. Effective Panel Processing Speed - Maximum permissible execution time is half a second. Execution time is defined as the time it takes the controller to execute all application software from some point in the software back to the same point while simultaneously responding to operator or terminal display requests and carrying out normal inter-panel communications. Set up an analog variable counter in each panel, incremented and reset by program code, to allow for verification of the processing speed.

32.4. Controllers shall have sufficient memory to support its operating system, database, programming and trending requirements. There shall be a minimum of 50% available memory free for future use.

32.5. Controllers shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

32.6. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

32.7. Controller operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m.

32.8. Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

32.9. Controller hardware shall be suitable for the anticipated ambient conditions.

32.10. Controllers used in conditioned ambient shall be mounted in NEMA 1 Type rated enclosures, and shall be rated for operation at 0°C to 50°C.

32.11. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 Type waterproof enclosures, and shall be rated for operation at –40°C to 65°C.

32.12. Controllers that perform scheduling shall have a real time clock.

33. BUILDING CONTROLLERS (B-BC)

33.1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the global control strategies specified in the Sequences of Operation section of the Specifications

33.2. Each Building Controller shall reside on a BACnet inter-network using the ISO 8802-3 (Ethernet) Physical/Data Link layer protocol. Each Building Controller shall also perform routing to a network of Advanced Application and Application Specific Controllers.

33.3. The Building Controller shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-2004, to communicate with BACnet objects in the inter-network.

33.4. The controller shall provide a communications port for connection of the Portable Operators Terminal using Point-to-Point BACnet physical/data link layer protocol or a connection to the inter-network.

33.5. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

33.6. Data shall be shared between networked Building Controllers on a peer-to-peer basis.

33.7. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

- assume a predetermined failure mode; and
- generate an alarm notification.

33.8. The building controllers shall be able to communicate with and download programs to third party Application Specific Controllers.

33.9. Outputs on B-BC controllers shall have three-position (on-off-auto) override switches and status lights

34. ADVANCED APPLICATION CONTROLLERS (B-AAC)

34.1. Advanced Application Controllers shall perform the control strategies specified in the Sequences of Operation section of the Specifications. Each of these panels shall meet the requirements as outlined in this section.

34.2. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Advanced Application Controllers to manage the local strategies described in System software section.

34.3. Controllers that perform scheduling shall have a real time clock.

34.4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

34.5. Data shall be shared between networked Controllers.

34.6. The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

- assume a predetermined failure mode; and
- generate an alarm notification.

34.7. The Advanced Application Controller shall communicate with other BACnet devices on the inter-network using the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-95.

34.8. Each controller shall reside on a BACnet network using a MS/TP Data Link/Physical layer protocol.

34.9. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol to a portable operator's terminal.

34.10. Outputs on B-AAC controllers shall have three-position (on-off-auto) override switches and status lights

35. APPLICATION SPECIFIC CONTROLLERS (B-ASC)

35.1. Application specific controllers shall not be used on this project

END OF SECTION

25 10 02 - EMCS SOFTWARE REQUIREMENTS

36. COMMUNICATIONS

36.1. The data communication protocol for the project shall comprise a BACnet inter-network. All PC Workstations and Building Controller components shall meet ASHRAE / ANSI Standard 135-2008, BACnet - A Data Communication Protocol for Building Automation and Control Networks

36.2. Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device as defined in Section 25 30 01.

36.3. All BACnet MS/TP networks shall communicate error free at a baud rate of 76,800 bps.

36.4. Low capacitance cable with less than 15 Pico farads per foot shall be provided for MS/TP networks to for stable and less network communication errors.

36.5. The Controls Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network.

36.6. All Building Controllers shall have a communications port for connection with operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node.

36.7. The Ethernet network shall be extended to all supervisory controllers, operator workstation and data server.

36.8. Ethernet network connection shall be provided in each mechanical room for laptop connection.

36.9. Networks connecting zone level controllers such as VAV boxes, re-heat systems, etc. shall be directly connected to the DDC controller controlling the associated air handling unit.

37. INPUT/OUTPUT INTERFACE

37.1. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

37.2. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices.

37.3. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

37.4. Analog inputs shall allow the monitoring of low voltage (0-10 VDC), current (4-20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.

37.5. Binary outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control. Binary outputs on Advanced Application and Building controllers shall have 3-position (on/off/auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

37.6. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 VDC or a 4-20 mA signal as required to provide proper control of the output device. Analog outputs on Advanced Aplication and Building controllers shall have status lights

and a 2-position (auto/manual) switch and manually adjustable potentiometer for manual override.

38. SYSTEM GRAPHICS

38.1. The Operator Workstation software shall be graphically oriented. The system shall allow display of multiple graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen.

38.2. An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation of equipment.

38.3. Graphic screens shall be created for main menu, network schematic, floor plans, and for each system schematics.

38.4. Floor plan graphics screens shall be created to reflect correct zoning such as areas served per each VAV box or radiant heating system.

38.5. Provide a Building Network Diagram graphic screen showing every controller and network panel complete with addresses and controller type and model.

38.6. Screen Navigation - A menu bar shall be located at the bottom of each graphics screen. The menu bar and menu buttons shall be placed at exactly the same location on each graphic screen to allow browsing through the system by clicking on the buttons without moving the mouse.

MAIN MENU: Clicking the Main Menu button, in the left most position on the menu bar on all graphic screens, shall open the main menu graphic screen.

PREVIOUS: Clicking the Previous button, the second from the left position on the menu bar on all graphic screens, shall open the graphic screen most recently displayed prior to the currently graphic.

CUSTOM: One or more buttons for commands specific to the currently displayed graphic screen.

A key plan shall be provided in the lower right hand corner with each graphic screen showing the related floor area plus the number of floors or levels. The shaded area will depict the area served by the graphic. Clicking on the level or floor number will present the corresponding location on that floor graphic. Clicking on the non-shaded areas will present the graphic representing that area on the same floor.

38.7. Minimum Requirements - Placement of any information or active icons close to the edge of the graphic display area shall be avoided to minimize issues when sizing windows or screen setup with monitors with various resolutions.

The graphic title shall be located at the top of each screen.

Graphics text font shall be reasonable sized for easy reading with a pleasing color contrast between lettering and background.

A point value or status shall be located as close as possible to the graphical representation of the actual physical location. If the point has an associated setpoint this point will be located directly below the actual point and be in a different colour.

Status of equipment shall be displayed as ON or OFF and located on top of commanded points.

Command points shall be defined as Start/Stop or Enable/Disable, etc, but not as ON/OFF.

Operator overrides of input and output points or values normally under program control shall result in display an override (hand) indication adjacent to the display.

Weekly schedules shall be symbolized by a clock icon. Access will be from every time controlled system graphic screen plus the Index. The Index graphic screen shall provide access to a graphic screen of all time schedules whereas time controlled points on a particular system graphic shall access only the relevant controlling schedule.

Graphic screens shall include trend /multi-trend icons for each specified multiple point trends directing to the specific trend graphic screen.

Runtime hour icons shall be placed as close as possible to the actual point or value being totalized. The icon shall provide access to the totalizer configuration data.

38.8. All analog output values for control of pneumatically actuated valves and dampers shall be scaled and limited to 0 to 100% open for display on graphic screens. Operating ranges for each valve and operator controlled by the DDC system shall be measured and appropriate scaling functions applied.

38.9. Graphic screens shall have as many trend /multi-trend icons as required for every equipment directing to the specific trend graphic screen.

38.10. Colour Selection - The visual impact of color shall align with the importance of the information.

- bright red or yellow for alarm information;
- next brightest colour for dynamic information such as temperature and status;
- next brightest colour for action items such as icons;
- darker colours for passive, but important information such as schematic lines; and
- pastel colours for passive, less important information such as backgrounds.

Color consistency shall be maintained throughout - all air systems similar, all hot water lines the same colour, all chilled water lines the same colour.

Colour selections shall provide legible gray scale outputs on non-colour printers.

38.11. Custom graphic files shall be created with the use of commonly available graphics packages. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as PCX, BMP, GIF and JPEG. The graphics generation package shall also provide the capability of capturing or converting graphics from other programs such as Visio, or AutoCAD.

39. ENGINEERING UNITS

39.1. Engineering units on this project shall be SI

40. POINT NAMING CONVENTION

40.1. System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

40.2. Point naming shall be composed as follows:

BLDG_SYS_POINT_FUNC

Where:

BLDG is an optional building identifier (applied where applicable)

SYS is the system identifier

POINT is the point identifier(s)

FUNC is the point function

40.3. Components of the point name shall be consistent throughout the installation and documentation.

41. PROGRAMMING

41.1. System point names as point, variable, trend, schedule, calendar and other names shall be modular in design, allowing easy operator interface without the use of a written point index.

41.2. Provide programming for the system as per specifications and adhere to the control sequences provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

41.3. Provide a description for each analog and binary variable created. The description property shall include application and scope of the variable.

41.4. All variables specified as adjustable or configurable shall be configured as system variables. Adjustable shall signify that the present value is displayed and can be modified on graphic screens whereas configurable signifies that the present value can only be modified from within the variable definition.

41.5. All variables specified as fixed shall be imbedded in control programs and shall not be configured as BACnet objects.

41.6. The controls contractor shall provide all the labour necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.

41.7. Occupant adjustment of space temperature setpoint at network thermostats shall be limited to ±1.5ºC of nominal value unless otherwise specified.

41.8. All variables specified as adjustable or configurable shall be configured as BACnet Analog Value objects. Adjustable shall signify that the object present value is displayed and can be modified on graphic screens whereas configurable signifies that the object present value can only be modified from within the object properties definition.

42. SCHEDULING

42.1. Provide the capability to schedule (including statutory holidays calendar) and control each object or group of objects in the system. The contractor is responsible for making adjustments in point names, day type numbers, and program logic such that the system operates according to the intent of previous control strategies.

43. ALARM

43.1. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

43.2. Alarms should be set with sufficient time delay, software interlocks and adequate range to avoid nuisance alarms.

43.3. Each binary object shall be set to alarm based on the operator specified state. Provide the capability to disable alarming when the associated equipment is turned off or is being serviced.

43.4. Each analog object shall have both high and low alarm limits and warning limits. Alarming must be able to be automatically and manually disabled.

44. ALARM REPORTING

44.1. The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the workstations based on time and other conditions. An alarm shall be able to start programs, be logged in the event log, printed, generate custom messages graphics.

44.2. The operator shall be able to view all logged system alarms and events from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All alarms that have not been cleared by the operator shall be archived to the hard disk on the workstation.

44.3. Any object (point) under alarm shall change its block colour to red on the graphic screen. Blocks indicating temperature alarms should be change colour to blue when at low limit alarm or red when high limit alarm.

44.4. Alarms shall be routed to the workstations based on time and other conditions. The system shall have the ability to send text messages and e-mails in the event of an alarm to designated smart phones, web enabled devices and e-mail addresses.

44.5. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system using web-based communications.

45. SYSTEM SECURITY

45.1. User access shall be secured using individual security passwords and user names.

45.2. Passwords shall restrict the user to only the objects, applications, and system functions as assigned by the system manager.

45.3. User logon/logoff attempts shall be recorded.

45.4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

END OF SECTION

25 30 02 - EMCS FIELD CONTROL DEVICES

46. ELECTRONIC DAMPER ACTUATORS

46.1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

46.2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.

46.3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.

46.4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.

46.5. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not require more than 11 VA.

46.6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.

46.7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation

46.8. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

46.9. Actuators shall be Underwriters Laboratories Standard 873 listed.

46.10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

46.11. Actuators shall allow smooth operation throughout entire operating range and assure tight shut-off against system pressure.

46.12. Actuators shall be sized to control against maximum pressure or dynamic closing pressure whichever is greater.

46.13. Provide position indicators on volume control dampers.

46.14. Actuators shall remain stationary until the applied signal changes.

47. CONTROL VALVES

47.1. Control valves for plant equipment shall be two-way or three-way type for two-position or modulating service as scheduled or shown.

47.2. Where CV is specified in the points list or on a valve schedule, ensure the control valve has a similar CV to that specified.

47.3. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

Water Valves:

- two-way: 150% of total system (pump) head; and
- three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

48. WATER VALVES

48.1. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

48.2. Sizing Criteria:

- two-position service: Line size;
- two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater;
- three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 5 psi maximum;
- valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball; and
- 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.

48.3. Water valves shall fail normally open or closed as scheduled on plans or as follows:

- heating coils in air handlers - normally open;
- chilled water control valves - normally closed; and
- other applications - as scheduled or as required by sequence of operation.

48.4. Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

49. TEMPERATURE SENSORS

49.1. Provide one of the following temperature sensor types throughout:

- 10,000 Ohm at 25°C thermistor;

49.2. Sensors shall have an accuracy of ±0.3°C or better.

49.3. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within ±0.1°C [0.2°F].

49.4. All temperature sensors provided shall be constructed as follows:

- integral anchored lead wires; and
- strain minimizing construction.

49.5. Duct Mounted Temperature Sensors (TSD)

49.6. Duct mount temperature sensors shall be as follows:

- copper sheathed construction;

- standard conduit box termination, complete with screw terminal connector block; and
- length to extend, at minimum, one-third of the distance across the duct.

49.7. Averaging Temperature Sensors (TSD1/x)

49.8. Averaging type temperature sensors shall be as follows:

- copper sheathed construction;
- internal parallel/series network of multiple sensing elements encapsulated at equal distances along the length;
- unless otherwise specified, a minimum of 4 internal sensing elements shall be used for sheath lengths less than 7 m. For lengths greater than 7 m - 9 sensing elements shall be used;
- location of each internal temperature sensing element to be clearly indicated on sheath;
- standard conduit box termination complete with screw terminal connector box;
- a minimum of 1.5m [5 feet] in length per 1 m2 (10 ft2) of duct cross section; and
- probe to be capable of being formed, at field installation time, to a minimum radius of 10 cm at any point along the probe length other than within 20 cm of the connector box with no degradation to the specified performance.

49.9. Outside Temperature Sensors (TSO)

49.10. Outside air temperature sensors shall be as follows:

- weather proof enclosure complete with on-corroding outdoor shield designed to minimize the effect of solar heating on the sensing element;
- threaded fittings for mating to 12 mm conduit or as applicable;
- total probe length of 50 mm;
- stainless steel sheath; and
- operating range: -35°C to +50°C.

49.11. Immersion Temperature Sensors (TSP1)

49.12. Provide, spring-loaded, thermowell mount sensors as follows:

- stainless steel sheath;
- spring loaded construction complete with compression fitting for 20 mm or 12 mm NPT well mounting as applicable;
- length as suitable for the application;
- standard conduit box termination, complete with screw terminal connector block.

49.13. Room Temperature sensors (TSR/TSR1/ TSR2/ TSR3)

49.14. Room temperature sensors shall be as follows:

- for non-security applications (TSR/TSR2/TSR3) the sensing element shall be installed in a vented wall mounted protective enclosure;
- for security applications (TSR1) the sensing element shall be attached directly to a rigid, metal cover plate designed for mounting into a recessed junction box;
- Room temperature sensors for the offices shall be equipped with set-point adjustment, override switch, display, and/or communication port as shown on points list; and
- Room temperature sensors for common areas and classrooms shall be without display or setpoint adjustment.

50. RELATIVE HUMIDITY TRANSMITTERS (HSD, HSR & HSO)

50.1. Provide relative humidity transmitters having the following minimum specifications:

- sensing range of 10% to 90% with accuracy of ±3% RH;
- response time shall not exceed 1 minute from 90% to 10% RH;
- temperature dependence 0.2% RH per degree C or less;
- drift shall not exceed 2% RH per year; and
- 200 mm minimum probe length with enclosure for duct mounting.

50.2. Relative humidity transmitters shall be suitable for operating conditions of 0ºC to 60ºC for duct applications and -40ºC to 75ºC for outdoor applications.

50.3. For room application the assembly shall be complete with a base plate for wall mounting, a rigid circuit board for all circuitry and the sensing element, and a ventilated enclosure.

50.4. Humidity sensor for the swimming pool if a replacement is required shall be Vaisala with Nema 4X or IP65 enclosure.

51. DIFFERENTIAL PRESSURE TRANSMITTERS – Liquids (DPTL)

51.1. Provide differential pressure transmitters as follows:

- solid-state design, operating on capacitance principle;
- internal materials of the transducer suitable for the application;
- minimum operating range of 0°C to 50°C with 20% to 90% rH (non-condensing);
- 0-10VDC, 4-20 mA, selectable signal output;
- pressure range selected to suit application. Maximum expected measured pressure shall be at 75% of the full selected range scale;
- integral, accessible non-interactive zero and span adjustment;
- output variation of less than 0.2% full scale for supply voltage variations of +/- 10%;
- accuracy of ±1% range including non-linearity and hysteresis and repeatability;
- accuracy of ±0.25% range (Setra);
- output short circuit and open circuit protection;
- proof pressure twice the maximum full scale range (150 psig minimum). Transducer shall be selected with proof pressure at least 20% above the operating static pressure at the transducer location;
- burst pressure 5 times the maximum full scale range (150 psig minimum);
- linear output signal. Zero and span shall be non-interactive and field adjustable;
- mount in a location accessible for service with required mounting brackets, block and bleed valves, and three-valve manifold;
- shock and vibration protection;
- over pressure input protection as necessary for the application;
- shock and vibration protection as necessary;
- optional LCD display with minimum 2 lines x 8 character;
- 3-way valve manifold assembly; and
- Provide Nema 4 or greater enclosure rate.

52. OCCUPANCY SENSORS - GENERAL (OS1/OS2/Os3)

52.1. Provide occupancy sensor controls for each area indicated and of type indicated as follows:

- sensors shall be low voltage type, with no minimum load required for proper operation;
- sensors shall be complete with two isolated low voltage 500 ma auxiliary contacts; one “normally open” (NO) type and one “normally closed” (NC) type. DDC interface connection shall be made to the NO auxiliary contact;

- all sensors must have non-volatile memory so as to retain settings in the event of power outage;
- ultrasonic and dual technology sensors are not to be utilized at mounting heights above 14' or in applications where the room ceiling height is greater than 15';
- wall mounted sensors shall be complete with swivel base and mounting bracket;
- ceiling mounted sensors shall be complete with surface mounting plate;
- sensors to be installed in areas where impact with equipment or where airborne objects may contact the sensor shall be complete with painted wireguard;
- all sensors shall be located to sense the occupant as they enter the room or are within the room. Sensors shall be located and installed as per manufacturer's guidelines;

53. CONTROL RELAYS (CR1, 2 & 3, CRS)

53.1. Control relays shall be as follows:

- control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application;
- electro mechanical relays shall have integral override switch to allow local override in event of DDC control failure; and
- motor rated relays shall be provided in DDC enable control application for small motors (pumps, fans, etc) equipped with manual starters.

54. CURRENT TRANSDUCERS (CS1)

54.1. Current transducers shall be as follows:

- range selected to match the current of the application;
- output to match the requirements of the DDC System;
- accuracy of ± 2% full scale or better;
- repeatability of ±2% full scale or better;
- over-current and over-voltage protection as applicable; and
- shock and vibration protection as necessary.

55. CARBON DIOXIDE TRANSMITTERS (CO2D & CO2R)

55.1. Carbon dioxide transmitters shall have the following characteristics:

- be non-dispersive infrared detection type for measurement of CO2;
- be duct or space mounted as specified in points list and/or drawings;
- have a range of 0 to 2000/2500 ppm minimum/maximum;
- have an accuracy ±50 ppm or better;
- have a response time of less than 2 minutes for 90% response to a step change; and
- have a minimum operating range of 5°C to 40°C with 5% to 95% rH.

56. PHOTOSENSORS

56.1. Provide photosensors as follows:

- Photosensors shall be micro-processor based light sensing device with 4-20 mA, 0 – 5 VDC, or 0 – 10VDC analog output;
- Supply Voltage:12-24 VDC, 20 mA max;
- Operating Temperature:-40° to 140°F (-40° to 60°C);
- Operating Humidity:10% to 95% Non-condensing;
- Protective Lens: Non-polarized plastic;

- Enclosure Rating: NEMA 1for indoor and skylight mounting; NEMA 3R for outdoor; and
- UL / CSA listed.

57. TRANSFORMERS AND POWER SUPPLIES

57.1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

57.2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Unit shall have built-in over-voltage protection.

57.3. A single transformer limited to a Class 2 (100VA) transformer could be used to power several VAV box controllers. Transformers shall be located inside a mechanical or electrical room.

58. LOCAL CONTROL PANELS

58.1. Existing control panels could be re-used.

58.2. All indoor control cabinets shall be enameled steel, fully enclosed NEMA 1 Type construction with hinged door, key-lock latch, and removable sub-panels. Outdoor and wet environment panel cabinets shall be fully enclosed NEMA 4 Type construction with hinged door, key-lock latch; removable sub-panels.

58.3. A single key shall be common to all field panels and sub-panels.

58.4. Controllers and devices shall be conveniently spaced and neatly wired. Cables shall be accommodated inside slotted wiring plastic duct (Panduit).

58.5. Panels shall have an additional 20% free face area space to accommodate additional control devices.

58.6. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 300-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

58.7. Provide on/off power switch with over-current protection for control power source to each local panel.

59. FIELD DEVICE TYPES

59.1. Field devices, specifications and standard of acceptance shall be based on the following device types as noted in points lists and/or drawings.

Table 1: Control Device Types

Device Type	Description	Technical Performance	Standard of Acceptance
CV3	Control Valve (2 – 3 way modulating, non-spring-return)	Globe valve body, with equal percentage flow characteristics, threaded connections. Material suitable for chilled water or hot water up to 125°C, Body pressure rating of 875 kPa (300 psi). Close off pressure rating to meet system pressure but no less than 12 psi minimum. Modulating actuator with 0-10 VDC signal range, power to open and power to close.	Belimo G2 / G3 MFT series Submittal Data - Submittal data shall include the proposed CV rating for each control valve.
CV4	Control Valve (2 - 3 way, modulating, spring return)	Globe valve body, with equal percentage flow characteristics, threaded connections. Material suitable for chilled water or hot water up to 125°C, Body pressure rating of 875 kPa (300 psi). Close off pressure rating to meet system pressure but no less than 12 psi minimum. 24VAC spring return to open modulating actuator with 0-10 VDC signal range.	Johnson VG4000/5000 Series Johnson VG7000 Series Belimo Submittal Data - Submittal data shall include the proposed CV rating for each control valve.
CV8	Ball control valve (2 - 3 way, modulating)	Ball valve with equal percentage flow characteristic, threaded connections. Material suitable for chilled water or hot water up to 125°C, Body pressure rating of 875 kPa (300 psi). Close off pressure rating to meet system pressure. 24VAC modulating actuator	Belimo B2 Series Belimo B3 Series Submittal Data - Submittal data shall include the proposed CV rating for each control valve.
CV9	Control valve (2 - 3 way, 2-position)	Ball valve with threaded connections. Material suitable for chilled water or hot water up to 125°C, Body pressure rating of 875 kPa (300 psi). Close off pressure rating to meet system pressure. 24VAC 2-position actuator	Belimo B2 Series Belimo B3 Series Submittal Data - Submittal data shall include the proposed CV rating for each control valve.

Device Type	Description	Technical Performance	Standard of Acceptance
CR2	Control relay (Dry contact electro-mechanical relay)	240V, 10A to suit application	IDEC - RH Series Carlo Gavazzi - RCP8 Functional Devices RIB Series
CS1	Current Transducer		Greystone CS-450. Enercorp Sentry 100
CO2D	Carbon dioxide transmitter – duct mounted		Quatrosense Environmental Ltd. (QEL) QTS – 2000 series
DA1	Damper Actuator (Electric, modulating, non-spring-return)	Power Voltage 24VAC Control Voltage 0-10VDC DC brushless motor with overload protection. Torque as required to control the damper.	Belimo GMB-24SR; AMB-24SR; HMB-24SR; LMB-24SR
DA2	Damper Actuator (Electric, modulating, spring return)	Power voltage 24VAC Control Voltage 0-10VDC DC brushless motor with overload protection. Torque as required to control the damper.	Belimo AF24-MFT-US; NF24-MFT-US; LF24-MFT-US
TSD1/x	Duct temperature sensor, averaging		Greystone TE-200-DC Enercorp TS-A-4/ TS-A-9
TSD2	Duct Temperature sensor		Greystone TE-200-B Enercorp TS-D
TSO	Outside air temperature sensor		Greystone TE-200-F Enercorp TS-O
TSP1	Temperature Sensor, immersion type.		Greystone TE-200-C. Enercorp TS-P
TSP2	Temperature Sensor, strap-on-type.	Apply heat transfer paste between sensor plate and pipe	Enercorp TS-BP Greystone TE-200-ES
TSR	Room temperature sensor		Greystone TE-200-AE Reliable SPACE-Sensor SST
TSR3	Room temperature sensor complete with momentary override switch, setpoint adjustment, and setpoint indication.		Greystone TE200-AE-x-AP-BS-AC Reliable SPACE-Sensor SST
TSR4	Room temperature sensor complete with momentary override switch, setpoint adjustment, and LCD display		Reliable SMART-Sensor LCD
LS1	Photocell light level sensor, with analogue output related to light intensity.		Hubble Automation Watt Stopper

Device Type	Description	Technical Performance	Standard of Acceptance
DPTA	Differential Pressure Transmitter –Air Service	+/- 1% FS Accuracy Pressure range to suit application Tips for duct static pressure measurements equal to Dwyer A-301 or Mamac A-520 Tips for room static pressure measurements equal to Kele RPS or Greystone RPV / CPV, Outdoor tip equal to Dwyer A-306 or Greystone OPV	Setra Model 264; 265 Greystone ULPBx

END OF SECTION

25 08 20 - EMCS INSTALLATION AND WIRING

60. INSTALLATION STANDARDS

60.1. The intention of this clause is to guide the Contractor as to the required quality of installation.

60.2. All installations to be performed by skilled and certified technicians and trades people.

60.3. Contractor shall continually monitor the installation for code compliance and quality of workmanship.

60.4. Contractor shall arrange for all field inspections required by local and/or provincial authorities having jurisdiction over the Work.

60.5. All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of the equipment.

60.6. Equipment shall be installed to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.

60.7. Equipment shall be installed in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation and with no condensate traps.

61. ELECTRICAL WORK BY THE CONTROLS CONTRACTOR

61.1. Controls contractor shall act as the prime contractor - direct and schedule the work.

61.2. All wiring required for devices supplied under this Specification, regardless of the voltage, shall be the responsibility of the Controls Contractor.

61.3. Provision of control panels, pilot lights, selectors, relays, etc., required for the proper operation of the control systems.

61.4. Conduit and wiring from the starter control circuits to the mechanical system control panels including 110 V wiring.

61.5. Conduit and wiring required for the interlocking of mechanical system motor starters as required for the proper operation of the control system.

61.6. Wiring from pilot devices, relays, contactors, or other control interface devices required for the proper operation of the control system.

61.7. Wiring from spare 15 amp circuit breakers in power panels for line voltage power sources where required by control system. Circuit breakers shall be locking type.

61.8. Controls Contractor shall confirm all wiring connections between controllers and field devices and provide a copy of the End-to-End Checkout Sheet for every control panel.

61.9. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with termination identified at the job site.

61.10. Power wiring to line voltage thermostats controlling force flow units and unit heaters, and wiring to float devices for sump pumps, etc.

62. CONTROL AND INTERLOCK WIRING

62.1. All control and interlock wiring shall comply with the national and local electrical codes as well as the following clauses.

62.2. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

62.3. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with local codes.

62.4. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.

62.5. Adhere to Division 26 requirements for installation in raceways.

62.6. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

62.7. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

62.8. Where there is no alternative to supplying equipment, which is not CSA certified, submit such equipment to Inspection Authorities for special inspection and obtains approval before delivery of equipment to site. Such equipment must be individually identified in the Contractor's proposal.

62.9. Use coded conductors throughout with different coloured conductors for each phase and white wire for neutral.

62.10. Identify each wire and cable at every termination point. Identify all conduits with “neat” colour bands at no more than 7.5 m intervals and on both sides of walls and floors.

62.11. All wiring in mechanical rooms and service rooms shall be in conduit or raceway. Provide 600 mm, B-X flexible connection to input and output devices where required for servicing or to accommodate vibration.

62.12. Low voltage wiring to input and output devices from Building Controller and Application Specific Controllers is not required to be installed in conduit except as noted. Use plenum rated wire in areas used as return air plenums. Provide sleeves where wires pass through walls and floors. Support wires from structure or fixed equipment in ceiling spaces at minimum 2 m intervals.

62.13. Junction and Pull boxes shall be adequate tagged to indicate its use for DDC system. Self sticker labels with controls company logo could be used for that purpose.

63. COMMUNICATION WIRING

63.1. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run inside conduit and separately from other wiring.

63.2. All communication wiring between main Building Controller and the Operator Interface shall be installed in conduit.

63.3. Wiring between Application Specific controllers as VAV Box Controllers does not have to be in conduit except in mechanical and electrical rooms, and where direct access is not available. Use plenum rated wire in areas used as return air plenums. Provide sleeves where wires pass through

walls and floors. Support wires from structure or fixed equipment in ceiling spaces at minimum 2 m intervals.

63.4. All communication devices such as repeaters, hubs and switches shall be installed in control boxes/panels located in mechanical rooms.

63.5. All exposed connection for external communication devices such as modem; laptop; etc. shall terminate with a utility box with a face plate mounted CAT5 connector.

64. CLASS 1 WIRING

64.1. 120 V circuits shall be, at a minimum, of #12 AWG RW-90 copper. For runs over 50 m in length, use #10 AWG-RW90 copper.

64.2. All 120 V interlock wiring and power supplies for panels to be installed in conduit.

64.3. Provide 120VAC power supplies to all main DDC panels, separately circuited from all other loads.

64.4. Several Application Specific or Advanced Application Controllers may be supplied from one 120/24VAC transformer in accordance with the manufacturer's design. Only Application Specific or Advanced Application Controllers connected to the same Building Controller may be connected to a common power supply.

65. CLASS 2 WIRING

65.1. 24 VAC power to controllers shall be separated from field devices transformer.

65.2. Size and type of control wiring shall be suitable for the service for which it will be put to use and be the responsibility of this Contractor; minimum wire size #18 AWG RW-90 flexible copper with stranded conductors.

65.3. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

- circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
- all cables shall be UL listed for application, i.e. cables used in ceiling plenums shall be UL listed specifically for that purpose.

65.4. Any existing wiring considered for re-use (i.e. thermostat wiring re-use for temperature sensor) must be fully tested and verified prior to connection to new system. Any wiring deemed to not meet the project requirements must be replaced at the cost of the contractor.

65.5. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

65.6. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m [10 ft] intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 1.5 m [5 ft] intervals or more often to achieve a neat and workmanlike result.

65.7. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

65.8. Junction and Pull boxes shall be adequate tagged to indicate its use for DDC system. Self sticker labels with controls company logo could be used for that purpose.

66. INSTALLATION OF SENSORS

66.1. Install sensors in accordance with the manufacturer's recommendations.

66.2. Mount sensors rigidly and adequate for the environment within which the sensor operates.

66.3. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.

66.4. Sensors used in mixing plenums shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct with each bend supported with a capillary clip.

66.5. Immersion temperature sensors shall be installed in such a manner to allow the sensing element to be truly indicative of the medium temperature. Sensors shall be installed in wells with heat conducting compound and fastened into the well with fittings designed for the purpose.

66.6. Supply approved thermal wells of the appropriate size and type for sensing water temperatures, as required in the Points List, to the mechanical contractor for installation.

66.7. Strap-on type sensors shall be installed with thermal conducting compound and stainless steel band clamp.

66.8. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

66.9. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

66.10. Duct static pressure sensing tip shall be located so as to properly sense the static pressure in the duct without being adversely affected by changes in flow from duct fittings. Locate sensing tip a minimum straight duct length of 6 duct diameters upstream and 4 duct diameters downstream from any duct takeoff or elbow fittings.

66.11. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.

66.12. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.

66.13. Install labels on the inside covers of all room sensors identifying the point name using peel and stick labels such as the Brother labelling system.

67. INSTALLATION OF DAMPER ACTUATORS

67.1. Mount and link control damper actuators per manufacturer's instructions.

67.2. Where damper motors operate outdoor relief, exhaust and fresh air dampers, pretension damper drive linkage to ensure tight closure.

67.3. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5% open position, manually close the damper, and then tighten the linkage.

67.4. Do not install damper motors on ductwork of less than 0.76 mm thick without reinforcement.

67.5. Where a damper motor is installed on an insulated surface of a duct plenum, mount it on a stand-off bracket so as not to interfere with the continuity of the insulation.

67.6. Actuators shall be easily removed for replacement.

67.7. Locate actuators so that they are easily accessible for testing and servicing.

67.8. Damper motors shall be selected for the torque requirements of the damper. Damper operators that are undersized for the application shall be replaced with larger operators, at no extra cost.

67.9. Provide one damper motor and linkage for every 2 m2 damper section area, or as required to meet the torque requirements of the damper under design air-flow conditions (or minimum of one damper motor per damper section). Do not use two motors linked together on one shaft, or by jackshaft.

67.10. Check operation of the damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

68. INSTALLATION OF VALVE ACTUATORS

68.1. Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

69. INSTALLATION OF PHOTO-SENSORS

69.1. Install system components in accordance with manufacture’s recommendations. Mount in location and direction as directed by system manufacturer. Mount sensors such that the aperture is shielded from direct sunlight.

69.2. Typical mounting for photosensors shall be based on type, as follows:

- Indoor sensor: ceiling mounted, aperture facing toward the floor, oriented out of direct sunlight;
- Outdoor sensor: wall, soffit or conduit mounted, aperture facing toward the ground, oriented out of direct sunlight;
- Atrium sensor: wall, truss or conduit mounted, aperture facing toward the glazing;
- Skylight sensor: wall, truss or conduit mounted, aperture facing toward the glazing.

69.3. Setpoints shall be initially set to turn the lights on at 35 fc (adjustable) and off at 200 fc (adjustable).

70. INSTALLATION OF RELAYS

70.1. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

70.2. Control Relays shall be identified with permanent labels. Identifiers shall match record documents. All plug-in components shall be labelled such that removal of the component does not remove the label.

71. INSTALLATION OF CONTROLLERS

71.1. Integral VAV box controllers shall be mounted directly on the VAV damper shaft. If existing damper actuator is re-used, mount new controller on the VAV box at same location as existing.

71.2. Other equipment controllers shall be mounted inside enameled steel, fully enclosed NEMA 1 construction control cabinets with hinged door, key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.

71.3. Controllers and devices shall be conveniently spaced and neatly wired. Cables shall be accommodated inside slotted plastic wiring duct (Panduit or equivalent).

71.4. Input and output point wiring shall have an extra length of 50cm (1.5ft) for future panel retrofit.

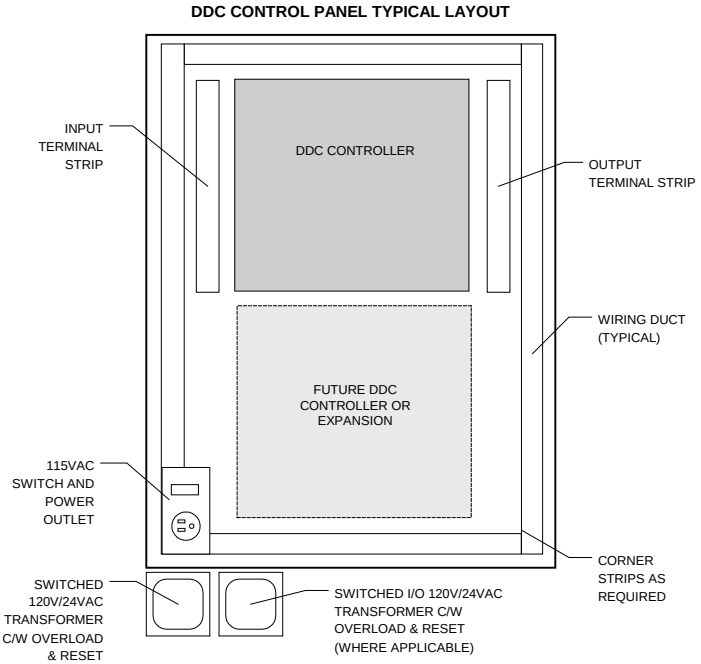
71.5. Panels shall have an additional 20% free face area space to accommodate additional control devices.

71.6. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.

71.7. All points associated with a single zone or an individual system shall be connected to the same controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.

71.8. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.

71.9. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.



71.10. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

71.11. Building Controllers shall have the I/O points powered from a separate transformer to maintain the sub-network communications over an I/O device short circuit.

72. CONTROL PANELS

72.1. Control panels shall be installed in accessible locations for ease of service.

72.2. Panels mounted inside mechanical rooms and other wall mount locations shall be mounted at 1.5m from floor.

72.3. Control panels mounted above dropped ceilings shall be located in corridors provided the resulting average wire length is less than 10m.

72.4. Control panels shall not obstruct service access to equipment.

72.5. A copy of the related as-built systems schematics, points list, and sequences of operation shall be placed inside each control panel. Points list shall be laminated and affixed inside the control panel door.

73. WARNING LABELS

73.1. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

> C A U T I O N
>
> This equipment is operating under automatic control and may start at any time without warning.

74. IDENTIFICATION OF HARDWARE AND WIRING

74.1. All wiring and cabling, including that within factory-fabricated panels, shall be labelled at each end within 2" of termination with a cable identifier. Cable identifier shall be shown on and match record documents.

74.2. Permanently label or code each point of field terminal strips to show the instrument or item served.

74.3. Identify all control panels, including interface panels (relay boxes, etc.) with minimum 1 cm letters on laminated plastic nameplates. Panel identifiers shall be shown on the record drawings indicating each contained device (controllers, relays, transducers, current sensors etc.)

74.4. Identify all other control components including control relays with permanent labels. Identifiers shall match record documents. All plug-in components shall be labelled such that removal of the component does not remove the label.

75. CONCEALED DEVICES IDENTIFICATION

75.1. Identification dots on ceiling shall be used to indicate the location of concealed devices installed above T-bar ceilings.

75.2. Dot colours shall be accordingly to existing code

END OF SECTION

25 90 01 - EMCS SEQUENCES OF OPERATION

76. GENERAL

76.1. Existing documentation is limited and some equipment/device may have not been fully addressed in this specification. Existing programs shall be copied and saved for reference during the implementation before any changes or controller replacement. Any sequences of operation missed in this specification shall initially use the existing program/sequences of operation. The sequences shall then be discussed with the consultant for final implementation.

76.2. DDC contractor shall consider that some of the sequences in this shall then be discussed with the consultant for final implementation.

76.3. Variables

All variables specified as *adjustable* or *configurable* shall be configured as system variables. Adjustable shall signify that the present value is displayed and can be modified on graphic screens whereas configurable signifies that the present value can only be modified from within the variable definition.

All "variables" specified as fixed shall be hard coded in the control programs.

76.4. Trim & Respond (T&R) Reset Routine

Trim & Respond reset where referenced in sequences of operation shall be implemented as described below.

A "Request" is a call to reset a static pressure, temperature or other setpoint, generated by downstream zones or systems. These Requests are sent upstream to the plant or system that serves the zone or system which generated the request.

For each downstream zone/system or, and for each type of setpoint reset request listed for a zone/system, provide the following software points:

- Importance Multiplier (default = 1): Used to scale the number of requests a zone/system generates. A value of zero causes the requests from a zone/system to be ignored. A value greater than one can be used to increase the number of requests from the zone/system based on the critical nature of the spaces served.
- Request-Hours: Accumulates the integral of requests (prior to adjustment of Importance Multiplier) to assist in identifying zones/systems that are driving the reset logic. Rogue zone identification is critical in this context, since a single rogue zone can keep the Trim & Response loop at maximum, and prevent it from saving energy.
- Every x minutes (default 5 min), add x/60 times the current number of requests to a request-hours accumulator (totalizer) point. The request-hours point is reset to zero upon a global command from the system/plant serving the zone/system. The global point shall simultaneously reset the request-hours point for all zones/systems served by the system/plant.
- Cumulative%-Request-Hours: This is the zone/system Request-Hours divided by the zone/system run-hours (the hours in any Mode other than Unoccupied Mode) since the last reset, expressed as a percentage.

For each upstream system or plant setpoint being controlled by a T&R, define the following variables. All variables below shall be adjustable from a reset graphic screen accessible from a link on the associated system/plant graphic. Initial values are defined in system/plant sequences.

Values for trim, respond, time interval, etc. shall be tuned to provide stable and responsive control.

Variable	Definition	Notes
SP_0	Initial setpoint	upon activation
SP_{min}	Minimum setpoint	
SP_{max}	Maximum setpoint	
Td	Delay timer	seconds or minutes
T	Time interval	seconds or minutes
I	Number of ignored requests	
R	Number of requests from zones/systems	
SP_{trim}	Trim amount	
SP_{res}	Respond amount	must be opposite in sign to SP_{trim}
$SP_{res-max}$	Maximum allowable change in setpoint per time interval	must be same sign as SP_{res}

Trim & Respond logic shall reset the setpoint within the range SPmin to SPmax. When the associated device (e.g. fan, pump) is off, the setpoint shall be SP0. The reset logic shall be active while the associated device is proven on, starting Td after initial device start command. When active, every time interval T, trim the setpoint by SPtrim. If there are more than I Requests, respond by changing the setpoint by SPres * (R-I), (i.e. the number of Requests minus the number of Ignored Requests), but no more than SPres-max.

In other words, at each time interval T:

$SP = SP - SP_{trim}$
If R>I Then
  If $SP_{res} > 0$ Then
    $SP = SP + Min((R-I) * SP_{res} , SP_{res-max})$
  Else
    $SP = SP + Max((R-I) * SP_{res} , SP_{res-max})$
  End If
End If
$SP = Limit(SP, SP_{min}, SP_{max})$

See zone and system control sequences for logic to generate and apply requests.

77. HEATING PLANT CONTROL

77.1. General

The heating plant has three 398 MBH Burnham atmospheric boilers with dedicated boiler pumps. There are four secondary pumps serving the Gym (pump P2-8, ¼ hp); Library (P2-5, ¼ hp); South Wing (P2-6, ¼ hp); and Pool (P2-9, ¾ hp). The secondary circuits serving the Library and South Wing are provided with 3-way mixing valves.

The hot water supply temperature sensor and the boilers B-1 to B-3 supply water temperatures sensors shall be replaced.

77.2. Start-up:

The heating water system shall operate based on an annual calendar allowing the boilers to be off during summer months. The heating plant shall be enabled when the outdoor air temperature is below 15°C (adjustable) for more than 30 minutes and disabled when the outdoor air temperature is above 18°C (adjustable).

77.3. Occupied Mode:

When the heating water system is enabled, the lead boiler pump shall start and operate continuously.

The boilers shall be controlled by the integral boiler thermostats and safeties. The boiler shall start and operate upon proof of water circulation by the boiler water flow switch. The lead boiler shall be alternated on a weekly basis.

Upon confirmation of pump operation, the DDC system shall start the boiler pump and enable boilers in sequence, to maintain the hot water supply water temperature setpoint. If the combustion air flow switch is not proven, the boilers shall remain off and an alarm shall be generated at the workstation.

The hot water supply temperature setpoint shall be reset according to outdoor air temperature as follows:

OAT	Supply Water Temp
-10°C (14°F)	90°C (194°F)
18°C (64°F)	60°C (140°F)

On a fill heating request from the pool heating system the heating plant supply water temperature setpoint shall be increased to 90ºC.

Enable the lead boiler when the hot water supply temperature is below setpoint.

The first stage (boiler) shall be enabled when the tot water supply temperature is below setpoint (First stage only).

Subsequent stages:

Every 2 minutes (adjustable):

Enable the next stage if the rate of temperature increase is less than 2ºC (adjustable).

If the hot water supply temperature is more than 2ºC below setpoint and the most recently added stage has been enabled for at least 5 minutes continuous, enable the next firing stage.

If the hot water supply temperature is more than 2 ºC above setpoint then disable the most recently added firing stage. If the hot water supply temperature is more than 5ºC above the setpoint for more than 5 minutes disable two stages.

A boiler failure alarm shall be issued if a boiler is enabled for more than 10 minutes and the boiler supply water temperature is less than 5ºC above the return water temperature. Upon failure of a boiler, the boiler shall be flagged as “Failed” and shall be omitted from the staging sequence until the boiler is repaired.

The DDC system shall monitor the boiler primary circuit return water temperature and enable a boiler stage if the return water temperature drops below the minimum boiler entering water temperature setpoint initially set to 50ºC (122ºF) or as recommended by the boiler manufacturer.

77.4. Morning Warm-up Mode / Cold Weather Mode:

Three (adjustable) boilers (stages) shall be enabled in Boost Mode when the system is in occupied or warm-up mode and the OAT< -5ºC (adjustable).

77.5. Unoccupied Mode

The heating plant shall operate in unoccupied mode when all systems are outside the assigned weekly schedule operating periods.

The heating plant (boilers and pumps) shall be disabled at the beginning of the unoccupied period when the outdoor air temperature is above the continuous operation setpoint initially set at 5ºC (adjustable).

The heating plant shall be enabled based on the number of systems calling for unoccupied heating (temperature in the spaces below the unoccupied temperature setpoint) initially set at 5 requests. The heating plant shall also be enabled if the return or supply water temperature decreases below 60ºC (adjustable) to avoid condensation. Once enabled, the lead heating boiler shall operate until the next occupied period.

77.6. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
High Boiler SWT (3)	Boiler SWT Sensor	> 105°C	-
Boiler Alarm (3)	Boiler Safeties		
Boiler Failure	SWT / RWT Sensor		(*)
Boiler Pump Failure	Motor status	-	-

(*) Boiler alarm shall be generated if the boiler has been enabled for more than 10 min continuously and the temperature differential is less than 2.5°C.

77.7. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms as shown in Appendix A. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

77.8. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Multitrend 1

Point	Trend Type
Outdoor air temperature	Polling
Common Supply Water Temperature	Polling
Common Supply Water Temperature Setpoint	Polling
Return Water Temperature	Polling
Boiler 1 Supply Water Temperature	Polling
Boiler 2 Supply Water Temperature	Polling
Boiler 3 Supply Water Temperature	Polling

77.9. Run Time Logs:

Run time totalizers shall be provided as follows:

Boiler Pump P-1 Status
Boiler Pump P-2 Status
Boiler Pump P-3 Status

78. P2-5 LIBRARY AND P2-6 SOUTH WING SECONDARY PUMP CONTROL

78.1. General

Secondary heating pump P2-5 (Library) and P2-6 (South Wing) circulates temperate hot water through the perimeter baseboard radiators. A 3-way valve modulates to maintain the supply water temperature.

78.2. Start-up:

The secondary heating water system for the Library and South Wing shall operate based on a weekly schedule for the spaces allowing the heating water pumps to shutdown during unoccupied periods. Pumps P2-5 and P2-6 shall run continuously if the outdoor air temperature is below 5ºC (adjustable).

78.3. Optimum Start Mode:

A heating optimum start algorithm shall be implemented to start the pumps at the latest possible time to bring the building temperature to the occupied setpoint at the beginning of occupancy.

78.4. Occupied Mode:

The hot water circulating pumps shall start during occupied periods if the outdoor temperature is lower than 18ºC (adjustable) for more than 15 minutes and disabled at +2ºC differential and on a heating request from more than (3) (adjustable) spaces.

The radiant hot water supply temperature setpoint shall be initially reset according to outdoor air temperature as follows:

OAT	Supply Water Temp
-5°C	80°C
18°C	35°C

A trim and respond algorithm shall be applied to adjust the secondary heating water setpoints, as determined by outdoor reset. The DDC shall pool the heating request at 5 minutes interval. If the heating requests are above the heating request setpoint initially set at 5 (adjustable), the reset temperature shall be increased by 1°C, else reduce the supply reset by 1°C.

Maximum and minimum supply water and outdoor air temperatures shall be adjustable at graphic screen.

78.5. Unoccupied Mode:

The secondary heating pumps shall be off at the end of the occupied period.

The pumps shall start if three (adjustable) or more spaces temperature falls below the unoccupied temperature setpoint initially set at 15ºC (adjustable) and stop when the all space temperatures are above the unoccupied temperature setpoint plus 2ºC.

78.6. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms as well as minimum and maximum setpoints temperatures and unoccupied temperature setpoint. Provide navigation buttons to main menu, associated trends and screens as well as to heating season calendar. All setpoints shall be adjustable at graphic screen.

78.7. Alarms

Alarms shall be provided as follows:

Alarm	Alarm Source	High Limit	Low Limit
Supply Water Temp. Extreme	SWT Sensor	SP + 3°C	SP - 3°C
Pump Failure	Motor status	-	-

78.8. Trends

Provide 300 sample trends, for each system, at 15-minute intervals as applicable, for the following points/variables:

Point	Trend Type
Outdoor Air Temperature	Polling
Minimum Room Temperature	Polling
Maximum Room Temperature	Polling
Unoccupied Temperature Setpoint	Polling
Sec Pump P2-x Status	Polling
Hot Water Supply Temperature	Polling
Hot Water Return Temperature	Polling
Heating Valve Command	Polling

78.9. Run Time Logs

Run time totalizers shall be provided as follows:

Pump P2-5 Status
Pump P2-6 Status

79. P2-8 GYM SECONDARY PUMP CONTROL

79.1. General

Secondary heating pump P2-8 circulates hot water through the Gym perimeter baseboard radiators.

79.2. Start-up:

The secondary heating water system for the Gym shall operate based on a weekly schedule allowing the heating water pumps to shutdown during unoccupied periods. The pump P2-8 shall run continuously if the outdoor air temperature is below 5ºC (adjustable).

79.3. Optimum Start Mode:

A heating optimum start algorithm shall be implemented to start the pump at the latest possible time to bring the Gym temperature to the occupied setpoint at the beginning of occupancy.

79.4. Occupied Mode:

The hot water circulating pump P2-8 and the New-Recep pump shall start during occupied periods if the outdoor temperature is lower than 18ºC (adjustable) for more than 15 minutes and the on a heating request from the Gym and reception spaces. The pump shall be off when the Gym and Reception is 2ºC above the temperature setpoint.

79.5. Unoccupied Mode:

The secondary heating pumps shall be off at the end of the occupied period.

The pumps shall start if the Gym or Reception temperature falls below the unoccupied temperature setpoint initially set at 15ºC (adjustable) and stop when the all space temperatures are above the unoccupied temperature setpoint plus 2ºC.

79.6. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms as well as minimum and maximum setpoints temperatures and unoccupied temperature setpoint. Provide navigation buttons to main menu, associated trends and screens as well as to heating season calendar. All setpoints shall be adjustable at graphic screen.

79.7. Alarms

Alarms shall be provided as follows:

Alarm	Alarm Source	High Limit	Low Limit
Supply Water Temp. Extreme	SWT Sensor	SP + 3°C	SP - 3°C
Pump Failure	Motor status	-	-

79.8. Trends

Provide 300 sample trends, for each system, at 15-minute intervals as applicable, for the following points/variables:

Point	Trend Type
Outdoor Air Temperature	Polling
Gym Temperature	Polling
Reception Temperature	Polling
Unoccupied Temperature Setpoint	Polling
Sec Pump P2-8 Status	Polling
Recep Pump Status	
Hot Water Supply Temperature	Polling
Hot Water Return Temperature	Polling

79.9. Run Time Logs

Run time totalizers shall be provided as follows:

Pump P2-8 Status
Recep Pump Status

80. P2-9 POOL SECONDARY PUMP CONTROL

80.1. General

Secondary heating pump P2-9 circulates hot water to the pool heating heat exchanger. A 3-way valve modulates to maintain the supply water temperature to the pool.

80.2. Start-up and Operation:

The secondary heating water system for the pool shall operate based on a heating demand for the pool as indicated by the heat exchanger valve position.

The 3-way HX mixing valve shall modulate to maintain the supply water temperature to the pool at the setpoint.

The pump P2-9 shall start when the HX valve position is above 15% and shall be off when the valve is less than 5% for more than 15 minutes. When the pump started it shall run for 5 minutes minimum run time.

A heating request shall be issued if the HX valve is fully open for more than 30 minutes (adjustable) for adjusting the boiler supply water temperature.

80.3. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms as well as minimum and maximum setpoints temperatures and unoccupied temperature setpoint. Provide navigation buttons to main menu, associated trends and screens. All setpoints shall be adjustable at graphic screen.

80.4. Alarms

Alarms shall be provided as follows:

Alarm	Alarm Source	High Limit	Low Limit
Supply Water Temp. Extreme	SWT Sensor	SP + 3^{o}C	SP - 3^{o}C
Pump Failure	Motor status	-	-

80.5. Trends

Provide 300 sample trends, for each system, at 15-minute intervals as applicable, for the following points/variables:

Point	Trend Type
Outdoor Air Temperature	Polling
Pool Water Supply Temperature	Polling
Pool Water Return Temperature	Polling
Sec Pump P2-9 Status	Polling
HX Valve position	Polling

80.6. Run Time Logs

Run time totalizers shall be provided as follows:

Pump P2-9 Status

81. SENIORS CENTRE HEATING PLANT CONTROL

81.1. General

The Senior Centre is served by and old 720 MBH Brian water tube boiler. There are three circulating pumps serving the radiant panels (pump P-1 1/3 hp); the re-heat coils in the VAV boxes (pump P-2 ¾ hp), and the unit heaters (pump P-3 1/6 hp).

All existing pneumatic hot water mixing valves and immersion temperature sensors shall be replaced.

If a Reliable Controls contractor is selected, the existing MACH-Pro controller in the Seniors Centre electrical room can be reused and shall be relocated to the Senior Centre boiler room.

81.2. Start-up:

The heating water system shall operate based on an annual calendar allowing the boilers to be off during summer months. The heating plant shall be enabled when the outdoor air temperature is below 15°C (adjustable) for more than 30 minutes and disabled when the outdoor air temperature is above 18°C (adjustable).

81.3. Occupied Mode:

When the heating plant is enabled, DDC system shall monitor the heating requests from the three systems and the status of the heating pumps P-1, P-2, and P-3. On a heating request from the spaces and upon confirmation of operation of at least two of the heating pumps, the DDC system shall enable the boiler, to maintain the hot water supply water temperature setpoint.

The boiler shall be controlled by the integral boiler thermostats and safeties. The boiler shall start and operate upon proof of water circulation by the boiler water flow switch.

The boiler shall be disabled when the heating requests from the spaces are below the setpoint of each the zones. At least one of the pumps shall operate for 15 minutes after the boiler is disabled for remaining heat dissipation.

The hot water supply temperature setpoint shall be reset according to outdoor air temperature as follows:

OAT	Supply Water Temp
-10°C (14°F)	85°C (185°F)
18°C (64°F)	60°C (140°F)

81.4. Unoccupied Mode

The boiler shall operate in unoccupied mode when the three systems are outside the assigned weekly schedule operating periods.

The boiler and pumps shall be disabled at the beginning of the unoccupied period when the outdoor air temperature is above the continuous operation setpoint initially set at 5ºC (adjustable).

The boiler shall be enabled based on the heating pumps operating in unoccupied periods. The heating plant shall also be enabled if the return or supply water temperature decreases below 60ºC (adjustable) to avoid condensation. Once enabled, the boiler and pumps shall operate until the next occupied period.

81.5. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
High Boiler SWT	Boiler SWT Sensor	> 105°C	-
Boiler Failure	SWT / RWT Sensor		(*)

(*) Boiler alarm shall be generated if the boiler has been enabled for more than 10 min continuously and the temperature differential is less than 2.5°C.

81.6. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms as shown in Appendix A. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

81.7. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Multitrend 1

Point	Trend Type
Outdoor air temperature	Polling
Boiler Supply Water Temperature	Polling
Boiler Supply Water Temperature Setpoint	Polling
Return Water Temperature	Polling

81.8. Run Time Logs:

Run time totalizers shall be provided as follows:

Boiler Enable Status

82. SENIOR CENTRE RADIANT PANELS PUMP P-1 CONTROL

82.1. General

Secondary heating pump P-1 circulates temperate hot water through the Seniors Centre radiant panels. A 3-way valve modulates to maintain the supply water temperature.

82.2. Start-up:

The heating water circulating pump shall operate based on a weekly schedule for the spaces allowing the pump to shutdown during unoccupied periods. Pumps P-1 shall run continuously if the outdoor air temperature is below 5ºC (adjustable).

82.3. Optimum Start Mode:

A heating optimum start algorithm shall be implemented to start the pumps at the latest possible time to bring the building temperature to the occupied setpoint at the beginning of occupancy.

82.4. Occupied Mode:

The hot water circulating pump shall start during occupied periods if the outdoor temperature is lower than 18ºC (adjustable) for more than 15 minutes and disabled at +2ºC differential and on a heating request from more than (3) (adjustable) spaces.

The radiant hot water supply temperature setpoint shall be initially reset according to outdoor air temperature as follows:

OAT	Supply Water Temp
-10°C	80°C
18°C	40°C

A trim and respond algorithm shall be applied to adjust the secondary heating water setpoint. The DDC shall pool the heating request at 5 minutes interval. If the heating requests are above the heating request setpoint initially set at 5 (adjustable), the reset temperature shall be increased by 1°C, else reduce the supply reset by 1°C.

Maximum and minimum supply water and outdoor air temperatures shall be adjustable at graphic screen.

82.5. Unoccupied Mode:

The secondary heating pumps shall be off at the end of the occupied period.

The pumps shall start if three (adjustable) or more spaces temperature falls below the unoccupied temperature setpoint initially set at 15ºC (adjustable) and stop when the all space temperatures are above the unoccupied temperature setpoint plus 2ºC.

82.6. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms as well as minimum and maximum setpoints temperatures and unoccupied temperature setpoint. Provide navigation buttons to main menu, associated trends and screens as well as to heating season calendar. All setpoints shall be adjustable at graphic screen.

82.7. Alarms

Alarms shall be provided as follows:

Alarm	Alarm Source	High Limit	Low Limit
Supply Water Temp. Extreme	SWT Sensor	SP + 3°C	SP - 3°C
Pump Failure	Motor status	-	-

82.8. Trends

Provide 300 sample trends, for each system, at 15-minute intervals as applicable, for the following points/variables:

Point	Trend Type
Outdoor Air Temperature	Polling
Minimum Room Temperature	Polling
Maximum Room Temperature	Polling
Unoccupied Temperature Setpoint	Polling
Sec Pump P-1 Status	Polling
Hot Water Supply Temperature	Polling
Hot Water Return Temperature	Polling
Heating Valve Command	Polling

82.9. Run Time Logs

Run time totalizers shall be provided as follows:

Pump P-1 Status

83. SENIOR CENTRE VAV RE-HEAT COIL PUMP P-2 CONTROL

83.1. General

Heating pump P-2 circulates hot water to the re-heat coils in the VAV boxes in the Seniors Centre.

83.2. Start-up:

The pump P-2 shall operate based on the weekly schedule for the spaces allowing the heating water pumps to shutdown during unoccupied periods. Pumps P-2 shall run continuously if the outdoor air temperature is below 5ºC (adjustable).

83.3. Optimum Start Mode:

A heating optimum start algorithm shall be implemented to start the pumps at the latest possible time to bring the building temperature to the occupied setpoint at the beginning of occupancy.

83.4. Occupied Mode:

The hot water circulating pumps shall start during occupied periods if the outdoor temperature is lower than 18ºC (adjustable) for more than 15 minutes and disabled at +2ºC differential and on a heating request from more than (3) (adjustable) spaces.

The radiant hot water supply temperature setpoint shall be initially reset according to outdoor air temperature as follows:

OAT	Supply Water Temp
-10°C	80°C
18°C	35°C

A trim and respond algorithm shall be applied to adjust the secondary heating water setpoint. The DDC shall pool the heating request at 5 minutes interval. If the heating requests are above the heating request setpoint initially set at 5 (adjustable), the reset temperature shall be increased by 1°C, else reduce the supply reset by 1°C.

Maximum and minimum supply water and outdoor air temperatures shall be adjustable at graphic screen.

83.5. Unoccupied Mode:

The secondary heating pump shall be off at the end of the occupied period. The pump shall start if the air handling unit serving the area starts in unoccupied heating mode.

83.6. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms as well as minimum and maximum setpoints temperatures and unoccupied temperature setpoint. Provide navigation buttons to main menu, associated trends and screens as well as to heating season calendar. All setpoints shall be adjustable at graphic screen.

83.7. Alarms

Alarms shall be provided as follows:

Alarm	Alarm Source	High Limit	Low Limit
Supply Water Temp. Extreme	SWT Sensor	SP + 3°C	SP - 3°C
Pump Failure	Motor status	-	-

83.8. Trends

Provide 300 sample trends, for each system, at 15-minute intervals as applicable, for the following points/variables:

Point	Trend Type
Outdoor Air Temperature	Polling
Sec Pump P-2 Status	Polling
Hot Water Supply Temperature	Polling
Hot Water Return Temperature	Polling

83.9. Run Time Logs

Run time totalizers shall be provided as follows:

Pump P-2 Status

84. AC-1 AUDITORIUM AIR HANDLING UNIT CONTROL

84.1. General

AC-1 is a constant volume rooftop unit with mixing dampers, 2-stage DX cooling coil, modulating gas fired burner, and supply fan serving the Auditorium.

A carbon dioxide (CO_2) transmitter shall be installed to measure the air handling unit return air CO_2 concentration level (ppm). Occupancy sensors shall be installed in the auditorium to control the air handling unit. A new space temperature sensor shall be provided with override option.

Override button shall be provided in room temperature sensor for extended operation hours. Setpoint adjustment range at the temperature sensor shall be limited to 17ºC to 22ºC (adjustable)

84.2. Start-up:

The air handling unit(s) shall operate during occupied hours based on an auditorium specific weekly schedule subject to the global holiday calendar.

Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation. On a supply fan failure alarm, the mixing dampers shall be set to full recirculation.

84.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

84.4. Occupied Mode:

The supply fan shall run continuously during occupied periods.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband).

The economizer mode shall be enabled when the outdoor air is 3ºC below the room temperature, and disabled when the outdoor air temperature is 1ºC below the room temperature. When the economizer is disabled the mixing dampers shall move to the existing minimum outdoor air damper position (adjustable). The mixing damper position shall be overridden to maintain a minimum mixed air temperature of 10°C (configurable).

First stage mechanical cooling shall be enabled when the room temperature is 1ºC above the cooling setpoint. Second stage shall be enabled if the first stage is enabled for more than 5 minutes and room temperature is 1ºC above the cooling setpoint.

Second stage mechanical cooling shall be disabled when the room temperature reaches the cooling setpoint. The first stage cooling shall be disabled when the room temperature drops 1ºC below the cooling setpoint.

A staging delay of 5 minutes (fixed) shall be applied to both the enabling and disabling of DX stages to avoid compressor short cycling.

Mechanical cooling shall be locked out if the outdoor air temperature is below the outdoor air lockout setpoint initially set at 16ºC (adjustable)

Coincident with activation of any DX stage, the mixing dampers shall be set to minimum outdoor air damper position and a damper output ramp shall be initiated. The damper ramp shall increase from minimum damper output at a rate of 1% (fixed) per second. The mixing dampers shall be controlled to the lesser of a DX leaving air temperature low limit control loop with a setpoint of 12°C (configurable) and the damper ramp.

The heating shall be enabled if the room temperature is 1ºC below the occupied heating temperature setpoint. Once enabled a 0-10VDC signal (control loop) to the C-TRAC3 integral burner controller shall reset the supply air temperature setpoint from 12.8ºC to 35ºC (C-TRAC3 settings to be confirmed) to maintain the occupied heating space temperature setpoint.

The heating shall be enabled only if the mechanical cooling is disabled and after the mixing dampers have moved to the minimum air damper position as reset by the demand control ventilation.

84.5. Demand Control Ventilation:

The DDC system shall maintain acceptable CO_2 levels in the space during occupied periods by modulating the outdoor air damper to control the return air CO_2 concentration.

Minimum outdoor air damper position shall be reset by a CO_2 control loop subject to a lower limit of 5%. The maximum damper position shall be set at 50%

The return air CO_2 concentration setpoint shall be 900 ppm (adjustable).

84.6. Standby Mode:

During occupied periods when occupancy has not been detected in the room for more than 15 minutes continuous the air handling unit shall be placed in standby mode. When in standby mode the supply fan shall shutdown and the mixing dampers shall be set to full recirculation.

The standby setpoint shall be an offset of +/- 1.5 °C (adjustable) from the occupied temperature setpoint. If the room temperature is above or below the standby temperature setpoint, the supply fan shall start and cycle within 1°C differential subject to a minimum 15 min "off" time. Unit operation shall be same as occupied mode except that mixing dampers shall be allowed to fully close when not in economizer mode.

When occupancy has not been detected for more than 2 hours (adjustable), the supply fan shall start and operate for 15 minutes (adjustable) to provide ventilation air to space. Unit operation shall be same as if in occupied mode, but to maintain the room standby setpoint temperature.

When occupancy (motion) is detected in the room for more than 2 min (adjustable) the unit shall start and operate in occupied mode.

84.7. Unoccupied Mode:

During unoccupied mode the supply fan shall be off and the outdoor air damper closed.

The unit shall start in full recirculation mode if the space temperature falls below the unoccupied temperature setpoint of 15ºC (adjustable). The unit shall stop when the space temperature increases 2ºC above the unoccupied temperature setpoint.

Upon activation of the override pushbutton the unit shall operate in occupied mode for a period of 120 minutes (adjustable).

84.8. Purge Mode:

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 °C (fixed) or more above the occupied setpoint and the outdoor air temperature is at least 5°C (fixed) below the occupied temperature setpoint. During purge mode gas burner and DX cooling shall be disabled.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (configurable).

The system shall revert to unoccupied mode when the space temperature falls below the occupied temperature setpoint or after a maximum of 2 hours of purge operation. Purge mode operation shall be limited to one instance per day.

84.9. Alarms

Provide the following alarms:

Alarm	**Alarm Source**	**High Limit**	**Low Limit**
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 3°C
Low Mixed Air Temperature	MAT Sensor	-	< 6°C
Supply Fan failure	Fan Motor status	-	-
Supply Temperature Extreme	SAT Sensor	> 45°C	< 10°C
High CO2 Concentration	CO2 Sensor	SP+200ppm	-
Filter Status	Filter Press Switch	Existing	-
Cooling failure (*)	Supply Air Temp	RMT - 4ºC	-
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(*) Cooling failure alarm shall be generated if the unit has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4ºC below the room temperature.
(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

A calibration warning shall be generated if the return air CO2 concentration is below 400 ppm (fixed) or above 1,200 ppm (fixed).

84.10. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

84.11. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	**Trend Type**
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Room Temperature	Polling
Mixing Damper Command	Polling
Return Air CO2 Concentration	Polling

Trend 2:

Point	**Trend Type**
Room Temperature	Polling
Supply Air Temperature	Polling
Occupancy Status	Polling
DX Command Stage 1	Polling
DX Command Stage 2	Polling
Heating Command	Polling

84.12. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Fan Status
DX Command Stage 1
DX Command Stage 2
Heating Enable

85. AC-2 MAIN AND BASEMENT AIR HANDLING UNIT CONTROL

85.1. General

AC-2 is a constant volume rooftop unit with mixing dampers, 2-stage DX cooling coil, modulating gas fired burner, and supply fan serving spaces in the main floor and basement.

Radiant heaters are provided for the Staff Room 110; Games Room 106; Offices 111A and 118 B; Coordinator Office 112 in the main floor and for the Music Room 014; Crafts Room 013; and Boardroom 005 in the basement.

An override pushbutton shall be provided in the staff room temperature sensor for extended operating hours.

Setpoint adjustment range at the staff room temperature sensor shall be limited to 20ºC to 24ºC (adjustable). Temperature sensors for remaining rooms shall not have setpoint adjustment or override provisions.

85.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation. On a supply fan failure alarm, the mixing dampers shall be set to full recirculation.

85.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

85.4. Occupied Mode:

The supply fan shall run continuously during occupied periods.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband)

The economizer mode shall be enabled when the outdoor air is 3ºC below the average room temperature, and disabled when the outdoor air temperature is 1ºC below the average room temperature. When the economizer is disabled the mixing dampers shall move to the existing minimum outdoor air damper position of 15% (adjustable). The mixing damper position shall be overridden to maintain a minimum mixed air temperature of 10°C (configurable).

First stage mechanical cooling shall be enabled when the average room temperature is more than 1ºC above the cooling setpoint. Second stage shall be enabled if the first stage is enabled for more than 5 minutes and average room temperature is 1ºC or more above the cooling setpoint.

Second stage mechanical cooling shall be disabled when the room temperature reaches the cooling setpoint. The first stage cooling shall be disabled when the room temperature drops 1ºC below the cooling setpoint.

A staging delay of 5 minutes (fixed) shall be applied to both the enabling and disabling of DX stages to avoid compressor short cycling.

Mechanical cooling shall be locked out if the outdoor air temperature is below the outdoor air lockout setpoint, 16ºC (adjustable)

Coincident with activation of any DX stage, the mixing dampers shall be set to minimum outdoor air damper position and a damper output ramp shall be initiated. The damper ramp shall increase from minimum damper output at a rate of 1% (fixed) per second. The mixing dampers shall be controlled to the lesser of a DX leaving air temperature low limit control loop with a setpoint of 12°C (configurable) and the damper ramp.

The baseboard heaters shall be used as a first stage of heating. The baseboard heating valve shall open when the room temperature is 1ºC below the room occupied heating temperature setpoint and close at the temperature setpoint.

A heating request shall be issued for each room if the space temperature variance is greater than 2ºC (adjustable).

The unit gas burner shall be enabled when two or more space temperatures have been 2ºC (adjustable) or more below the occupied heating temperature setpoint for 15 minutes.

The heating shall only be enabled if the mechanical cooling is disabled and after the mixing dampers have moved to the minimum air damper position.

Once enabled a 0-10VDC signal (control loop) to the C-TRAC3 integral burner controller shall reset the supply air temperature setpoint from 12.8ºC to 35ºC (C-TRAC3 settings to be confirmed) to maintain the occupied heating temperature setpoint.

The gas burner shall be disabled when all the room temperature are at the occupied heating temperature setpoint.

85.5. Unoccupied Mode:

During unoccupied mode the supply fan shall be off and the outdoor air damper closed.

The unoccupied temperature setpoint shall be set initially 15ºC (adjustable). The unoccupied temperature setpoint shall be primarily maintained in each room by the baseboard heaters.

The unit shall start in full recirculation mode if the space temperatures in three or more zones are 3ºC below the unoccupied temperature setpoint. The heating shall be disabled fan shall stop when not more than one space temperature is below the unoccupied temperature setpoint + 2°C.

Override button in the staff room temperature sensor shall allow the unit to operate in occupied mode for 120 minutes (adjustable).

85.6. Purge Mode:

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 °C (fixed) or more above the occupied setpoint and the outdoor air temperature is at least 5°C (fixed) below the occupied temperature setpoint. During purge mode gas burner and DX cooling shall be disabled.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (configurable).

The system shall revert to unoccupied mode when the space temperature falls below the occupied temperature setpoint or after a maximum of 2 hours of purge operation. Purge mode operation shall be limited to one instance per day.

85.7. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 3°C
Low Mixed Air Temperature	MAT Sensor	-	< 6°C
Supply Fan failure	Fan Motor status	-	-
Supply Temperature Extreme	SAT Sensor	> 45°C	< 10°C
Filter Status	Filter Press Switch	Existing	-
Cooling failure (*)	Supply Air Temp	RMT - 4ºC	-
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(*) Cooling failure alarm shall be generated if the unit has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4ºC below the room temperature.
(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

85.8. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

85.9. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:
Trend 1:

Point	Trend Type
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Average Room Temperature	Polling
Mixing Damper Command	Polling

Trend 2:

Point	Trend Type
Room Temperature	Polling
Supply Air Temperature	Polling
DX Command Stage 1	Polling
DX Command Stage 2	Polling
Heating Command Stage 1	Polling
Heating Command Stage 2	Polling

Trend 2:

Point	Trend Type
Staff Room 110 Temperature	Polling
Games Room 106 Temperature	Polling
Office 111A Temperature	Polling
Office 118 B Temperature	Polling
Coord. Office 112 Temperature	Polling
Music Room 014 Temperature	Polling
Crafts Room 013 Temperature	Polling
Boardroom 005 Temperature	Polling

85.10. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Air Fan Status
DX Command Stage 1
DX Command Stage 2
Heating Enable

86. AC-3 LOBBY AIR HANDLING UNIT CONTROL

86.1. General

AC-3 is a constant volume rooftop unit with fixed outdoor air dampers, 2-stages DX cooling, gas fired burner, supply fan serving the lobby and offices areas. The existing damper actuator shall be replaced and controlled by the DDC system.

Radiant heaters are provided for the Play Area (105); Reception (107); and Offices 109 and 109A.

Setpoint adjustment and override button shall be provided for the temperature sensor located in the Lobby 102 or another temperature sensor (to be confirmed by staff). Setpoint adjustment range at the temperature sensor shall be limited to 20ºC to 24ºC (adjustable)

86.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation. On a supply fan failure alarm, the mixing dampers shall be set to full recirculation.

86.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

86.4. Occupied Mode:

The supply fan shall run continuously during occupied periods.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband). The heating setpoint for all the radiant heaters shall be the same as the rooftop unit heating setpoint.

The economizer mode shall be enabled when the outdoor air is 3ºC below the average room temperature, and disabled when the outdoor air temperature is 1ºC below the average room temperature. When the economizer is disabled the mixing dampers shall move to the existing minimum outdoor air damper position (adjustable). The mixing damper position shall be overridden to maintain a minimum mixed air temperature of 10°C (configurable).

First stage mechanical cooling shall be enabled when the average room temperature is 1ºC above the cooling setpoint. Second stage shall be enabled if the first stage is enabled for more than 5 minutes and the average room temperature is still 1ºC above the cooling setpoint.

Mechanical cooling shall be locked out if the outdoor air temperature is below the outdoor air lockout setpoint initially set at 16ºC (adjustable)

Coincident with activation of any DX stage, the mixing dampers shall be set to minimum outdoor air damper position and a damper output ramp shall be initiated. The damper ramp shall increase from minimum damper output at a rate of 1% (fixed) per second. The mixing dampers shall be controlled to the lesser of a DX leaving air temperature low limit control loop with a setpoint of 12°C (configurable) and the damper ramp.

The minimum outdoor air damper position currently set at 15%.

A staging delay of 5 minutes (fixed) shall be applied to both the enabling and disabling of DX stages to avoid compressor short cycling.

The baseboard heaters shall be used as a first stage of heating. The baseboard heating valve shall open when the room temperature is 1ºC below the room occupied heating temperature setpoint and close at the room temperature setpoint.

The baseboard heaters shall be used as a first stage of heating. The baseboard heating valve shall open when the room temperature is 1ºC below the room occupied heating temperature setpoint and close at the temperature setpoint.

A heating request shall be issued for each room if the space temperature variance is greater than 2ºC (adjustable).

The unit gas heater first stage shall be enabled if two or more space temperatures drop 2ºC (adjustable) below the occupied heating temperature setpoint for more than 15 minutes. Second stage shall be enabled if the first stage is enabled for more than 5 minutes and two or more space temperatures are still 2ºC below the heating setpoint.

The gas heater shall be disabled when all the room temperature are at the occupied heating temperature setpoint.

The heating shall be enabled only if the mechanical cooling is disabled and after the mixing dampers have moved to the minimum air damper position.

86.5. Unoccupied Mode:

During unoccupied mode the supply fan shall be off and the outdoor air damper closed.

The unoccupied temperature setpoint shall be primarily maintained in each room by the baseboard heaters. The unoccupied temperature setpoint shall be set initially 15ºC (adjustable).

The unit shall start in full recirculation mode if the space temperature falls below the unoccupied temperature setpoint of 15ºC (adjustable). The unit shall stop when the space temperature increases 2ºC above the unoccupied temperature setpoint.

Override button shall be provided in the Lobby 102 temperature sensor to allow the unit to operate in occupied mode for an extended period of 120 minutes (adjustable).

86.6. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 3°C
Low Mixed Air Temperature	MAT Sensor	-	< 6°C
Supply Fan failure	Fan Motor status	-	-
Supply Temperature Extreme	SAT Sensor	> 45°C	< 10°C
Filter Status	Filter Press Switch	Existing	-
Cooling failure (*)	Supply Air Temp	RMT - 4ºC	-
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(*) Cooling failure alarm shall be generated if the unit has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4ºC below the room temperature.
(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

86.7. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

86.8. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	Trend Type
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Room Temperature	Polling
Mixing Damper Command	Polling

Trend 2:

Point	Trend Type
Room Temperature	Polling
Supply Air Temperature	Polling
DX Command Stage 1	Polling
DX Command Stage 2	Polling
Heating Command Stage 1	Polling
Heating Command Stage 2	Polling

86.9. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Air Fan Status
DX Command Stage 1
DX Command Stage 2
Heating Command Stage 1
Heating Command Stage 2

87. AC-4 (EXERCISE) and AC-5 (WEIGHT) ROOMS AIR HANDLING UNIT CONTROLS

87.1. General

AC-4 and AC-5 are constant volume rooftop units with mixing dampers, 1-stage DX cooling coil, gas fired burner, and supply fan serving the Exercise and Weight Rooms in the basement.

Override button shall be provided in the Exercise and Weight Rooms temperature sensor for extended operation hours. Setpoint adjustment range at the temperature sensors shall be limited to 17ºC to 24ºC (adjustable)

87.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar. Exhaust fan EF-10 and Washroom exhaust fan be interlocked with AC-4 and AC-5 rooftop units and operate when any of the units is operating.

Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation. On a supply fan failure alarm, the mixing dampers shall be set to full recirculation.

87.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

87.4. Occupied Mode:

The AHU-4, AHU-5 supply fans and the exhaust fans EF-10 and Washroom Exhaust Fan shall run continuously during occupied periods.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband)

The economizer mode shall be enabled when the outdoor air is 3ºC below the room temperature, and disabled when the outdoor air temperature is 1ºC below the room temperature. When the economizer is disabled the mixing dampers shall move to the existing minimum outdoor air damper position (adjustable). The mixing damper position shall be overridden to maintain a minimum mixed air temperature of 10°C (configurable).

Mechanical cooling shall be enabled when the room temperature is 1ºC above the cooling setpoint and disabled at the nominal setpoint. A delay of 5 minutes (fixed) shall be applied to both the enabling and disabling the mechanical cooling to avoid compressor short cycling.

Mechanical cooling shall be locked out if the outdoor air temperature is below the outdoor air lockout setpoint initially set at 16ºC (adjustable)

Coincident with activation of the mechanical cooling, the mixing dampers shall be commanded to the minimum outdoor air damper position.

On a call for heating the DDC system shall enable and cycle the unit gas heater to maintain the room occupied heating temperature setpoint.

The heating shall be enabled only if the mechanical cooling is disabled and after the mixing dampers have moved to the minimum air damper position.

87.5. Unoccupied Mode:

During unoccupied mode the supply fan and exhaust fans shall be off and the AHUs outdoor air damper closed.

The unit shall start in full recirculation mode if the space temperature falls below the unoccupied temperature setpoint of 15ºC (adjustable). The unit shall stop when the space temperature increases 2ºC above the unoccupied temperature setpoint.

Override button shall be provided in the temperature sensor to allow the unit to operate in occupied mode for an extended period of 120 minutes (adjustable).

87.6. Purge Mode:

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 ºC (fixed) or more above the occupied setpoint and the outdoor air temperature is at least 5°C (fixed) below the occupied temperature setpoint. During purge mode gas burner and DX cooling shall be disabled.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (configurable).

The system shall revert to unoccupied mode when the space temperature falls below the occupied temperature setpoint or after a maximum of 2 hours of purge operation. Purge mode operation shall be limited to one instance per day.

87.7. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 3°C
Low Mixed Air Temperature	MAT Sensor	-	< 6°C
Supply Fan failure	Fan Motor status	-	-
Supply Temperature Extreme	SAT Sensor	> 45°C	< 10°C
Filter Status	Filter Press Switch	Existing	-
Cooling failure (*)	Supply Air Temp	RMT - 4ºC	-
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(*) Cooling failure alarm shall be generated if the unit has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4ºC below the room temperature.
(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

87.8. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

87.9. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	Trend Type
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Room Temperature	Polling
Mixing Damper Command	Polling

Trend 2:

Point	Trend Type
Room Temperature	Polling
Supply Air Temperature	Polling
Occupancy Status	Polling
DX Command Stage 1	Polling
DX Command Stage 2	Polling
Heating Command	Polling

87.10. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Air Fan Status
DX Command Stage 1
DX Command Stage 2
Heating Command

88. AC-6, AC-7 and AC-8 MULTIUSE AIR HANDLING UNITS CONTROLS

88.1. General

AC-6 serving Multiuse room 109, AC-7 serving Activity Room 226, and AC-8 serving Multiuse Room 222 are constant volume rooftop units with mixing dampers, DX cooling coil, gas fired burner, and supply fan.

A carbon dioxide (CO_2) transmitter shall be installed to measure the air handling unit return air CO_2 concentration level (ppm). Occupancy sensors shall be installed in the rooms to control the air handling unit.

Override button shall be provided in room temperature sensor for extended operation hours. Setpoint adjustment range at the temperature sensor shall be limited to 18ºC to 24ºC (adjustable)

88.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation. On a supply fan failure alarm, the mixing dampers shall be set to full recirculation.

88.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

88.4. Occupied Mode:

The supply fan shall run continuously during occupied periods.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband)

The economizer mode shall be enabled when the outdoor air is 3ºC below the room temperature, and disabled when the outdoor air temperature is 1ºC below the room temperature. When the economizer is disabled the mixing dampers shall move to the existing minimum outdoor air damper position (adjustable). The mixing damper position shall be overridden to maintain a minimum mixed air temperature of 10°C (configurable).

Mechanical cooling shall be enabled when the room temperature is 1ºC above the cooling setpoint and disabled at the nominal setpoint. A delay of 5 minutes (fixed) shall be applied to both the enabling and disabling the mechanical cooling to avoid compressor short cycling.

Mechanical cooling shall be locked out if the outdoor air temperature is below the outdoor air lockout setpoint initially set at 16ºC (adjustable)

Coincident with activation of the mechanical cooling, the mixing dampers shall be commanded to the minimum outdoor air damper position.

The baseboard heaters shall be used as a first stage of heating. The baseboard heating valve shall open when the room temperature is 1ºC below the room occupied heating temperature setpoint and close at the temperature setpoint.

A heating request shall be issued for each room if the space temperature variance is greater than 2ºC (adjustable).

The unit gas heater shall be enabled if the room temperature drops 2ºC (adjustable) below the occupied heating temperature setpoint for more than 15 minutes. The gas heater shall be disabled when all the room temperature are at the occupied heating temperature setpoint.

The heating shall be enabled only if the mechanical cooling is disabled and after the mixing dampers have moved to the minimum air damper position as reset by the demand control ventilation.

88.5. Demand Control Ventilation:

The DDC system shall maintain acceptable CO_2 levels in the space during occupied periods by modulating the outdoor air damper to control the return air CO_2 concentration.

Minimum outdoor air damper position shall be reset by a CO_2 control loop subject to a lower limit of 5%. The maximum damper position shall be set at 50%

The return air CO_2 concentration setpoint shall be 900 ppm (adjustable).

88.6. Standby Mode:

During occupied periods when occupancy has not been detected in the room for more than 15 minutes continuous the air handling unit shall be placed in standby mode. When in standby mode the supply fan shall shutdown and the mixing dampers shall be set to full recirculation.

The standby setpoint shall be an offset of +/- 1.5 °C (adjustable) from the occupied temperature setpoint. If the room temperature is above or below the standby temperature setpoint, the supply fan shall start and cycle within 1°C differential subject to a minimum 15 min “off” time. Unit operation shall be same as occupied mode except that mixing dampers shall be allowed to fully close when not in economizer mode.

When occupancy has not been detected for more than 2 hours (adjustable), the supply fan shall start and operate for 15 minutes (adjustable) to provide ventilation air to space. Unit operation shall be same as if in occupied mode, but to maintain the room standby setpoint temperature.

When occupancy (motion) is detected in the room for more than 2 min (adjustable) the unit shall start and operate in occupied mode.

88.7. Unoccupied Mode:

During unoccupied mode the supply fan shall be off and the outdoor air damper closed.

The unoccupied temperature setpoint shall be primarily maintained in each room by the baseboard heaters. The unoccupied temperature setpoint shall be set initially 15ºC (adjustable).

The rooftop unit shall start in full recirculation mode if the temperature in the space served by the rooftop unit decrease 2ºC below the unoccupied temperature setpoint. The air handling unit shall stop when the space temperature increase 2ºC above the unoccupied temperature setpoint.

Override button shall be provided in the room temperature sensor. Upon activation of the override pushbutton the unit shall operate in occupied mode for a period of 120 minutes (adjustable).

88.8. Purge Mode:

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 °C (fixed) or more above the occupied setpoint and the outdoor air temperature is at least 5°C (fixed) below the occupied temperature setpoint. During purge mode gas burner and DX cooling shall be disabled.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (configurable).

The system shall revert to unoccupied mode when the space temperature falls below the occupied temperature setpoint or after a maximum of 2 hours of purge operation. Purge mode operation shall be limited to one instance per day.

88.9. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 3°C
Low Mixed Air Temperature	MAT Sensor	-	< 6°C
Supply Fan failure	Fan Motor status	-	-
Supply Temperature Extreme	SAT Sensor	> 45°C	< 10°C
CO2 Concentration	CO2 Sensor	SP+200ppm	350ppm
Filter Status	Filter Press Switch	Existing	-
Cooling failure (*)	Supply Air Temp	RMT - 4ºC	-
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(*) Cooling failure alarm shall be generated if the unit has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4ºC below the room temperature.
(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

A calibration warning shall be generated if the CO2 concentration in the [return][supply] air is below 400 ppm or above 1,200 ppm.

88.10. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

88.11. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	Trend Type
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Room Temperature	Polling
Mixing Damper Command	Polling
Return Air CO2 Concentration	Polling

Trend 2:

Point	Trend Type
Room Temperature	Polling
Supply Air Temperature	Polling
Occupancy Status	Polling
DX Command Stage 1	Polling
Heating Command	Polling

88.12. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Air Fan Status
DX Command Stage 1
Heating Enable

89. AC-9 KARATE and CORE & STRETCH AIR HANDLING UNIT CONTROL

89.1. General

AC-9 is a constant volume rooftop unit with mixing dampers, 1-stage DX cooling coil, gas fired burner, and supply fan serving the Karate (015) and Core & Stretch (016) rooms in the basement.

Occupancy sensors shall be installed in both rooms for standby control.

Override button shall be provided in room temperature sensor for extended operation hours. Setpoint adjustment range at the temperature sensor shall be limited to 17ºC to 22ºC (adjustable)

89.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation. On a supply fan failure alarm, the mixing dampers shall be set to full recirculation.

89.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

89.4. Occupied Mode:

The supply fan shall run continuously during occupied periods.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband)

The economizer mode shall be enabled when the outdoor air is 3ºC below the room temperature, and disabled when the outdoor air temperature is 1ºC below the room temperature. When the economizer is disabled the mixing dampers shall move to the existing minimum outdoor air damper position (adjustable). The mixing damper position shall be overridden to maintain a minimum mixed air temperature of 10°C (configurable).

Mechanical cooling shall be enabled when the room temperature is 1ºC above the cooling setpoint and disabled at the nominal setpoint. A delay of 5 minutes (fixed) shall be applied to both the enabling and disabling the mechanical cooling to avoid compressor short cycling.

Mechanical cooling shall be locked out if the outdoor air temperature is below the outdoor air lockout setpoint initially set at 16ºC (adjustable)

Coincident with activation of the mechanical cooling, the mixing dampers shall be commanded to the minimum outdoor air damper position.

The baseboard heater shall be used as a first stage of heating. The baseboard heating valve shall open when the room temperature is 1ºC below the room occupied heating temperature setpoint and close at the temperature setpoint.

A heating request shall be issued for each room if the space temperature variance is greater than 2ºC (adjustable).

The unit gas heater shall be enabled any room temperatures drops 2ºC (adjustable) below the occupied heating temperature setpoint for more than 15 minutes. The gas heater shall be disabled when all the room temperatures are at the occupied heating temperature setpoint.

The heating shall be enabled only if the mechanical cooling is disabled and after the mixing dampers have moved to the minimum air damper position.

89.5. Standby Mode:

During occupied periods when occupancy has not been detected in any of the rooms for more than 15 minutes continuous the air handling unit shall be placed in standby mode. When in standby mode the supply fan shall shutdown and the mixing dampers shall be set to full recirculation.

The standby setpoint shall be an offset of +/- 1.5 °C (adjustable) from the occupied temperature setpoint. If the room temperature is above or below the standby temperature setpoint, the supply fan shall start and cycle within 1°C differential subject to a minimum 15 min “off” time. Unit operation shall be same as occupied mode except that mixing dampers shall be allowed to fully close when not in economizer mode.

When occupancy has not been detected for more than 2 hours (adjustable), the supply fan shall start and operate for 15 minutes (adjustable) to provide ventilation air to space. Unit operation shall be same as if in occupied mode, but to maintain the room standby setpoint temperature.

When occupancy (motion) is detected in the room for more than 2 min (adjustable) the unit shall start and operate in occupied mode.

89.6. Unoccupied Mode:

During unoccupied mode the supply fan shall be off and the outdoor air damper closed.

The unit shall start in full recirculation mode if the space temperature falls below the unoccupied temperature setpoint of 15ºC (adjustable). The unit shall stop when the space temperature increases 2ºC above the unoccupied temperature setpoint.

Override button shall be provided in the room temperature sensor. Upon activation of the override pushbutton the unit shall operate in occupied mode for a period of 120 minutes (adjustable).

89.7. Purge Mode

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 °C (fixed) or more above the occupied setpoint and the outdoor air temperature is at least 5°C (fixed) below the occupied temperature setpoint. During purge mode gas burner and DX cooling shall be disabled.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (configurable).

The system shall revert to unoccupied mode when the space temperature falls below the occupied temperature setpoint or after a maximum of 2 hours of purge operation. Purge mode operation shall be limited to one instance per day.

89.8. Alarms

Provide the following alarms:

Alarm	**Alarm Source**	**High Limit**	**Low Limit**
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 3°C
Low Mixed Air Temperature	MAT Sensor	-	< 6°C
Supply Fan failure	Fan Motor status	-	-
Supply Temperature Extreme	SAT Sensor	> 45°C	< 10°C
Filter Status	Filter Press Switch	Existing	-
Cooling failure (*)	Supply Air Temp	RMT - 4ºC	-
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(*) Cooling failure alarm shall be generated if the unit has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4ºC below the room temperature.
(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

89.9. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

89.10. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	**Trend Type**
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Room Temperature	Polling
Mixing Damper Command	Polling

Trend 2:

Point	**Trend Type**
Room Temperature	Polling
Supply Air Temperature	Polling
Occupancy Status	Polling
DX Command Stage 1	Polling
DX Command Stage 2	Polling
Heating Command	Polling

89.11. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Air Fan Status
DX Command Stage 1
DX Command Stage 2
Heating Enable

90. AC-10 MULTIPURPOSE ROOM 221 AIR HANDLING UNIT CONTROL

90.1. General

AC-10 is a constant volume rooftop unit with mixing dampers, 1-stage DX cooling coil, gas fired burner, and supply fan serving the Multipurpose Room 221 and Activity Rooms 217 to 220.

Radiant heating with temperature control is provided for all the spaces

Occupancy sensor shall be installed in the multipurpose room 221 for standby control.

Override button shall be provided in the multipurpose room 221 temperature sensor for extended operation hours. Setpoint adjustment range at the temperature sensor shall be limited to 20ºC to 24ºC (adjustable)

90.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation. On a supply fan failure alarm, the mixing dampers shall be set to full recirculation.

90.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

90.4. Heating Request:

A heating request shall be issued for each room if the space temperature variance is greater than 2ºC (adjustable).

90.5. Occupied Mode:

The supply fan shall run continuously during occupied periods.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband)

The economizer mode shall be enabled when the outdoor air is 3ºC below the average room temperature, and disabled when the outdoor air temperature is 1ºC below the average room temperature.

When the economizer is disabled the mixing dampers shall move to the existing minimum outdoor air damper position (adjustable). The mixing damper position shall be overridden to maintain a minimum mixed air temperature of 10°C (configurable).

Mechanical cooling shall be enabled when the average room temperature is 1ºC above the cooling setpoint. A delay of 5 minutes (fixed) shall be applied to both the enabling and disabling the mechanical cooling to avoid compressor short cycling.

Mechanical cooling shall be locked out if the outdoor air temperature is below the outdoor air lockout setpoint initially set at 16ºC (adjustable)

Coincident with activation of the mechanical cooling, the mixing dampers shall be commanded to the minimum outdoor air damper position.

The baseboard heaters shall be used as a first stage of heating. The baseboard heating valve shall open when the room temperature is 1ºC below the room occupied heating temperature setpoint and close at the temperature setpoint.

A heating request shall be issued for each room if the space temperature variance is greater than 2ºC (adjustable).

The unit gas heater shall be enabled if two or more space temperatures drop 2ºC (adjustable) below the occupied heating temperature setpoint for more than 15 minutes. The gas heater shall be disabled when all the room temperature are at the occupied heating temperature setpoint.

The heating shall be enabled only if the mechanical cooling is disabled and after the mixing dampers have moved to the minimum air damper position.

90.6. Standby Mode:

The activities rooms 217 to 220 are small and with very few occupants. Most of the ventilation air is provided to the multipurpose room 221. The minimum damper position is currently set at 25%.

During occupied periods when occupancy has not been detected in the multipurpose room 221 for more than 15 minutes continuous the air handling unit shall be placed in standby mode. When in standby mode the rooftop unit shall operate same as in occupied mode but the mixing dampers shall be allowed to move to the standby damper position initially set at 10% (adjustable)

When occupancy (motion) is detected in room 221 for more than 2 min (adjustable) the unit shall operate in occupied mode.

90.7. Unoccupied Mode:

During unoccupied mode the supply fan shall be off and the outdoor air damper closed.

The unoccupied temperature setpoint shall be set initially 15ºC (adjustable). The unoccupied temperature setpoint shall be primarily maintained in each room by the baseboard heaters.

The rooftop unit shall start in full recirculation mode if the space temperatures for three or more zones are 3ºC below the unoccupied temperature setpoint. The heating shall be disabled fan shall stop when not more than one space temperature is below the unoccupied temperature setpoint + 2°C.

Override button shall be provided in the temperature sensor. Upon activation of the override pushbutton the unit shall operate in occupied mode for a period of 120 minutes (adjustable).

90.8. Purge Mode

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 °C (fixed) or more above the occupied setpoint and the outdoor air temperature is at least 5°C (fixed) below the occupied temperature setpoint. During purge mode gas burner and DX cooling shall be disabled.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (configurable).

The system shall revert to unoccupied mode when the space temperature falls below the occupied temperature setpoint or after a maximum of 2 hours of purge operation. Purge mode operation shall be limited to one instance per day.

90.9. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 3°C
Low Mixed Air Temperature	MAT Sensor	-	< 6°C
Supply Fan failure	Fan Motor status	-	-
Supply Temperature Extreme	SAT Sensor	> 45°C	< 10°C
Filter Status	Filter Press Switch	Existing	-
Cooling failure (*)	Supply Air Temp	RMT - 4ºC	-
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(*) Cooling failure alarm shall be generated if the unit has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4ºC below the room temperature.
(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

90.10. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

90.11. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	Trend Type
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Room Temperature	Polling
Mixing Damper Command	Polling

Trend 2:

Point	Trend Type
Room Temperature	Polling
Supply Air Temperature	Polling
Occupancy Status	Polling
DX Command Stage 1	Polling
DX Command Stage 2	Polling
Heating Command	Polling

90.12. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Air Fan Status
DX Command Stage 1
DX Command Stage 2
Heating Enable

91. POTTERY SUPPLY FAN AND HEATING CONTROL

91.1. General

Pottery Room 002, located in the basement, is served by a supply air system provided with a hot water heating coil and a relief air damper. An existing occupancy sensor controls the fan operation.

91.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

Freezestat shall shutdown the supply fan and close the relief damper

91.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

A heating request shall be issued for the room if the space temperature variance is greater than 2ºC (adjustable).

91.4. Occupied / Standby Mode:

Occupancy sensor is installed in the Pottery Room for standby operation.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband)

When occupancy (motion) is detected for more than 2 min (adjustable) the fan shall start and operate continuously to maintain the room temperature setpoint (cooling or heating operation)

The heating coil valve shall modulate to maintain the supply air temperature setpoint from 15ºC to 35ºC (adjustable) as reset by the room setpoint.

During occupied periods when occupancy has not been detected in the Pottery Room for more than 15 minutes continuous the supply fan shall be off and relief damper closed.

The standby setpoint shall be an offset of +/- 1.5 °C (adjustable) from the occupied temperature setpoint. If the room temperature is above or below the standby temperature setpoint, the supply fan shall start and cycle within 1°C differential subject to a minimum 15 min “off” time. Unit operation shall be same as occupied mode.

When the room is not in use for more than 2 hours (adjustable), the supply fan shall start and operate for 15 minutes (adjustable) to provide ventilation air to space. Unit operation shall be same as if in occupied mode, but to maintain the room standby setpoint temperature.

Low limit temperature thermostat with manual reset (freezestat) installed after the heating coil is hardwired to shutdown the supply air fan. The freezestat auxiliary contact shall indicate an alarm to the DDC system. On freezestat alarm the DDC system shall shutdown the supply fan, close the relief air damper, and modulate the heating coil valve to maintain 10ºC supply air temperature.

91.5. Unoccupied Mode:

During unoccupied mode the supply fan shall be off and the relief air damper closed.

If the room temperature decreases below the unoccupied temperature setpoint initially set at 15ºC (adjustable) the supply fan shall start and the heating valve shall fully open. The supply fan shall stop and the heating valve closes with a 2ºC room temperature differential. The relief damper shall remain closed during unoccupied operation

91.6. Purge Mode

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 °C (fixed) or more above the occupied setpoint and the outdoor air temperature 5°C below the occupied temperature setpoint. During purge mode the relief damper shall open and heating shall be closed.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (adjustable)

The system shall revert to unoccupied mode when the space temperature is equal or less than the occupied temperature setpoint or after a maximum 2h purge operation. Purge mode operation shall be limited to one instance per day

91.7. Alarms

Provide the following alarms:

Alarm	**Alarm Source**	**High Limit**	**Low Limit**
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 3°C
Supply Fan failure	Fan Motor status	-	-
Supply Temperature Extreme	SAT Sensor	> 45°C	< 10°C
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

91.8. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

91.9. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	Trend Type
Outdoor Air Temperature	Polling
Supply Air Temperature	Polling
Room Temperature	Polling
Occupancy Status	Polling
Heating Coil Valve Position	Polling

91.10. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Air Fan Status

92. HV-I SENIORS AIR HANDLING UNIT CONTROL

92.1. General

HV-I serving the Seniors Centre is a variable volume air handling unit with mixing air dampers, 3-stage DX cooling coil, hot water heating coil, and supply air fan equipped with variable frequency drive.

DDC points currently wired to MACH-Pro controller in the boiler mechanical room shall be relocated to the new HV-I controller located in the air handling unit mechanical room.

Existing heating coil valve with pneumatic actuator shall be replaced with a valve with electronic actuator selected for the same water flow and CV as existing.

92.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule for the Seniors Centre subject to the global holiday calendar.

When the unit is enabled, the supply fan variable frequency drives shall be started at low speed and gradually ramp up to the required speed. Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be annunciate at the operator workstation. On a supply fan failure alarm, the mixing dampers shall be set to full recirculation.

92.3. Heating Request:

A heating request shall be issued for each room if the space temperature variance is greater than 2ºC (adjustable).

92.4. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

92.5. Occupied Mode:

The supply fan shall run continuously during occupied periods.

For each VAV zone served by the system, zone temperature high variance shall be determined as the lesser of:

- the number of degrees by which the space temperature exceeds the space temperature setpoint; and
- the number of degrees by which the space temperature exceeds the zone temperature high limit established for the system of 23°C (adjustable)

and shall be limited to positive values. *Consequently, a high variance will exist only when zone temperature is above both the space temperature setpoint and the zone temperature high limit.*

The economizer shall be enabled when the outdoor air temperature is 2°C (fixed) below the return air temperature for more than 15 minutes. The economizer shall be disabled when the outdoor air temperature is equal to the return air temperature. When the economizer is disabled the mixing dampers shall move to the existing minimum outdoor air damper position (adjustable). The mixing damper position shall be overridden to maintain a minimum mixed air temperature of 10°C (configurable).

Mechanical cooling shall be enabled when the average space temperature high variance for three or more spaces reaches 2ºC (adjustable). Mechanical cooling shall be locked out if the outdoor air temperature is below the outdoor air lockout setpoint initially set at 16ºC (adjustable)

Coincident with activation of any DX stage, the mixed air dampers shall be set to minimum outdoor air damper position and a damper output ramp shall be initiated. The damper ramp shall increase from minimum damper output at a rate of 1% per second. The mixing dampers shall be controlled to the lesser of a DX leaving air temperature low limit control loop with a setpoint of 12°C and the damper ramp.

A staging delay of 5 minutes shall be applied to both the enabling and disabling of DX stages to avoid compressor short cycling.

The heating coil valve shall modulate open only when the mixing dampers have moved to the commanded minimum outside air damper position. Minimum outdoor air damper position shall be set as per each existing air handling unit settings.

The heating coil pump shall start and run continuously on a heating coil valve command above 15%. The heating coil pump shall stop when the heating coil valve is closed for 10 minutes continuously. The pump shall run continuously when the outdoor air temperature is below 3°C.

92.6. Supply Static Pressure Control / Critical Zone Reset

The air handling unit supply static pressure setpoint shall be reset by a trim and respond routine from the VAV boxes as follows:

Each VAV zone shall set a pressure reset request when the VAV box damper has been fully open for 5 minutes continuous and the flow is less than 95% of flow setpoint, otherwise the request shall be set to zero. All zone importance multipliers shall initially be set to a value of 1.

SP_0	SP_{min}	SP_{max}	Td	T	I	SP_{trim}	SP_{res}	$SP_{res\text{-}max}$
300 Pa	150 Pa	400 Pa	5 min	10 min	1	10 Pa	5 Pa	25 Pa

The magnitude of the static pressure reset shall be adjusted during the commissioning based on analysis of trend data. The minimum supply fan VFD speed shall be reset as required to maintain

the DX leaving air temperature low limit setpoint of 12ºC when the mechanical cooling is enabled.

92.7. Unoccupied Mode:

During unoccupied mode the supply and return fans shall be off, the outdoor air damper and relief air dampers closed. The return air damper shall be in the fully open in re-circulation position.

When the outdoor air temperature is below 4°C, the heating coil valve shall modulate to maintain a minimum mixed air temperature of 10°C. When the outdoor air temperature is above 4°C the heating coil valve shall be closed.

The supply fan shall start and with the heating valve fully open if the space temperature of three or more zones are below the unoccupied temperature setpoint of 15°C (adjustable). The fan shall stop and the heating valve closes when not more than one space temperature is below NSB + 2°C.

Override button shall be provided in the office temperature sensor to allow the unit to operate in occupied mode for an extended period of 120 minutes (adjustable).

92.8. Purge Mode

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 °C (fixed) or more above the occupied setpoint and the outdoor air temperature is at least 5°C (fixed) below the occupied temperature setpoint. During purge mode the heating valve shall be closed and mechanical cooling disabled.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (configurable).

The system shall revert to unoccupied mode when the space temperature falls below the occupied temperature setpoint or after a maximum of 2 hours of purge operation. Purge mode operation shall be limited to one instance per day.

92.9. Alarms

Provide the following alarms:

Alarm	**Alarm Source**	**High Limit**	**Low Limit**
Supply Temperature Extreme	SAT Sensor	> 35°C	< 10°C
Low Mixed Air Temperature	MAT Sensor	-	< 6°C
Supply Fan failure	Fan Motor status	-	-
Duct Static Pressure Extreme	Duct Press. Sensor	SP +50 Pa	-
Heating Coil Pump Failure	Motor status		
Filter Status	Filter Press Switch	Existing	-
Cooling failure (*)	Supply Air Temp	RMT - 4ºC	-
Heating Failure (**)	Supply Air Temp	RMT + 4ºC	-

(*) Cooling failure alarm shall be generated if the unit has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4ºC below the room temperature.
(**) Heating failure alarm shall be generated if the unit has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4ºC above the room temperature.

Adequate time delay shall be provided to avoid nuisance alarms caused by changes of state or normal temperature recovery period.

92.10. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms including the number static pressure request from the VAV boxes.

The AHU graphic screen shall include a link to an associated Static Pressure Reset graphic screen that includes display of each of nine configuration variables together with labels displaying the variable definitions.

Provide navigation buttons to main menu, associated trends and screens. All setpoints shall be adjustable at graphic screen.

92.11. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	**Trend Type**
AHU Supply Static Pressure	Polling
AHU Supply Static Pressure Setpoint	Polling
Number of Starved Boxes	Polling
Supply Fan VFD Command	Polling
Supply Air Temperature	Polling

Trend 2:

Point	**Trend Type**
Average Space Temperature	Polling
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Supply Air Temperature Setpoint	Polling
Heating Coil Valve Command	Polling

Trend 2:

Point	**Trend Type**
Outdoor Air Temperature	Polling
Supply Air Temperature	Polling
Mixed Air Temperature	Polling
DX Cooling Stage 1	Polling
DX Cooling Stage 2	Polling

DX Cooling Stage 3	Polling

92.12. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Air Fan Status
DX Cooling Stage 1 Command
DX Cooling Stage 2 Command
DX Cooling Stage 3 Command
Heating Coil Pump Status

93. VAV BOX WITH RE-HEAT COIL CONTROL

93.1. General

There are twelve VAV boxes with re-heat coil installed in the Seniors Centre spaces served by HV-I. VAV boxes shall be identified as per base building drawings.

Space temperature sensors / network thermostats shall be mounted at the same locations as the existing temperature sensor. If an incorrect location is found during installation, the sensor shall be relocated to the appropriate location as discussed with the consultant.

Room temperature setpoints shall be set based on a nominal setpoint. Cooling setpoint shall be set as +1ºC and the heating setpoint as -1ºC of the nominal setpoint (2ºC deadband)

The temperature sensor shall provide setpoint adjustment allowing occupants to adjust the zone temperature setpoint. Setpoint adjustment range at the temperature sensor shall be limited to 24^{o}C to 21^{o}C (+/- 1.5^{o}C) (adjustable)

The maximum and minimum airflow setpoint shall be set as per existing DDC settings. Maximum and minimum airflow setpoints shall be default variables in the program code and shown on the graphic screen allowing building operator override adjustment and automatic restoration to default settings.

Existing re-heat valves with pneumatic actuators shall be replaced with valves with electronic actuators. Size and CV as per table at the end of this specification.

93.2. Start-up:

VAV boxes shall operate during occupied hours based on the occupancy schedule for the area served by the boxes. VAV boxes shall be grouped according to occupancy areas. The building operator shall be able to set separate schedules for each occupancy group.

93.3. Morning Warm-up Mode / Optimal Start:

VAV boxes shall operate in occupied mode when the associated air handling unit is in optimal start. Minimum box flow rates shall not apply.

93.4. Heating Request:

A heating request shall be issued for each room if the space temperature variance is greater than 2ºC (adjustable).

93.5. Occupied Mode:

The VAV box shall be controlled by the associated zone temperature sensor.

Room occupied temperature setpoint default shall be initially set at 22.5°C. This setpoint shall be adjustable at operator workstation graphic screen. The occupant shall be able to reset the local setpoint from 24°C to 21°C (+/- 1.5°C).

If the room temperature increases above the occupied cooling temperature setpoint, the DDC controller shall modulate the VAV damper from the minimum to the maximum airflow setting as required to maintain the cooling occupied temperature set point.

If the room temperature decreases below the occupied heating temperature setpoint the VAV controller shall modulate the damper to maintain the minimum airflow setting and then the re-heat coil valve to maintain the required occupied heating temperature setpoint. VAV control loop shall be commissioned to avoid cycling between cooling and heating.

The air handling unit static pressure setpoint shall be reset by a trim and respond algorithm. Each VAV zone shall set a pressure reset request when the VAV box damper has been fully open for 5 minutes continuous and the flow is less than 90% of flow setpoint, otherwise the request shall be set to zero.

All zone importance multipliers shall initially be set to a value of 1.

93.6. Standby Mode:

The VAV boxes provided with occupancy sensor shall be placed in Standby Mode during occupied periods when occupancy has not been detected in the space for more than 15 min (adjustable) continuous.

When in standby mode, the space temperature shall be allowed to drift up to 1.5ºC from setpoint and the minimum flow rates on VAV boxes serving perimeter areas shall be overridden allowing the dampers to fully close. Heating, subject to available capacity, would be provided by the radiant panels.

VAV boxes shall be programmed for a periodic flush of 15 minutes when in standby mode for an period of 4 hours (adjustable) to provide ventilation air to space as if in occupied mode, but to maintain the room standby setpoint temperature.

When occupancy (motion) is detected in the room for more than 2 min (adjustable) the VAV box shall change its operation to occupied mode and run for a minimum of 30 min (adjustable).

93.7. Unoccupied Mode:

During unoccupied periods the VAV damper and re-heat coil valve shall be closed.

Room unoccupied temperature setpoint default shall be initially set at 15°C. This setpoint shall be adjustable at operator workstation graphic screen.

If the temperature in three (3) VAV zones (adjustable) decrease below the unoccupied temperature setpoint (night setback), the DDC system shall enable the VAV box in occupied mode and start the associated air handling unit supply fan. The supply fan shall stop when the minimum zone temperature reaches 18°C.

93.8. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
Space Temperature Extreme	RMT Sensor	SP + 3°C	SP - 5°C
Heating Valve Leak	SAT Sensor	(1)	

(1) Heating Valve Leak alarm shall be generated if the heating valve is commanded closed for more than 10 minutes continuous and the box supply air temperature is +5^{o}C higher than the primary air (AHU supply) temperature.

93.9. System Graphics

VAV box graphic screens shall indicate all related inputs, outputs, and setpoints including occupied and unoccupied temperatures; minimum and maximum airflow, as well as alarms and starved box indication.

A graphic screen, with tabular format, grouping all VAV boxes served by the associated air handling unit shall be created.

The table shall include: VAV box identification; VAV damper position; actual air flow; minimum and maximum airflow setpoints; supply air temperature; re-heat valve command; room temperature; room temperature setpoint, requested-hours totalizer; importance multiplier;

The graphic screen shall include the AHU identification, air handling unit supply air temperature and setpoint;

The VAV summary graphic screen shall include a Request-Hours reset button to clear all associated Request-Hours totalizers.

Links in the graphic screen shall direct to specifics VAV graphic screen; VAV trend logs; to the associated AHU; and to an associated AHU Static Pressure Reset graphic screen that includes display of each of nine configuration variables together with labels displaying the variable definitions.

Floor plan graphic screens shall be created for the Seniors Centre indicating the area served by each VAV box, including space temperature and setpoint. All setpoints shall be adjustable at graphic screen

93.10. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Point	**Trend Type**
Room Temperature	Polling
Room Temperature Setpoint	Polling
VAV Damper Command	Polling
Actual VAV Airflow	Polling
Re-Heat Coil Valve Command	Polling
VAV Box Supply Temperature	Polling

93.11. Starved Box Totalizer

Provide starved box time totalizer for every VAV box. Totalizer shall indicate the number of hours of a VAV box is starved during occupied period. The totalizer shall be reset automatically at the 1st day of the month.

94. HV-1 NATATORIUM AIR HANDLING UNIT CONTROL

94.1. General

HV-1 is a constant volume air handling unit with mixing dampers, gas fired burner, supply fan and return fan serving the Natatorium. A wall mounted exhaust fan and intake air dampers installed on the opposite wall provides flush air during chlorine wash procedures.

94.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

When the unit is enabled, the supply fan shall start. Subject to a 30 second delay the return fan shall start. Once supply fan operation is confirmed the outdoor air damper shall slowly ramp to its minimum position. If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation.

A push-button override switch shall be installed in the pool office for operate the RTU supply fan and the exhaust fan in full outdoor air ventilation during pool chlorine wash. The return fan shall be off during this period.

Door switches shall be installed at the exterior doors to disable the heating if the doors are left open for more than 15 minutes.

94.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

94.4. Occupied Mode:

The supply and return fans shall run continuously during occupied periods.

The heating burner and mixing dampers shall modulate in sequence (split range control) to maintain supply air temperature setpoint as reset by the room temperature setpoint.

The heating shall be enabled if the room temperature is 1ºC below the occupied heating temperature setpoint. Once enabled a 0-10VDC signal (control loop) to the C-TRAC3 integral burner controller shall reset the supply air temperature setpoint from 12.8ºC to 35ºC (C-TRAC3 settings to be confirmed) to maintain the occupied heating temperature setpoint.

A humidity control loop shall override the temperature control opening the outdoor air damper position (mixing dampers) if the humidity in the pool increases limited to a minimum space temperature of 20ºC (adjustable).

The mixing damper positions shall be overridden to maintain a minimum mixed air temperature of 10°C (fixed).

The economizer mode shall be enabled when the outdoor air is 3ºC below the room temperature.

There is no mechanical cooling. The rooftop unit shall operate at 100% ventilation when the space temperature exceeds the outdoor air temperature. The pool intake dampers shall open and the exhaust fan run continuously if the space temperature exceeds the outdoor air temperature plus 2ºC.

94.5. Pool Exhaust Fan:

The exhaust fans shall be disabled when the outdoor air temperature is below the exhaust fan lockout temperature setpoint initially set at15ºC.

The pool intake dampers shall open and the exhaust fan run for 120 minutes (adjustable) during pool chlorine wash if the push-button override switch installed in the pool office ventilation is pressed.

94.6. Unoccupied Mode:

During unoccupied mode the HV-1 supply/ return fans and the exhaust fan shall be off and the outdoor air dampers closed.

The HV unit shall start in full heating if the space temperature is below the unoccupied temperature setpoint initially set at 12ºC (adjustable). The heating shall be disabled and fan shall stop when the space temperature increases 3ºC above the unoccupied temperature setpoint.

94.7. Purge Mode:

The air handling unit shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2°C or more above the occupied setpoint and the outdoor air temperature is at least 5°C below the occupied setpoint. Purge Mode shall be locked-out if the outdoor air temperature is less than 12ºC (adjustable)

During purge mode outdoor air dampers shall be fully open. Heating valves shall remain closed.

The system shall revert to unoccupied mode when the space temperature is equal to or less than the occupied temperature setpoint. Purge mode operation shall be limited to one instance per day

94.8. Alarms

Provide the following alarms:

Alarm	**Alarm Source**	**High Limit**	**Low Limit**
Space Temperature Extreme	Space Temp Sensor	SP + 3ºC(*)	SP - 5ºC
Supply Temperature Extreme	Supply Temp Sensor	45ºC	10ºC
Low Mixed Air Temperature	MAT Sensor	-	< 4°C
Supply Fan failure	Fan Motor Status	-	-

(*) When heating is enabled – There is no mechanical cooling

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

94.9. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms.

Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

94.10. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1: HV-1 System

Point	Trend Type
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Mixing Damper Command	Polling
Heating Command	Polling
Supply Fan Status	Polling

94.11. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Fan Status
Return Fan Status
Exhaust Fan Status

Totalizers shall be reset on an annual basis or as commanded by the building operator.

95. HV-2 POOL OFFICE HEAT RECOVERY UNIT CONTROL

95.1. General

HV-2 is a constant volume heat recovery unit with air-to-air heat exchanger, bypass dampers, gas fired burner, supply fan and exhaust fan serving the Pool Office.

A new DDC controller shall be installed inside the unit control panel and wired to existing DJM controller as per points list in this specification. The DJM controller settings shall be adjusted for supply air temperature reset by the DDC system.

A modulating bypass damper allows the unit to operate in full economizer, with outdoor air bypassing the air-to-air heat exchanger. Existing bypass damper actuator shall be replaced.

95.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

When the unit is enabled, the supply and exhaust fans shall start. If proper operation is not established after a timed delay an alarm shall be annunciated at the operator workstation.

95.3. Morning Warm-up / Optimal Start:

The system shall incorporate a heating and cooling optimal start routine that shall start the unit at the latest possible time to have the space at the setpoint at the weekly schedule start times.

The outdoor air damper shall be allowed to fully close during the warm-up period.

The optimal start period shall be limited to a maximum two hours operation.

95.4. Occupied Mode:

The supply and exhaust fans shall run continuously during occupied periods.

The bypass damper and heating burner shall modulate in sequence (split range control) to maintain supply air temperature setpoint as reset by the room temperature setpoint.

The heating shall be enabled if the room temperature is 1ºC below the occupied heating temperature setpoint. Once enabled a 0-10VDC signal (control loop) to the integral burner

controller shall reset the supply air temperature setpoint from 12.8ºC to 35ºC (settings to be confirmed) to maintain the occupied heating temperature setpoint.

95.5. Unoccupied Mode:

During unoccupied mode the HV-2 supply/ exhaust fans shall be off and the bypass air damper closed.

The HV-2 unit shall start in full heating mode if the space temperature falls below the unoccupied temperature setpoint of 12ºC (adjustable). The heating shall be disabled and fan shall stop when the space temperature increases 2ºC above the unoccupied temperature setpoint.

During this period the bypass damper shall remain closed.

95.6. Purge Mode:

The system shall operate in purge mode during unoccupied periods between 3:00AM and 5:00AM if the space temperature is 2 °C (fixed) or more above the occupied setpoint and the outdoor air temperature is at least 5°C (fixed) below the occupied temperature setpoint.

During purge mode gas burner shall be disabled.

Purge Mode shall be disabled if the outdoor air temperature is less than 12ºC (configurable).

The system shall revert to unoccupied mode when the space temperature falls below the occupied temperature setpoint or after a maximum of 2 hours of purge operation. Purge mode operation shall be limited to one instance per day.

95.7. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
Space Temperature Extreme	Space Temp Sensor	SP + 3ºC(*)	SP - 5ºC
Supply Temperature Extreme	Supply Temp Sensor	45ºC	10ºC
Supply Fan Failure	Fan Motor Status	-	-
Exhaust Fan Failure	Fan Motor Status	-	-

(*) When heating is enabled – There is no mechanical cooling

95.8. System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms.

Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

95.9. Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1: HV-2 Temperatures

Point	Trend Type
Entering Outdoor Air Temperature	Polling
Entering Exhaust Air Temperature	Polling

Supply Air Temperature	Polling
Supply Air Temperature Setpoint (Reset)	Polling
Bypass Damper Command	Polling
Heating Command	Polling

95.10. Run Time Logs

Run time totalizers shall be provided as follows:

Supply Fan Status
Exhaust Fan Status
Heating Command

Totalizers shall be reset on an annual basis or as commanded by the building operator.

96. URINAL VALVE CONTROL

96.1. General

Occupancy sensors are provided in the basement washrooms and change room for control the urinal valves. Occupancy sensors and solenoid valve are connected to a controller as indicated in the points list

96.2. Operation:

The urinal valves shall operate during occupied hours based on a weekly schedule subject to the global holiday calendar.

The DDC system will monitor the occupancy in the spaces.

When motion is detected in the space for more than 3 minutes a flush variable shall be set. The urinal valve shall then open for 5 minutes (configurable) when occupancy is no longer detected or 10 minutes (configurable) after the flush variable is set.

97. LIBRARY RADIANT HEATING CONTROL

97.1. General

The DDC system shall be extended to the Library radiant heating valves and exhaust fan.

There are three existing baseboard heating valves serving the North, West and the South zones. The zones are currently controlled by three thermostats installed on the columns.

An exhaust fan is installed in the South window and is manually controlled. Hand operate windows provide ventilation to the space.

97.2. Start-up:

The air handling unit(s) shall operate in occupied hours based on a system specific weekly schedule subject to the global holiday calendar.

The radiant heaters shall be disabled based on the outdoor air temperature lockout for the heating plant.

97.3. Morning Warm-up Mode / Optimum Start:

The system shall incorporate an optimum start heating routine that will enable the heating units at the latest possible time to have the space at occupied setpoint at the start of occupancy.

The optimal start shall be limited to a maximum two hours operation.

97.4. Heating Request:

A heating request shall be issued for the room if the space temperature variance is greater than 2ºC (adjustable).

97.5. Occupied Mode:

During occupied periods the baseboard radiant heating valves shall cycle as required to maintain the occupied temperature setpoint with 1ºC (adjustable) temperature offset (open at SP-1 and close at SP). A single setpoint shall control all three radiant heaters.

The exhaust fan shall be enabled when the average room temperature is above the outdoor air temperature limited to a minimum outdoor air lockout of 15ºC.

97.6. Unoccupied Mode:

During unoccupied mode heating valves shall be closed and the exhaust fan off.

To avoid issues with temperature recovering from the unoccupied setpoint, a higher unoccupied temperature setpoint shall be used on colder nights.

The radiant heating and unit heaters valves shall cycle to maintain the unoccupied temperature setpoint as reset by the outdoor air temperature. The unoccupied temperature setpoint shall be reset from 15ºC to 20ºC as the outdoor air temperature varies from 12ºC to 5ºC. Upper and lower ranges shall be adjustable in the graphic screens. The heating valve shall open at the unoccupied temperature setpoint and closes at NSB_SP+2ºC.

97.7. Alarms

Provide the following alarms:

Alarm	Alarm Source	High Limit	Low Limit
Space Temperature Extreme	Space Temp Sensor	SP + 3°C (*)	SP - 5°C

(*) When heating is enabled – There is no mechanical cooling

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

97.8. System Graphics

Baseboard radiant heaters and unit heaters shall be indicated on the floor plan graphic screen with room temperature, room temperature setpoint, and heating valve position, and runtime total. Provide navigation buttons to main menu, associated trends and associated screens.

97.9. Trends

Provide 300 sample trends, at 15 minutes intervals as applicable for each of the rooms, for the following points/variables:

Point	Trend Type
Average Room Temperature	Polling
Room Temperature Setpoint	Polling
Heating Valve 1 Command	Polling
Heating Valve 2 Command	Polling
Heating Valve 3 Command	Polling

97.10. Run Time Logs

Run time totalizers shall be provided for each heating valve as follows:

Heating Valve 1 Command
Heating Valve 2 Command
Heating Valve 3 Command

Totalizers shall be reset on an annual basis or by command by the building operator.

98. EXTERNAL LIGHTS CONTROL

98.1. General

The DDC system controls the Parking and the Gym external lights. Currently the lights are controlled by weekly schedule.

An outdoor photosensor shall be provided and wired to the Seniors Centre DDC controller to control the lights.

Setpoints shall be set to turn the lights on at 35 fc (adjustable) and off at 200 fc (adjustable).

99. RELOCATE THE GYM OCCUPANCY OVERRIDE SWITCH

99.1. General

The lights in the Gym are directly controlled by occupancy sensors. A standard wall switch is provided to override the occupancy sensor. There is no tagging at this switch and it is prone to being switched resulting in lights staying on.

The override switch shall be relocated to inside the electric room and correctly tagged. A blank stainless steel cover plate shall be installed to cover the existing box.

END OF SECTION

25 90 02 - DDC POINTS LIST

BOILER ROOM – (CP#2)

Point	Label	Point Description	Device	Comments
xx-IP1	KER_B1_S	Boiler B-1 Status	-	Existing
xx-IP2	KER_BP1_S	Boiler Pump BP-1 Status	-	Existing
xx-IP3	KER_B2_S	Boiler B-2 Status	-	Existing
xx-IP4	KER_BP2_S	Boiler Pump BP-2 Status	-	Existing
xx-IP5	KER_B3_S	Boiler B-3 Status	-	Existing
xx-IP6	KER_BP3_S	Boiler Pump BP-3 Status	-	Existing
xx-IP7	KER_BLR_HWST	Boiler Common Supply Water Temperature	TSP1	Replace
xx-IP8	KER_BLR_COMB_S	Boiler Comb Status	-	Existing
xx-IP9	KER_P2-5_S	Sec Pump P-2-5 Status	-	Existing
xx-IP10	KER_P2-6_S	Sec Pump P-2-6 Status	-	Existing
xx-IP11	KER_P2-8_S	Sec Pump P-2-8 Status	-	Existing
xx-IP12	KER_P2-9_S	Sec Pump P-2-9 Status	-	Existing
xx-IP13	KER_SW_HWST	South Wing Supply Water Temperature	TSP1	Replace
xx-IP14	KER_SW_HWRT	South Wing Return Water Temperature	TSP1	Replace
xx-IP15	KER_LIB_HWST	Library Supply Water Temperature	TSP1	Replace
xx-IP16	KER_LIB_HWRT	Library Return Water Temperature	TSP1	Replace
xx-IP17	KER_GYM_HWST	Gym Supply Water Temperature	TSP1	New
xx-IP18	KER_GYM_HWRT	Gym Return Water Temperature	TSP1	New
xx-IP19	KER_POOL_HX_HWST	Pool HX Supply Water Temperature	TSP1	New
xx-IP20	KER_POOL_HX_HWRT	Poll HX Return Water Temperature	TSP1	New
xx-IP21	KER_DHW_P_S	DHW Circulating Pump Status	-	Existing
xx-IP22	KER_B1_LW_ALM	Boiler B-1 Low Water Alarm	-	Existing
xx-IP23	KER_B1_SWT	Boiler B-1 Supply Water Temperature	TSP1	Replace
xx-IP24	KER_B2_LW_ALM	Boiler B-2 Low Water Alarm	-	Existing
xx-IP25	KER_B2_SWT	Boiler B-2 Supply Water Temperature	TSP1	Replace
xx-IP26	KER_B3_LW_ALM	Boiler B-3 Low Water Alarm	-	Existing
xx-IP27	KER_B3_SWT	Boiler B-3 Supply Water Temperature	TSP1	Replace
xx-IP28	KER_SW_HV_FB	South Wing Heating Valve Position	-	Existing
xx-IP29	KER_LIB_HV_FB	Library Heating Valve Position	-	Existing
xx-IP30	KER_REC-P_S	Reception Pump Status	-	Existing
xx-OP1	KER_B1_C	Boiler B-1 Command	-	Existing
xx-OP2	KER_BP1_C	Boiler Pump BP-1 Command	-	Existing
xx-OP3	KER_B2_C	Boiler B-2 Command	-	Existing
xx-OP4	KER_BP2_C	Boiler Pump BP-2 Command	-	Existing
xx-OP5	KER_B3_C	Boiler B-3 Command	-	Existing
xx-OP6	KER_BP3_C	Boiler Pump BP-3 Command	-	Existing
xx-OP7	KER_P2-5_C	Sec Pump P-2-5 Command	-	Existing
xx-OP8	KER_P2-6_C	Sec Pump P-2-6 Command	-	Existing
xx-OP9	KER_P2-8_C	Sec Pump P-2-8 Command	-	Existing
xx-OP10	KER_P2-9_C	Sec Pump P-2-9 Command	-	Existing
xx-OP11	KER_SW_HTG_C	South Wing Heating Valve Command	-	Existing
xx-OP12	KER_LIB_HTG_C	Library Heating Valve Command	-	Existing
xx-OP13	KER_DHW_P_C	DHW Circulating Pump Command	-	Existing
xx-OP14	KER_PHC_EF_C	Photo Copier Room Exhaust Command	-	Existing
xx-OP15	KER_REC-P_C	Reception Pump Command	-	Existing

CP# 2B4 - AC-1 – Auditorium

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC1_SF_S	AC-1 Supply Fan Status	-	Existing
xx-IP2	KER_AC1_SAT	AC-1 Supply Air Temperature	-	Existing
xx-IP3	KER_AC1_MAT	AC-1 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC1_FIL_S	AC-1 Filter Status	-	Existing
xx-IP5	KER_ AC1_CO2	AC-1 Auditorium Return Air CO2	CO2D	NEW
xx-IP6	KER_ AC1_OAT	AC-1 Outdoor Air Temperature	-	Existing
xx-IP7	KER_ AC1_OCC	AC-1 Auditorium Occupancy	OS1	NEW
Network	KER_ RM107_RT	Auditorium Room 107 Temperature	TSR4	NEW
xx-OP1	KER_AC1_SF_C	AC-1 Supply Fan Command	-	Existing
xx-OP2	KER_AC1_MAD_C	AC-1 Mixing Damper Command	-	Existing
xx-OP3	KER_AC1_HTG_C	AC-1 Gas Heating Command	-	Existing
xx-OP4	KER_AC1_CLG1_C	AC-1 DX Cooling Stage-1 Command	-	Existing
xx-OP5	KER_AC1_CLG2_C	AC-1 DX Cooling Stage-2 Command	-	Existing
xx-OP6	KER_AC1_HTG_RST	AC-1 Gas Heating Reset	-	Existing

AC-2 – Main and Basement Floors (relocate from existing CP# 2B1 and 2B6)

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC2_SF_S	AC-2 Supply Fan Status	-	Existing
xx-IP2	KER_AC2_SAT	AC-2 Supply Air Temperature	-	Existing
xx-IP3	KER_AC2_MAT	AC-2 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC2_FIL_S	AC-2 Filter Status	-	Existing
xx-IP5	KER_ CORR_RT	Main Level Corr Temperature	-	Remove
xx-IP6	KER_ RM106_RT	Games Room RM-106 Temperature	TSR	Replace
xx-IP7	KER_ RM111B_RT	Office RM-111B Temperature	TSR	Replace
xx-IP8	KER_ RM111A_RT	Office RM-111A Temperature	TSR	Replace
xx-IP9	KER_ RM112_RT	Co-Ord Office RM-112 Temperature	TSR	Replace
xx-IP10	KER_ RM014_RT	Music Room RM-014 Temperature	-	Replace
xx-IP11	KER_ RM013_RT	Craft Room RM-013 Temperature	-	Replace
xx-IP12	KER_ RM005_RT	Boardroom RM-005 Temperature	-	Replace
xx-IP13	KER_EFx_S	Basement Lockers Exhaust Fan Status	CS1	NEW
Network	KER_ RM110_RT	Staff Room RM-110 Temperature	TSR4	NEW
xx-OP1	KER_AC2_SF_C	AC-2 Supply Fan Command	-	Existing
xx-OP2	KER_AC2_MAD_C	AC-2 Mixing Damper Command	-	Existing
xx-OP3	KER_AC2_HTG_C	AC-2 Gas Heating Command	-	Existing
xx-OP4	KER_AC2_HTG_RST	AC-2 Gas Heating Reset	-	Existing
xx-OP5	KER_AC2_CLG1_C	AC-2 DX Cooling Stage-1Command	-	Existing
xx-OP6	KER_AC2_CLG2_C	AC-2 DX Cooling Stage-2Command	-	Existing
xx-OP7	KER_ RM110_RAD	Staff Room RAD110 Valve Command	-	Existing
xx-OP8	KER_ RM106_RAD	Games Room RAD-106 Valve Command	-	Existing
xx-OP9	KER_ RM016_RAD	Core & Stretch RAD-016 Valve Command	-	Existing

xx-OP10	KER_ RM013_RAD	Craft Room RAD-013 Valve Command	-	Existing
xx-OP11	KER_ RM005_RAD	Boardroom RAD-005 Valve Command	-	Existing
xx-OP12	KER_EFx_C	Basement Lockers Exhaust Fan Command	CR2	NEW

CP# 2B12 – Lobby AC-3

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC3_SF_S	AC-3 Supply Fan Status	-	Existing
xx-IP2	KER_AC3_SAT	AC-3 Supply Air Temperature	-	Replace
xx-IP3	KER_AC3_MAT	AC-3 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC3_FIL_S	AC-3 Filter Status	-	Existing
xx-IP5	KER_ RM104_RT	Women's Washroom 104 Temperature	-	Existing
xx-IP6	KER_ RM105_RT	Play Area Room 105 Temperature	-	Existing
xx-IP7	KER_ RM107_RT	Reception Room 107 Temperature	-	Existing
xx-IP8	KER_ RM109_RT	Office 109 Temperature	-	Existing
xx-IP9	KER_ RM109A_RT	Office 109A Temperature	-	Existing
xx-IP10	KER_ FF1_RT	Entrance FF-1 Room Temperature	-	Existing
xx-IP11	KER_ FF1_S	Entrance FF-1 Fan Status	-	Existing
xx-IP12	KER_ EF1_S	Washroom EF-1 Fan Status	-	Existing
Network	KER_ RM102_RT	Lobby Room 102 Temperature	TSR4	NEW
xx-OP1	KER_AC3_SF_C	AC-3 Supply Fan Command	-	Existing
xx-OP2	KER_AC3_MAD_C	AC-3 Mixing Damper Command	DA2	NEW
xx-OP3	KER_AC3_HTG1_C	AC-3 Heating Stage-1 Command	-	Existing
xx-OP4	KER_AC3_HTG2_C	AC-3 Heating Stage-2 Command	-	Existing
xx-OP5	KER_AC3_CLG1_C	AC-3 Cooling Stage-1 Command	-	Existing
xx-OP6	KER_AC3_CLG2_C	AC-3 Cooling Stage-2 Command	-	Existing
xx-OP7	KER_ RAD105_C	Play Area Room 105 Rad Valve Command	-	Existing
xx-OP8	KER_ RAD104_C	Women's Washroom 104 Rad Valve Command	-	Existing
xx-OP9	KER_ RAD109_C	Office 109 Rad Valve Command	-	Existing
xx-OP10	KER_ RAD109A_C	Office 109A Rad Valve Command	-	Existing
xx-OP11	KER_ RAD107_C	Reception Room 107 Rad Valve Command	-	Existing
xx-OP12	KER_ FF1_VLV_C	Entrance FF-1 Valve Command	-	Existing
xx-OP13	KER_ FF1_SF_C	Entrance FF-1 Fan Command	-	Existing
xx-OP14	KER_ EF1_C	Washroom EF-1 Fan Command	-	Existing

Points IP 5 – 12 and OP7 – 14 were is a separate controller in electric room

CP# 2B5 - AC-4 – Basement Exercise Room 007

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC4_SF_S	AC-4 Supply Fan Status	-	Existing
xx-IP2	KER_AC4_SAT	AC-4 Supply Air Temperature	-	Existing
xx-IP3	KER_AC4_MAT	AC-4 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC4_FIL_S	AC-4 Filter Status	-	Existing
xx-IP5	KER_EF10_S	EF-10 Status	-	Existing
Network	KER_ RM007_RT	Exercise Room 007 Temperature	TSR4	NEW
xx-OP1	KER_AC4_SF_C	AC-4 Supply Fan Command	-	Existing
xx-OP2	KER_AC4_MAD_C	AC-4 Mixing Damper Command	-	Existing
xx-OP3	KER_AC4_HTG1_C	AC-4 Gas Heating Stage-1 Command	-	Existing
xx-OP4	KER_AC4_HTG2_C	AC-4 Gas Heating Stage-2 Command	-	Existing

xx-OP5	KER_AC4_CLG_C	AC-4 DX Cooling Command	-	Existing
xx-OP6	KER_EF10_C	EF-10 Command	-	Existing

CP# 2B7 - AC-5 – Basement Weight Room 008

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC5_SF_S	AC-5 Supply Fan Status	-	Existing
xx-IP2	KER_AC5_SAT	AC-5 Supply Air Temperature	-	Existing
xx-IP3	KER_AC5_MAT	AC-5 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC5_FIL_S	AC-5 Filter Status	-	Existing
xx-IP5	KER_WR_EF_S	Main Washroom Exhaust Fan Status	CS1	NEW
Network	KER_ RM008_RT	Weight Room 008 Temperature	TSR4	NEW
xx-OP1	KER_AC5_SF_C	AC-5 Supply Fan Command	-	Existing
xx-OP2	KER_AC5_MAD_C	AC-5 Mixing Damper Command	-	Existing
xx-OP3	KER_AC5_HTG_C	AC-5 Gas Heating Command	-	Existing
xx-OP4	KER_AC5_CLG_C	AC-5 DX Cooling Command	-	Existing
xx-OP5	KER_WR_EF_C	Main Washroom Exhaust Fan Command	CR2	NEW

CP# 2B3 - AC-6 – Multipurpose Room 109

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC6_SF_S	AC-6 Supply Fan Status	-	Existing
xx-IP2	KER_AC6_SAT	AC-6 Supply Air Temperature	-	Existing
xx-IP3	KER_AC6_MAT	AC-6 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC6_FIL_S	AC-6 Filter Status	-	Existing
xx-IP5	KER_RM109_OCC_S	Multiuse Room 109 Occupancy	OS1	NEW
Network	KER_ RM109_RT	Multiuse Room 109 Temperature	TSR4	NEW
xx-OP1	KER_AC6_SF_C	AC-6 Supply Fan Command	-	Existing
xx-OP2	KER_AC6_MAD_C	AC-6 Mixing Damper Command	-	Existing
xx-OP3	KER_AC6_HTG_C	AC-6 Gas Heating Command	-	Existing
xx-OP4	KER_AC6_CLG_C	AC-6 DX Cooling Command	-	Existing
xx-OP5	KER_ RM109_RAD1	Multiuse Room 109 RAD-1 Command	-	Existing
xx-OP6	KER_ RM109_RAD2	Multiuse Room 109 RAD-2 Command	-	Existing
xx-OP7			-	Existing

CP# 2A3 - AC-7 – Activity Room 226

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC7_SF_S	AC-7 Supply Fan Status	-	Existing
xx-IP2	KER_AC7_SAT	AC-7 Supply Air Temperature	-	Existing
xx-IP3	KER_AC7_MAT	AC-7 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC7_FIL_S	AC-7 Filter Status	-	Existing
xx-IP5	KER_RM226_OCC_S	Activity RM 226 Occupancy	OS1	NEW
Network	KER_ RM226_RT	Activity RM-226 Temperature	TSR4	NEW
xx-OP1	KER_AC7_SF_C	AC-7 Supply Fan Command	-	Existing
xx-OP2	KER_AC7_MAD_C	AC-7 Mixing Damper Command	-	Existing
xx-OP3	KER_AC7_HTG_C	AC-7 Gas Heating Command	-	Existing

xx-OP4	KER_AC7_CLG_C	AC-7 DX Cooling Command	-	Existing
xx-OP5	KER_ RM226_RAD	Multipurpose RAD-226 Command (2)	-	Existing

Point OP-5 relocated from controller 2A1 to AC-7

CP# 2A4 - AC-8 – Multipurpose Room 222

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC8_SF_S	AC-8 Supply Fan Status	-	Existing
xx-IP2	KER_AC8_SAT	AC-8 Supply Air Temperature	-	Existing
xx-IP3	KER_AC8_MAT	AC-8 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC8_FIL_S	AC-8 Filter Status	-	Existing
xx-IP5	KER_RM222_OCC_S	Multipurpose RM 222 Occupancy	OS1	NEW
Network	KER_RM222_RT	Multipurpose RM-222 Temperature	TSR4	NEW
xx-OP1	KER_AC8_SF_C	AC-8 Supply Fan Command	-	Existing
xx-OP2	KER_AC8_MAD_C	AC-8 Mixing Damper Command	-	Existing
xx-OP3	KER_AC8_HTG_C	AC-8 Gas Heating Command	-	Existing
xx-OP4	KER_AC8_CLG_C	AC-8 DX Cooling Command	-	Existing
xx-OP5	KER_ RAD222_C	Room 222 Rad Valve Command	-	Existing

Point OP-5 relocated from controller 2A1 to AC-8

CP# 2B2 - AC-9 – Basement Karate and Core & Stretch Rooms

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC9_SF_S	AC-9 Supply Fan Status	-	Existing
xx-IP2	KER_AC9_SAT	AC-9 Supply Air Temperature	-	Existing
xx-IP3	KER_AC9_MAT	AC-9 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC9_FIL_S	AC-9 Filter Status	-	Existing
xx-IP5	KER_ RM015_OCC_S	Karate Room RM-015 Occupancy	OS1	NEW
xx-IP6	KER_ RM016_OCC_S	Core & Stretch RM-016 Occupancy	OS1	NEW
Network	KER_ RM015_RT	Karate Room RM-015 Temperature	TSR4	NEW
Network	KER_ RM016_RT	Core & Stretch RM-016 Temperature	TSR4	NEW
xx-OP1	KER_AC9_SF_C	AC-9 Supply Fan Command	-	Existing
xx-OP2	KER_AC9_MAD_C	AC-9 Mixing Damper Command	-	Existing
xx-OP3	KER_AC9_HTG_C	AC-9 Gas Heating Command	-	Existing
xx-OP4	KER_AC9_CLG_C	AC-9 DX Cooling Command	-	Existing
xx-OP5	KER_ RM016_RAD	Core & Stretch RAD-016 Command	-	Existing

CP# 2A2 - AC-10 – Rooms 217 to 221

Point	Label	Point Description	Device	Comments
xx-IP1	KER_AC10_SF_S	AC-10 Supply Fan Status	-	Existing
xx-IP2	KER_AC10_SAT	AC-10 Supply Air Temperature	-	Existing
xx-IP3	KER_AC10_MAT	AC-10 Mixed Air Temperature	-	Existing
xx-IP4	KER_AC10_FIL_S	AC-10 Filter Status	-	Existing
xx-IP5	KER_RM221_OCC_S	Multipurpose RM 221 Occupancy	OS1	NEW
xx-IP6	KER_ RM217_RT	Activity RM-217 Temperature		Replace
xx-IP7	KER_ RM218_RT	Boardroom RM-218 Temperature		Replace
xx-IP8	KER_ RM220_RT	Office RM-220 Temperature		Replace
Network	KER_ RM221_RT	Multipurpose RM-221 Temperature	TSR4	NEW
xx-OP1	KER_AC10_SF_C	AC-10 Supply Fan Command	-	Existing
xx-OP2	KER_AC10_MAD_C	AC-10 Mixing Damper Command	-	Existing
xx-OP3	KER_AC10_HTG1_C	AC-10 Heating Stage-1 Command	-	Existing
xx-OP4	KER_AC10_HTG2_C	AC-10 Heating Stage-2 Command	-	Existing
xx-OP5	KER_AC10_CLG1_C	AC-10 Cooling Stage-1 Command	-	Existing
xx-OP6	KER_ RAD217_C	Room 217 Rad Valve Command	-	Existing
xx-OP7	KER_ RAD218_C	Room 218 Rad Valve Command	-	Existing
xx-OP8	KER_ RAD220_C	Room 220 Rad Valve Command	-	Existing
xx-OP9	KER_ RAD221_C	Room 221 Rad Valve Command (2)	-	Existing
xx-OP10				

Points IP-5 to 7 and OP-7 to 10 relocated from controller 2A1 to AC-10

CP# 2A5 – Pottery Ventilation SF-1

Point	Label	Point Description	Device	Comments
xx-IP1	KER_SF1_S	Pottery Supply Fan SF-1 Status	-	Existing
xx-IP2	KER_SF-1_SAT	Pottery SF-1 Supply Air Temperature	-	Existing
xx-IP3	KER_RM002_RT	Pottery Room RM-002 Temperature	-	Existing
xx-IP4	KER_RM105_OCC_S	Pottery RM-105 Occupancy Status	-	Existing
xx-IP5	KER_SF-1_FRZ_ALM	Pottery SF-1 Freezestat Alarm	-	Existing
xx-OP1	KER_SF1_C	Pottery Supply Fan SF-1Command	-	Existing
xx-OP2	KER_SF-1_HCV_C	Pottery SF-1 Heating Coil Valve Command	-	Existing
xx-OP3	KER_RM105_RLDMP_C	Pottery RM-105 Relief Damper Command	-	Existing
xx-OP4				

CP# 2B9 - HV-1 - Pool

Point	Label	Point Description	Device	Comments
xx-IP1	KER_HV1_SF_S	HV-1 Supply Fan Status	-	NEW
xx-IP2	KER_HV1_SAT	HV-1 Supply Air Temperature	-	Existing
xx-IP3	KER_ HV1_RT	HV-1 Pool Room Temperature	-	Existing
xx-IP4	KER_ HV1_RH	HV-1 Pool Room Humidity	-	Existing
xx-IP5	KER_HV1_RAD_ES	HV-1 Return Air Damper End Switch Status	-	Existing
xx-IP6	KER_ HV1_EF1_S	Pool Change Rooms Exhaust Fan Status	CS1	NEW
xx-OP1	KER_ HV1_SF_C	HV1 Supply Fan Command	-	Existing
xx-OP2	KER_ HV1_RF_C	HV1 Return Fan Command	-	Existing
xx-OP3	KER_ HV1_OAD_C	HV1 Outdoor Air Damper Command	-	Existing
xx-OP4	KER_ HV1_RAD_C	HV1 Return Air Damper Command	-	Existing
xx-OP5	KER_ HV1_HTG_RST	HV1 Gas Heating Reset	-	Existing
xx-OP6	KER_ HV1_EF_C	Pool Exhaust Fan Command	-	Existing
xx-OP7	KER_ HV1_EF1_C	Pool Change Rooms Exhaust Fan Command	-	NEW

CP# - HV-2 – Pool Office (new controller to be installed in the HV-2 control panel)

Point	Label	Point Description	Device	Comments
xx-IP1	KER_HV2_SF_S	HV-2 Supply Fan Status	CS1	NEW
xx-IP2	KER_HV2_EF_S	HV-2 Exhaust Fan Status	CS1	NEW
xx-IP3	KER_HV2_SAT	HV-2 Supply Air Temperature	-	Existing
xx-IP4	KER_HV2_EOAT	HV-2 Entering Outdoor Air Temperature	TSD2	NEW
xx-IP5	KER_HV2_EEAT	HV-2 Entering Exhaust Air Temperature	TSD2	NEW
Network	KER_ HV2_RT	HV-2 Pool Office Temperature	TSR4	NEW
xx-OP1	KER_ HV2_C	HV2 SF/EF Fans Command	-	Existing
xx-OP2	KER_ HV2_BYP_C	HV2 Bypass Dampers Command	DA2	NEW/Replace
xx-OP3	KER_ HV2_HTG_RST	HV2 Gas Heating Reset	0-10VDC	NEW
xx-OP4				

CP#x Seniors Centre Boiler (new controller)

Point	Label	Point Description	Device	Comments
xx-IP1	KER_SEN_OAT	Outdoor Air Temperature	TSO	Replace
xx-IP2	KER_SEN_BLR_S	Seniors Boiler Status		Existing
xx-IP3	KER_SEN_BLR_HWST	Boiler Supply Water Temperature	TSP1	Replace
xx-IP4	KER_SEN_BLR_HWRT	Boiler Return Water Temperature	TSP1	New
xx-IP5	KER_SEN_P1_S	Seniors Radiant Heating Pump P-1 Status	CS1	New
xx-IP6	KER_SEN_P2_C	Seniors VAV Heating Pump P-2 Status	CS1	New
xx-IP7	KER_SEN_VAV_HWST	Seniors Heating Water Supply Temperature		Existing
xx-IP8	KER_DHW_SWT	Pool DHW Supply Water Temperature		Existing
xx-IP9	KER_POOL_HX_SWT	Pool HX Supply Water Temperature		Existing
xx-IP10	KER_POOL_HX_RWT	Pool HX Return Water Temperature		New
xx-OP1	KER_SEN_BLR_C	Seniors Boiler Enable	-	Existing
xx-OP2	KER_SEN_P1_C	Seniors Radiant Heating Pump P-1 Command	-	Existing
xx-OP3	KER_SEN_P2_C	Seniors VAV Heating Pump P-2 Command	-	Existing
xx-OP4	KER_SEN_RAD_VLV_C	Seniors Radiant Valve V27 Command	CV4	Replace Valve
xx-OP5	KER_POOL_DHW_C	Pool DHW Boiler Enable	-	Existing
xx-OP6	KER_POOL_DHWP_C	Pool DHW Pump Command	-	Existing
xx-OP7	KER_POOL_HX_VLV_C	Pool HX Valve Command	-	Existing
xx-OP8	KER_DHW_PX_C	DHW Shower Pump Command	-	Existing
xx-OP9	KER_SEN_FC3_C	Seniors Kitchen FC-3 Fan and V-24 Valve	CR2 + CV9	Replace Valve
xx-OP10	KER_SEN_UH1_C	Boiler Room 116 UH Fan and V-29 Valve	CR2 + CV9	Replace Valve

CP#x Seniors Centre HV-I and EF

MACH-Pro controller/expansion relocated from electrical room 006 or new Delta controller/expansion)

Point	Label	Point Description	Device	Comments
xx-IP1	KER_HVI_SF_FB	Seniors HV-I Supply Fan Speed Feedback		Existing
xx-IP2	KER_HVI_SAT	Seniors HV-I Supply Air Temperature		Existing
xx-IP3	KER_HVI_MAT	Seniors HV-I Mixed Air Temperature	TSD1	New
xx-IP4	KER_HVI_RAT	Seniors HV-I Return Air Temperature	TSD2	New
xx-IP5	KER_HVI_DSP	Seniors HV-I Supply Air Static Pressure		Replace
xx-IP6	KER_HVI_CLG_S	HV-1 DX Cooling Status (Amps)		Existing
xx-IP7	KER_HVI_HCP_S	HV-I Heating Coil Pump P-3 Status	CS1	New
xx-IP8	KER_SEN_EF2_S	Seniors Kitchen EF-2 Status		Existing
xx-IP9	KER_SEN_EF1_S	Seniors Washroom EF-1 Status	CS1	New
xx-IP10	KER_SEN_UH1_RT	Boiler Room 116 Unit Heater Temperature	TSR	New
xx-IP11	KER_SEN_WF25_RT	Seniors Women's Washroom Temperature	TSR	New
xx-IP12	KER_SEN_WF26_RT	Seniors Men's Washroom Temperature	TSR	New
xx-IP13	KER_BSB_OCC	Basement Occupancy		Existing
xx-IP14	KER_SEN_WF23_RT	Seniors Kitchen Storage Temperature	TSR	New
xx-IP15	KER_CRM_OCC	Change Room Occupancy		Existing
xx-IP16	KER_GYM_RT	Gym Temperature		Existing
xx-IP17	KER_LGHT_PCELL	Outdoor Lights Photocell		New
xx-IP18	KER_SEN_FC3_RT	Seniors Kitchen FC-3 Temperature	TSR	New
xx-OP1	KER_HVI_SF_C	HV-I Supply Fan Command	CR2	Replace relay
xx-OP2	KER_HVI_HCV_C	HV-I Heating Coil Valve V-28 Command	CV4	Replace Valve
xx-OP3	KER_HVI_MAD_C	HV-I Mixing Damper Command	DA2	Replace Actuator
xx-OP4	KER_HVI_SF_SPD	HV-I Supply Fan Speed Command	-	Existing
xx-OP5	KER_HVI_SPD_C	HV-I Supply Fan Speed Command	-	Existing
xx-OP6	KER_HVI_HCP_C	HV-I Heating Coil Pump P-3 Command	-	Existing
xx-OP7	KER_HVI_CLG1_C	HV-1 DX Cooling Stage-1 Command	-	Existing
xx-OP8	KER_HVI_CLG2_C	HV-1 DX Cooling Stage-2 Command	-	Existing
xx-OP9	KER_HVI_CLG3_C	HV-1 DX Cooling Stage-3 Command	-	Existing
xx-OP10	KER_HVI_RLD_C	HV-I Relief Dampers Command (3)	DA2	New (*)
xx-OP11	KER_RW_EF1_C	RW Exhaust Fan EF-1 Command	-	Existing
xx-OP12	KER_RW_EF2_C	RW Exhaust Fan EF-2 Command	-	Existing
xx-OP13	KER_RC_EF1_C	Men's Washroom Exhaust Fan EF-1 Command	-	Existing
xx-OP14	KER_RC_EF2_C	Storage Room Exhaust Fan EF-2 Command	-	Existing
xx-OP15	KER_RC_EF3_C	Women's Washroom Exhaust Fan EF-3	-	Existing
xx-OP16	KER_WR_EF1_C	Seniors Washroom EF-1 Command	CR2	New
xx-OP17	KER_EF2_C	Seniors Kitchen EF-2 Command	-	Existing
xx-OP18	KER_GYM_LITE_C	Outside Lights Gym	-	Existing
xx-OP19	KER_ELRM_LITE_C	Outside Lights ELRM	-	Existing
xx-OP20	KER_EF?_C	New Washroom Exhaust Fan	-	Existing
xx-OP21	KER_BSB_URN_VLV	Basement Urinal Valve Command	-	Existing
xx-OP22	KER_CHRM_URN_VLV	Change Room Urinal Valve Command	-	Existing
xx-OP23	KER_SEN_WF23_C	Seniors Kitchen WF Valve V-23 Command	CV9	Replace Valve
xx-OP24	KER_SEN_WF25_C	Women's Wash WF Valve V-25 Command	CV9	Replace Valve
xx-OP25	KER_SEN_WF26_C	Men's Wash WF Valve V-26 Command	CV9	Replace Valve

(*) Relief Dampers RD-1 corridor 121; RD-2 corridor 109; RD-3 corridor 121

CP#x Seniors Centre Additional Points – Wire to VAV Controllers

Point	Label	Point Description	Device	Comments
xx-IPx	KER_SEN_FC1_RT	Seniors Vestibule100 FC-1 Temperature	TSR	NEW (VAV-4)
xx-IPx	KER_SEN_FC2_RT	Seniors Entrance FC-2 Temperature	TSR	NEW (VAV-8)
xx-IPx				
xx-OPx	KER_SEN_FC1_C	Seniors Vestibule FC-1 Fan Command	CR2	NEW (VAV-4)
xx-OPx	KER_SEN_FC2_C	Seniors Entrance FC-2 Fan Command	CR2	NEW (VAV-8)
xx-OPx				

CP# – Seniors Centre VAV w/ Reheat Coil (Typical of 12)

Point	Label	Point Description	Device	Comments
xx-IP1				
xx-IP2	KER_VAVxxx_SAT	VAVxxx Supply Air Temperature	-	Existing
xx-IP3	KER_VAVxxx_OCC_S	VAVxxx Occupancy Status	-	(see list)
xx-IP4				
xx-IP5				
Xx-IP6				
Network	KER_RMxxx_RT	Room RMxxx Temperature	TSR4	NEW
xx-OP1	KER_RMxxx_HCV_C	VAVxxx Re-Heat Valve Command	CV8	Replace Valve
xx-OP2	KER_RMxxx_RAD_C	VAVxxx RAD xx Valve Command	CV8	Replace Valve
xx-OP3			-	
xx-OP4				
xx-OP5			-	

VAV	Service	RHC Valve	Rad Valve	Supply Temp	Occ Sensor
VAV-1	Crafts 108 (211)	V-1	V-22 RH 108	X	X
VAV-2	Billiards 107 (Games 222)	V-2	V-21 RH 107	X	X
VAV-4	Office 104 (Rm 223)	V-4	V-20 RH 104	X	
VAV-5	Waiting 105 (reception)	V-5	-	X	
VAV-6	Lounge 120	V-6	-	X	X
VAV-7	Corridor 101	V-7	V-19 RH 101	X	
VAV-8	Special Adults 118	V-8	V-14 RH 118	X	
VAV-9	Multipurpose 129	V-9	V-15 RH 129	X	
VAV-10	Multipurpose 128	V-10	V-16 RH 128	X	
VAV-11	Dining Room 127 (229)	V-11	V-17 RH 127	X	X
VAV-12	Dining Room 126 (228B)	V-12	V-18 RH 126	X	X
VAV-13	Kitchen 125	V-13			

Seniors Centre Valve List

Valve	Size	Valve Type	Flow l/s	CV	System	
V-1	½" (13mm)	2-way	0.13	2.2	VAV-1	
V-2	½" (13mm)	2-way	0.13	2.2	VAV-2	
V-4	½" (13mm)	2-way	0.03	0.4	VAV-4	
V-5	½" (13mm)	2-way	0.13	2.2	VAV-5	
V-6	½" (13mm)	2-way	0.19	3.3	VAV-6	
V-7	½" (13mm)	2-way	0.13	2.2	VAV-7	
V-8	½" (13mm)	2-way	0.06	1.3	VAV-8	
V-9	½" (13mm)	2-way	0.06	1.3	VAV-9	
V-10	½" (13mm)	2-way	0.06	1.3	VAV-10	
V-11	½" (13mm)	2-way	0.06	1.3	VAV-11	
V-12	½" (13mm)	2-way	0.06	1.3	VAV-12	
V-13	½" (13mm)	2-way	0.19	3.3	VAV-13	
V-14	½" (13mm)	2-way	0.12	2.2	RH 118	
V-15	½" (13mm)	2-way	0.16	3.3	RH 129	
V-16	½" (13mm)	2-way	0.05	1.3	RH 128	
V-17	½" (13mm)	2-way	0.05	1.3	RH 127	
V-18	½" (13mm)	2-way	0.05	1.3	RH 126	
V-19	½" (13mm)	2-way	0.07	1.3	RH 101	
V-20	½" (13mm)	2-way	0.02	0.4	RH 104	
V-21	½" (13mm)	2-way	0.07	1.3	RH 107	
V-22	½" (13mm)	2-way	0.07	1.3	RH 108	
V-23	½" (13mm)	2-way	0.03	0.4	Wall Fin	
V-24	½" (13mm)	2-way	0.11	2.2	FC-3	
V-25	½" (13mm)	2-way	0.03	0.4	Wall Fin	
V-26	½" (13mm)	2-way	0.03	0.4	Wall Fin	
V-27	½" (32mm)	3-way	1.28	16.0	Heating Water	
V-28	½" (32mm)	3-way	1.22	16.0	HV-I Coil	
V-29	½" (13mm)	2-way	0.20	3.3	UH-1	