

Government of Canada
Existing Building Renovation
Issue for Tender
Alberta, Canada

Addendum No. 3

September 16, 2016

The Bidding Documents are amended as noted in this Addendum, which consists of one (1) page and the following attachments:

1. Added Addendas:
 - a. Structural Addendum No. S1, one (1) pages, dated September 16, 2016
 - b. Mechanical Addendum No. M-02, two (2) pages, dated September 16, 2016
 - c. Electrical Addendum No. E-02, one (1) pages dated September 16, 2016

This addendum is issued prior to bid closing to amend the bid documents. This Addendum will form part of the Contract Documents. Include in the Bid price all such revisions which will become part of the Work. Perform all such Work in accordance with the contract documents.

Acknowledge receipt of this Addendum by reference in the Bid Form submitted by the bidding Contractors. Ensure that all parties submitting bids are aware of all items included in this addendum.

END OF ADDENDUM NO. THREE

The Bidding Documents are amended as noted in this Addendum, which consists of one (1) page and the following attachments:

1. Added Specifications:
None at this time
2. Drawings:
None at this time

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1. SPECIFICATIONS

- .1 None

2. DRAWINGS

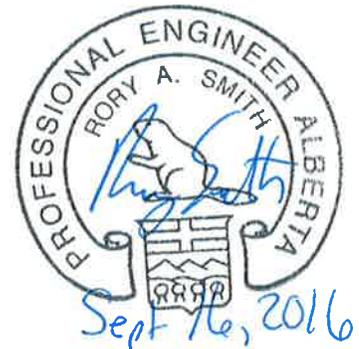
- .1 St Paul site drawing S101, add plan note for the south range wall;

Epoxy inject the joint between the top of concrete wall and ceiling slab with Sikadur F or approved equal.

- .2 Edson site drawing S101, add plan note for the east range wall;

Repair vertical cracks in the foundation wall by cleaning the crack and epoxy injecting Sikadur F into the crack or approved equal. Typical at 2 locations.

END OF ADDENDUM NO. S1



The Bidding Documents are amended as noted in this Addendum, which consists of two (2) page and the following attachments:

1. Added Specifications:

Appendix 1 – 144202775.200, St. Paul Location

- 23 09 00 – Instrumentation and Control for HVAC, fourteen (14) pages
- 23 09 13 – Instrumentation and Control Devices for HVAC, four (4) pages
- 23 09 23.6 – Direct Digital Control Systems for HVAC – Input/Output Devices, five (5) pages
- 23 09 93.1 – Sequence of Operations for HVAC Control, two (2) pages
- 23 09 93.2 – Point Schedules, two (2) Pages

Appendix 2 – 144202775.205, Edson Location

- 23 09 00 – Instrumentation and Control for HVAC, fourteen (14) pages
- 23 09 13 – Instrumentation and Control Devices for HVAC, four (4) pages
- 23 09 23.6 – Direct Digital Control Systems for HVAC – Input/Output Devices, five (5) pages
- 23 09 93.1 – Sequence of Operations for HVAC Control, two (2) pages
- 23 09 93.2 – Point Schedules, two (2) Pages

Appendix 3 – 144202775.210, Red Deer Location

- 23 09 00 – Instrumentation and Control for HVAC, fourteen (14) pages
- 23 09 13 – Instrumentation and Control Devices for HVAC, four (4) pages
- 23 09 23.6 – Direct Digital Control Systems for HVAC – Input/Output Devices, five (5) pages
- 23 09 93.1 – Sequence of Operations for HVAC Control, two (2) pages
- 23 09 93.2 – Point Schedules, two (2) Pages

Appendix 4 – 144202775.215, Edmonton Location

- 23 09 00 – Instrumentation and Control for HVAC, seven (7) pages
- 23 09 13 – Instrumentation and Control Devices for HVAC, four (4) pages
- 23 09 23.6 – Direct Digital Control Systems for HVAC – Input/Output Devices, four (4) pages
- 23 09 93.1 – Sequence of Operations for HVAC Control, one (1) pages
- 23 09 93.2 – Point Schedules, one (1) Pages

2. Drawings:

N/A

This addendum is issued prior to bid closing to amend the bid documents. This Addendum will form part of the Contract Documents. Include in the Bid price all such revisions which will become part of the Work. Perform all such Work in accordance with the contract documents.

Acknowledge receipt of this Addendum by reference in the Bid Form submitted by the bidding Contractors. Ensure that all parties submitting bids are aware of all items included in this addendum.

1. SPECIFICATIONS

Refer to Appendix No 1, 144202775.200 – St. Paul; Appendix No 2, 144202775.205 – Edson; Appendix No 3, 144202775.210 - Red Deer & Appendix No 4, 144202775.200 - Edmonton

.1 Section 23 09 00 – Instrumentation and Control for HVAC

Replace previously issued section with updated section attached.

.2 Section 23 09 13 – Instrumentation and Control Devices for HVAC

Replace previously issued section with updated section attached.

.3 Section 23 09 23.6 – Direct Digital Control Systems for HVAC – Input / Output Devices

Replace previously issued section with updated section attached.

.4 Section 23 09 93.1 – Sequence of Operations for HVAC Controls

Replace previously issued section with updated section attached.

.5 Section 23 09 23.6 – Point Schedule for HVAC Controls

Replace previously issued section with updated section attached.

Edmonton, Red Deer & St. Paul

.1 Section 23 72 23 – Packaged Air to Air Energy Recovery Units

This section is to be deleted.

.2 DRAWINGS

N/A

END OF ADDENDUM NO. M-02

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Section 23 05 00 – Common Work Results for HVAC and with the requirements outlined below.
- .2 Submit the shop drawings and technical data describing the proposed system within 90 days after award of the BAS contract. Provide sufficient detail to enable the consultant to evaluate the proposed system and determine whether the requirements of the specification will be met.
 - .1 Schematic of system architecture indicating the type and location of all digital controllers, the major system equipment monitored and controlled by each panel and how the controllers are to be networked.
 - .2 The proposed digital I/O points list including at a minimum the point mnemonic, point description, controller number and controller I/O point number.
 - .3 Equipment schedule for all hardware, valves, dampers, field instrumentation, input/output devices, transducers and actuators.
 - .4 Technical description and specifications for the primary and sub-networks.
 - .5 Schematic diagram for each mechanical system showing all input/output points, wiring diagrams for all I/O points and a written detailed operational description of control sequences. For terminal equipment controllers, submission of field point wiring diagrams for each type is adequate.
 - .6 Engineering/technical data and maintenance information for each system component, including sizing and arrangements as requested. Include calculations for control valve selections.
- .3 Shop drawings are to be submitted in an organized fashion complete with table of contents, tab sheets and sequentially numbered pages to enable easy location of information. This also applies to component data sheets.
- .4 Component data sheets shall be organized by device type with tab sheets for each section i.e. Controllers, Digital Input devices, Digital output devices, Analog input devices, Analog output devices.
- .5 The table of contents for component data sheets must indicate product description, specification I/O device type or specification section, and page number.
- .6 Component specification sheets that include more than one product shall be clearly marked to identify the applicable product(s), options and specifications.
- .7 Submit copies of the complete shop drawings to the consultant for review and approval. Partial submissions may be accepted depending on the detail and acceptance by the Consultant. Provide additional copies of the complete approved shop drawings with the O&M Manuals.

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- .8 Within 120 days after award of the contract submit printed copies of all dynamic graphic displays, proposed calibration check sheets.
 - .9 Within 180 days after award of the contract submit two (2) draft Operating and Maintenance manuals as specified in this section under System Documentation.
 - .10 BAS shop drawings shall be based on approved mechanical equipment shop drawings. The Mechanical Contractor is to provide approved mechanical equipment shop drawings to the BAS Contractor.

1.6 Owner Orientation

- .1 Formal training sessions shall commence only after "as-built" drawings have been completed, reviewed and approved by the Engineer.
- .2 Individuals who have had specific training as an instructor shall conduct training sessions.
- .3 All training sessions shall include training materials and shall follow a documented course outline.
- .4 A copy of the training materials, which shall include a detailed course outline, shall be submitted to the Engineer for approval three weeks prior to commencing any training sessions.
- .5 Any training conducted without prior approval of the Engineer shall be repeated at the discretion of the Engineer and/or will not count toward the contractors training obligations.
- .6 The BAS contractor shall provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.
- .7 The BAS contractor shall provide three (3) complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Engineer.
- .8 Provide for operator training according to the following schedule.
 - .1 A one (1) day system and component familiarization seminar/workshop during the first week of trial usage.
 - .2 A one (1) day seminar/workshop the week before the 7-day acceptance test covering all aspects of system use as follows:
 - .1 Operation of hardware components
 - .2 System software configuration
 - .3 User/system interaction
 - .4 Calibration of sensors and system
 - .5 Trouble shooting of system and components

.6 Preventative maintenance

.3 A one (1) day review workshop at one month after system acceptance.

1.7 Warranty

.1 Include warranty provisions identified in the specifications.

.2 In addition to the warranty in item .1, provide a two (2) year warranty on all items provided under this contract including but not limited to all equipment, wiring and software. The warranty period shall commence on the date of final written acceptance of the BAS system.

.3 Provide on site service including all labor, materials and software to maintain the complete control system in optimal functioning condition during the warranty period.

.4 Perform preventive maintenance (PM) during the warranty period.

.5 In addition to warranty call backs provide one (1) service and calibration inspections of a minimum four (4) of hours duration. These calls will be initiated by the Owner.

.6 The overtime premiums for weekend and overtime service calls shall be clearly identified within your proposal.

.7 The BAS contractor shall supply and install at no cost all system software updates and upgrades occurring up to 2 months prior to the expiration of the warranty period.

.8 Maintain a service log on site of all control system maintenance activities during the warranty period.

1.8 System Activation

.1 Submit control calibration and point verification check sheets to the Engineer for approval prior to any calibration of devices or end to end point verification commences. Check sheets to include:

.1 Controller identification number

.2 Controller input/output point number

.3 Control point mnemonic

.4 A complete concise English description of each point

.5 Device controlled

.6 Interlock devices

.7 Measured and displayed analog input values

.8 Analog Output zero and full scale verification

.9 End to End verification for all points

.10 Wire labels verification

- .11 Device tag verification
- .12 Date of verification
- .13 Initials of person performing verification
- .2 Submit sample control loop trend log plot, of the type to be used for demonstrating control loop tuning, to the Engineer for approval.
- .3 Verify that each hardware component has been properly installed as recommended by the manufacturer and is functioning correctly.
- .4 Calibrate all devices including sensors, transmitters, transducers, current relays, valve actuators, damper motors, etc., verifying that end to end calibration accuracy as specified has been achieved.
- .5 Ensure tight shut off and fail safe operation of valves and dampers. Hysteresis shall not be greater than 5% of the operating range.
- .6 Set damper linkages, static pressure/volume controls as required.
- .7 Set up run time capture for each digital input point.
- .8 Set up alarm point for each digital input/output pair, with delay before alarm is annunciated.
- .9 Set up deviation alarm for each control loop measured variable input with appropriate alarm interlocks, dead-bands and time delays.
- .10 Set up high and low alarm limit points for analog input points as shown on the point list.
- .11 Set up zero scale and full scale alarms for each analog input to alarm point failures.

1.9 Acceptance Testing

- .1 A final operational acceptance test of seven consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the specifications.
- .2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software. Specific testing shall include but not be limited to:
 - .1 Power Failure Restart.
 - .2 Room Temperature Reset Schedules
 - .3 Mechanical Heating

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- .3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free test days have occurred.
 - .4 Prior to conducting the final operational acceptance testing, submit to the Engineer:
 - .1 Completed calibration and verification check sheets including airflow station calibration sheets.
 - .2 Hard copy and electronic copy on CD of final data base listings.
 - .3 If electronic copy of final database listing is not in Microsoft Word, Excel or Access format, provide a final points list to the Engineer in either Microsoft Word, Excel, or Access format.
 - .4 Hardcopy of all system Graphics.
 - .5 A signed declaration stating that all work has been completed or identifying any outstanding deficiencies and the anticipated completion date(s).
 - .5 After successful completion of the acceptance test, the Engineer will issue written acceptance of the control system.
 - .6 For all systems prior to substantial completion the BAS contractor shall successfully demonstrate the response to
 - .1 All fire alarm interlocks, shut-down sequences and fire control strategies
 - .2 All power failure interruptions
 - .7 The initiation of the Fire Alarm system into alarm mode and simulation or tripping of the main power feeders shall be performed by others.

1.10 System Documentation

- .1 Operating and Maintenance Manuals
 - .1 The BAS Operation and Maintenance Manuals shall contain operational, product data, cleaning and maintenance information on all products and equipment supplied as part of this projects BAS. The final Manuals shall accompany the Project Record Drawings and shall be in place prior to substantial performance.
 - .2 Submit a draft Manual for format review three (3) months after award of Contract and three (3) Manuals of Documentation for interim submission at 75% construction. Draft Manuals are to be complete in all aspects less control programming. Interim submission is to include all control shop drawings, programming and system descriptions. Draft and Interim Manuals are to be submitted in 3 ring binders. Final Manuals to be in catalogue type binder.

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- .3 Each manual shall be 215 mm x 280 mm capacity extension type Catalogue Binder bound in heavyweight fabricord, colour to be reviewed with the Owner prior to order and hot stamped in white lettering front and spine.
 - .4 The spine and front face of the binder shall be lettered with the following:
 - .1 Full identification title of the project
 - .2 Building Automation System
 - .3 Operation and Maintenance Manual
 - .4 Set X of Y
 - .5 Volume X of Y
 - .5 The manual shall be arranged according to the following format. Utilize colour coded laminated mylar plastic divider tabs with headings according to section.
 - .1 Table of Contents
 - .2 Introduction
 - .3 Control System Design
 - .4 Building System Descriptions
 - .5 DDC Panel Layout
 - .6 Shop Drawings
 - .7 Equipment Schedules
 - .8 Certification and Testing
 - .9 Product Manuals
 - .10 Maintenance
 - .11 Software & Certificates
 - .6 On the first page of each binder, before the table of contents identify the following:
 - .1 Prime Consultant: name, address, telephone number.
 - .2 Contractor: name, address, telephone number.
 - .3 Subcontractors: name address, telephone number.
 - .7 Table of Contents
 - .1 Include in each binder a table of contents that provides an index in order of appearance of all sections and subsections within the manual.
 - .8 Introduction
 - .1 Provide a written explanation of the layout of the manual.

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- .2 List all other control system manuals submitted for this project including all software manuals and hardware manuals. Identify the quantities of each manual provided.
- .9 Control System Design
 - .1 Design Intent
 - .1 Explain, in this section, the design intent and give a system overview which outlines the relationships between the hardware, operating system, control software and other control components.
 - .2 Provide a detailed description of all parts, components and software in the system.
 - .3 Describe the system architecture. Provide a system configuration schematic with the location, type and model of all control panels, work stations, remote access modems, etc. and identify the major equipment monitored and controlled by each panel.
 - .4 The schematic must identify network communication protocols and communication speeds between all control panels and indicate BACnet compatibility where applicable.
 - .5 Identify the number of controllers that can be added to each network and sub-network and any maximum distance between controllers or maximum length of network without the need to add additional communication devices.
 - .6 Identify all software products provided including third party software. This shall include but not be limited to all operator workstation, graphics, controller and laptop software. For each product, indicate the number of software licenses provided, the name of the respective vendor and any software protection devices required. Indicate the number of software protection devices provided.
 - .2 Operations
 - .1 Provide an overview of the building automation system operations. Include basic instruction on:
 - .1 System access
 - .2 Alarms management (including, how and where alarms are annunciated, after-hours reporting of critical alarms, etc.)

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- .3 Commonly used reports
 - .4 Laptop, local and remote system access and
 - .5 Basic trouble shooting directions.
 - .2 These instructions are to provide a basic understanding of the system operations and are to reference specific areas of the software manuals for further detailed instructions.
 - .3 Provide detailed back-up and data recovery procedures including recommended frequencies and data to be backed up. Here again refer to specific areas of product manuals where appropriate. Provide sample back-up log sheets.
 - .10 Building System Descriptions
 - .1 System Design intent - Explain, in this section, the design intent and give a system overview which outlines the system components and the intended system function.
 - .2 Provide a schematic, control sequences, wiring diagram, device list and points list for each building system controlled by the BAS.
 - .3 Control sequences shall identify start-up and shut-down sequences, control loop set-points, reset schedules, system interlocks, etc.
 - .4 As built record drawings in 11" X 17" format, folded to fit into the O&M binders may be used to provide part or all of the information required for this section.
 - .11 DDC Panel Layout
 - .1 Provide as-built panel layout sheets and include locations of all panels.
 - .2 Include a panel points list that identifies each point name with concise English description and termination point. Identify panel spare points.
 - .3 Identify power source for each panel including emergency/normal, UPS, panel number and circuit number.
 - .12 Shop Drawings
 - .1 Insert in this section all approved shop drawings organized in the format specified in section 23 05 00 – Common Work Results for HVAC.
 - .13 Equipment Schedules

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- .1 Provide an equipment schedule for all hardware provided including valves, dampers, actuators, controllers, transducers, input/output devices and other instrumentation.
- .14 Certification and Testing
 - .1 Provide final copies of all completed calibration and verification check sheets including all airflow station calibration check sheets.
- .15 Product Manuals
 - .1 Include in this manual or within product, user manuals and technical manuals, complete and detailed instruction on the use, setup and support of all control system software and hardware provided under this project.
 - .2 Provide detailed instructions on set-up and user operations including but not limited to system access, navigation, alarms, trending, historical trending, reporting and trouble shooting.
 - .3 Provide complete detailed instruction on database structure, set-up, initialization, expansion and editing.
 - .4 Provide complete detailed instruction to enable creation, modification and implementation of control sequences.
- .16 Maintenance
 - .1 Provide a description in this section of maintenance procedures for all equipment and systems, as defined in this specification, including a schedule for recommended planned and preventative maintenance work items and intervals.
 - .2 Include a preventative maintenance program complete with suggested check list sheets.
 - .3 Provide a list of resources to call upon for maintenance and servicing of equipment which includes name, address and phone numbers for supplier and service contact for each piece of equipment.
 - .4 Include in this section a complete set of as-built drawings if not included elsewhere in this manual.
 - .5 Certification, guarantee, warranty.
- .17 Software & Certificates
 - .1 Provide original copies of all software distribution media on CDs inserted into vinyl page holders that are designed for 3 ring binders. The originals are to be provided in "Set 1" of these O&M manuals and back-up copies are to be provided in "Set 2".

- .2 Provide software registration certificates, or other documents that verify authenticity of software.
- .3 Provide back-up copies of entire system at the time of system turn over on CDs in vinyl CD page holders designed for 3 ring binders. Backup to include complete control sequence source code.

1.11 Record Drawings

- .1 Before the certification of substantial performance will be issued the contractor must provide the Engineer with record drawings as follows:
 - .1 One electronic copy of record drawings in AutoCAD version 2000 or Visio format.
 - .2 Four (4) copies of as-built white prints in 280mmx432mm (8½" x 17") capacity blue binders bound in heavy fabricated, hot stamped in white lettering front and spine. Each is to be identified As-Built Drawings and permanently numbered 1 to 4.
 - .3 The spine shall be lettered with the full identification title of the project and the front face shall be lettered with the following on the respective binders:
 - .1 Full identification title of the project
 - .2 Prime Consultant and Sub-Consultant - full identification
 - .3 Prime Contractor - full identification
 - .4 Mechanical Contractor - full identification
 - .4 Maintain an accurate record of all deviations and changes on a record drawing set of prints. Such record is to be maintained on a day-to-day basis.
 - .5 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

2. Products

2.1 Approved Contractors & Suppliers

- .1 Tenders on the following will be accepted:
 - .1 Siemens Building Systems – APOGEE product
 - .2 Johnson Controls – Metasys product
 - .3 ESC Automation – Delta Controls product
 - .4 Serv-All – Reliable Controls

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- .2 Alternates to these approved control system products can be submitted as a separate price from the base system specified.

2.2 General

- .1 Provide control system components consisting of sensors, motorized dampers, actuators, indicating devices, and interface equipment required to operate mechanical equipment and perform functions specified.
- .2 Provide all materials and labor required to connect control components.

2.3 BAS Architecture

- .1 The BAS system shall be native BACnet, utilizing BACnet BTL approved modules.
- .2 The BAS shall be comprised of a stand-alone digital controller and other devices as specified herein.
- .3 The BAS shall incorporate the ability to access all user interface functions as specified within these documents using standard internet browsers. Operator access to the BAS shall not require any proprietary operator interface or configuration software to be loaded on the respective PC and access shall only be limited by password.
- .4 The BAS system shall incorporate BACnet native devices and they shall be ANSI/ASHRAE 135-2012 BACnet BTL compliant. For components utilized on this project, they shall include the following capabilities:
 - .1 Building Controllers – BACnet I/P with Building Controllers software (B-BC)
 - .2 Advanced Application Controllers – BACnet I/P and/or MS/TP with Advanced Application software (B-AAC)
 - .3 Third Party Devices – BACnet I/P and/or MS/TP with BACnet software
- .5 The installed system shall provide secure multilevel password access to all features, functions and data contained in the overall BAS.
- .6 Provide licenses for all software residing in the BAS system and transfer these licenses to the Owner, at no cost, prior to project completion. Provide software on CDs and/or DVDs and licenses for:
 - .1 Database creation and editing
 - .2 Engineering of the system
 - .3 Service, Troubleshooting and/or Tool software
 - .4 Trending
 - .5 Historical trending to cover all hardware and software points

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- .7 With the CDs and/or DVDs as noted above it shall not require the Owner to obtain any information, data, programs, etc. from the manufacturer and shall not require access over the internet to the manufacturer's site to perform the functionality. Provide 3 copies of the above CDs and/or DVDs.
 - .8 Downloading and Uploading
 - .1 Provide the capability to generate BAS software-based sequences, database items and associated operational definition information and user-required revisions to same, at any Operator PC, and the means to download same to the associated controller.
 - .2 Application software tool used for the generation of custom logic sequences shall be provided to the owner as part of this project.
 - .3 Provide the capability to upload BAS operating software information, database items, sequences and alarms to the designated server.

3. Execution

3.1 Electrical Work

- .1 The BAS contractor shall supply and install all line and low voltage power and control wiring for the BAS system, including all 120/1/60 emergency power wiring to power the various BAS components. Refer to Section 23 09 13 for system requirements.
- .2 For each 120/1/60 exhaust fan motor that is controlled from the BAS, the BAS contractor shall supply an electrical horsepower rated relay module, fully enclosed and turn over to the Electrical contractor for installation. The power wiring to the module and from the module to the motor shall be provided by the Electrical contractor, with the BAS contractor supplying and installing the control wiring to the BAS system.
- .3 The BAS contractor shall supply and install all necessary 120/24 transformers and power supplies for the BAS equipment and shall supply and install all conduit, wire, fittings, boxes, etc. to extend the 24 volt AC/DC power to all the BAS equipment.
- .4 Separate 120/24 volt transformers and/or power supplies shall be provided to each digital controller and transformers shall not be shared between digital controllers nor shall the transformers serving the digital controllers power the sensors, transducers, etc.

3.2 MUA Unit

- .1 The existing MUA unit provides make up air to the building and is complete with integral controls to control the full functionality of the unit. The existing logic and controls shall remain with the BAS monitoring the system and providing a new remote panel located as shown on the drawings.

3.3

Exhaust Fan

- .1 The interlocks between the MUA unit and updated exhaust fan EF-1 shall remain. Review the existing wiring and interlocks and provide disconnection and reconnection of the control wiring relative to the existing exhaust fan being replaced with a new fan and starter.

END OF SECTION

1. General

1.1 Scope

- .1 Control Devices and Hardware
 - .1 Control Panels
 - .2 Wire
 - .3 Conduit and Cables
 - .4 Related Accessories
 - .5 Room Sensors
 - .6 Outdoor Air Sensors
 - .7 Duct Mount Sensors

2. Products

2.1 Control Panels

- .1 Mount digital controllers in control panels with field interface equipment (i.e. relays, transducers, etc.) segregated in the panel and minimizing the electrical interference and heat to the digital controllers.
- .2 The power supplies, transformers, contactors, etc. shall be mounted in separate ventilated metal enclosures.
- .3 Control panels are to be of unitized cabinet type construction, fabricated from rolled sheet metal sheet with baked enamel finish, flush fitting, gasketed doors hung on piano type hinges and locking handles. All panels shall be CSA approved and equal to Hoffman enclosures and shall be common keyed.
- .4 Mount pilot lights and switches flush on cabinet panel face.
- .5 Mount panels on vibration free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- .6 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.
- .7 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 volt supply.
- .8 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

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- .9 Identify all wiring by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.
 - .10 Install bonding conductor between main control and auxiliary panels complete with grounding lugs, in addition to CSA grounding requirements.
 - .11 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.
 - .12 Power for control panels shall be 120/1/60 15 amp circuits from power panel with wiring from power panel by the BAS contractor.

2.2 Wire

- .1 Control wiring for digital functions shall be 20 AWG minimum with 300 Volt insulation.
- .2 Control wiring for analog functions shall be 20 AWG minimum with 300 Volts insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.
- .3 Sensor wiring shall be 22 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

2.3 Conduits and Cables

- .1 All wiring, whether line voltage, low voltage or control wiring shall be in conduit or fully enclosed metal trays. Flexible conduit may be used for final connection of control devices. Maximum length of flexible conduit to be 1m (3 ft). Conform to Division 26 requirements for conduit, tray, fittings, junction boxes, cabinets, wire, cable and trays specifications.
- .2 Exposed plenum rated cable shall not be utilized; all wiring shall be in conduit.
- .3 Seal conduit where such conduit leaves heated areas and enters unheated area.
- .4 In the field, run low level (<30 volts) signal lines in separate conduit from high level (>30 volts) signal and power transmission lines.
- .5 In the field panel, run low level signal lines in separate conduit from high level signal and power transmission lines.
- .6 Identify each cable and wire at every termination point by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring.
- .7 Provide instrumentation complete with standard electrical conduit box for termination unless otherwise noted.

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- .8 Color code all conductors and conduits by permanently applied color bands. Color code shall follow base building schedule. Color code all conduit couplings orange, with orange banding on the conduits.
 - .9 All wiring for terminal equipment controllers including network communications, sensors and actuator wiring must be in conduit.

2.4 Related Accessories

- .1 Provide and install all necessary transducers, interposing relays, interface devices, etc., to perform control functions required.
- .2 It is the responsibility of the BAS Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

2.5 Thermostats and Room Sensors

- .1 Provide tamper proof guards for the space sensor. Guards to be equal to BAPI-Guard.

2.6 Duct Mount Sensors

- .1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
- .2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

3. Execution

3.1 Installation

- .1 Verify location of sensors and other exposed control sensors with drawings before installation. Locate room temperature sensors 1500mm (5 ft) above floor.
- .2 Install the control panel containing the digital controller at the location as shown on the drawings.
- .3 Wire "hand/off/auto" selector switches such that only automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.
- .4 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.
- .5 Install all safety limits at the operator's level.
- .6 Control System Power

- .1 Provide power to all BAS components as necessary to provide continued monitoring and control.
- .2 Power for all transducers and other instrumentation associated with a controller shall come from the same circuit that is feeding the digital controller.
- .3 Identify in the record drawings the panel and circuit number serving each controller.

END OF SECTION

1. General

- .1 This section is a module which specifies the Field Instrumentation, Sensing Devices and Actuators.
- .2 For general requirements relating to all sections see Section 23 09 00 – Instrumentation and Control for HVAC.

2. Products

2.1 General

- .1 Provide analog or digital field instrumentation devices as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the ASC and/or SCU terminal strip that conform to the input requirements.
- .2 Provide output devices and actuators which convert the digital or analog output signal from the ASC and/or SCU to activate relays or open and close valves, dampers, etc.
- .3 The end to end accuracy called for in Subsection 2.2 includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the input to the analog-to-digital convertor in the ASC and/or SCU or between the ASC and/or SCU input to the digital-to-analog convertor and the controlled variable for the full sensing range.
- .4 The letter under the "Type" column in Subsection 2.2 is the same used in the points list.
- .5 Acceptable manufacturers of sensors are indicated in Section 3.0.

2.2 Analog Input Sensors

- .1 Temperature

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct Mounted	Tp	0°C to 60°C (32°F to 140°F)	±0.5°C	
Pipe Well	Tw	0°C to 50°C (32°F to 122°F)	±0.5°C	c/w thermal wells
Mounted		0°C to 100°C (32°F to 212°F)	±0.5°C	
		50°C to 150°C (122°F to 300°F)	±0.5°C	
Averaging	Ta	-30°C to 60°C (-20°F to 140 °F)	±0.5°C	Length to suit duct side

Space Temp.	Tr	10°C to 301°C (50°F to 572°F)	±0.5°C	c/w tamper-proof cover
Outside Air	To	-50°C to 50°C (-58°F to 122°F)	±1.0°C	c/w solar-shield
Surface Temp	Ts	0°C to 50°C (32°F to 122°F)	±0.3°C	

.2 Relative Humidity

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct mounted	Hp	5 - 90% RH 0°C to 60°C (32 °F to 140 °F)	±5%	
Space	Hr	5 - 90% RH	±5%	c/w tamper-proof cover
Outside air	Ho	5 - 100% RH	±5%	c/w solar-shield

.3 Pressure

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Static-water	Ps	0 to 104 kPa (0 to 15 psi)	±2%	
		0 to 208 kPa (0 to 30 psi)	±2%	
		0 to 689 kPa (0 to 100 psi)	±2%	
		0 to 2,000 kPa (0 to 300 psi)	±2%	
		Static-air	Sp	0 to 500 Pa (0 to 2" WG)
		0 to 1,250 Pa (0 to 5" WG)	±2%	
		0 to 2,500 Pa (0 to 10" WG)	±2%	
Instrument	Ia	0 to 150 kPa (0 to 20 psi)	±2%	
Velocity pressure monitoring station – air	Vp	0-62.5 Pa (0-0.25" WG)	±1.0%	-multi-point static & total pressure sensing element manifold -self-averaging manifold -air equalizer &
		0-125 Pa (0-0.5" WG)		
		0-250 Pa (0-1" WG)		

straightener
 -max. pressure loss 36 Pa @ 10 m/sec.
 -lowest sensitivity 1% of range

Flow monitoring station – water, steam	Pv	As required	±2.0%	-Paddle wheel
Fan Inlet- Air Flow Traverse Probes	Vpi	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±3.0%	Multiple total and static pressure sensors connected to a self averaging manifold. Provide steady non-pulsating signals of standard total and static pressure. Accuracy of ±3.0% of actual flow over a fan operating range of 6 to 1 capacity turn down.

.4 Electrical

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Kilowatts	kW	Various voltages		From digital metering systems
Current transmitters	Ct	As required	±0.25% full scale	

2.3 Analog Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
To damper motors	De	0 - 10 VDC 4-20 MA	±2% full scale	
To valve actuators	Ve	0 - 10 VDC 4 - 20 MA	±1% full scale	

2.4 Digital Input Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Pressure	Pd	As required	±1.5%	-adjustable setpoint

Switches				full scale	and differential
Temperature	Td	As required		±1°C	-adjustable setpoint and differential -automatic reset -normal reset for freeze protection
Current Sensing Relays	Ri	As required		N/A	-adjustable trip c/w LED Status indication.
Motor status Relays	St	As required		N/A	-auxiliary contacts
Level	Ls	N/A		N/A	
Misc Inputs	Rc	N/A		N/A	Auxiliary contacts

2.5 Digital Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Relays	Ry	N/A	N/A	Plug-in type with terminal base contacts rated at 5 amp 120 VAC.

3. Execution

3.1 General

- .1 Codes and Standards
 - .1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, latest CSA Electrical Bulletins and Division 26.
- .2 Current sensing relays shall be equal to Greystone series CS-610-75 with LED and range adjustment and provide a dry contact signal.
- .3 Static and differential air pressure transmitters shall be equal to SETRA DPT 264 series, 1.0% accuracy with a 0-10V DC and/or 4-20 ma signal for connection to the BAS.
- .4 For each static and/or differential air flow transmitter, air pressure switch, etc. connection into the ductwork provide a standard production Dwyer series 160 pitot tube, or equal, with duct clamp and gasket for sensing the total and/or static pressure.
- .5 Differential pressure transmitters shall be located in the control panel with tubing extended out to the filter modules. Install tubing in conduit.

- .6 For all the various transducers, supply and install the required transformers, power supplies, fusing, filters, etc. as required to provide the reduced voltage to the devices.

END OF SECTION

1. General

- .1 The control sequences below provide a general description of the intent of the operation of the systems to be controlled. The BAS Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 Consult with the Engineer during the shop drawing stage to finalize the control sequences for each system
- .3 On loss of building power and building power being restored, all equipment, including that on emergency power, shall be reset to nominal start up conditions and shall run through its normal start up sequence prior to returning to required operating conditions.
- .4 The interlock of exhaust fan EF-1 to the MUA unit exists and is to be retained. The BAS shall providing monitoring and alarm as indicated below.

1.2 Systems

- .1 Make-Up Air Unit
- .2 Exhaust Fans

2. Products

Not Applicable

3. Execution

3.1 General

- .1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

3.2 Make-Up Air Unit

- .1 Make-up air unit MUA-1 is an existing outdoor, constant volume, 100% outside air system serving the firing range. The unit consists of an outside air intake, filter section, one (1) supply air fan complete and direct gas-fired heat exchanger.
- .2 System Start/Stop
 - .1 The Make Up Air system will be energized via the BAS and operate continuously when selected by the operator.
 - .2 The exhaust fan is interlocked to the MUA unit and shall operate when the MUA unit operates.

.3 Upon a signal from the Fire Alarm system, the Make Up Air system and associated exhaust fan shall be de-energized; the connection to the Fire Alarm system shall be hardwired by the Electrical contractor.

.4 The BAS control panel shall be located as shown on the drawing. The panel shall provide status lights for unit operation, alarm and filter status.

.3 Temperature Control

.1 The make-up air unit shall be controlled by the integral controls and shall modulate the gas valve to maintain a supply air temperature setpoint.

.2 A space sensor shall be utilized in the BAS software to indicated room temperature.

.4 Filter Operation

.1 Provide individual differential pressure sensors across the pre-filters and HEPA filters to monitor the status of the filters.

.2 Provide software limits on the differential pressure sensors to turn on a pilot light on the panel to indicate filter change requirements.

3.3 Cleaning Station

.1 The exhaust fan EF-2 shall be energized by a manual switch located adjacent to the cleaning station, with no connection or monitoring by the BAS.

END OF SECTION

Miscellaneous

System

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Range HEPA Filter Differential Pressure Change Filter Soor Change Filter Now	Sp								
	Ry		X						Remote Pilot light
	Ry		X						Remote Pilot light
Range Pre-Filter Differential Pressure Change Filter Soor Change Filter Now	Sp								
	Ry		X						Remote Pilot light
	Ry		X						Remote Pilot light

1. General

1.1 Scope

- .1 Provide all materials and services as documented within these specifications and as required to furnish a complete and fully operational DDC Building Automation System (BAS) to monitor and control the building systems referred to in this specification.
- .2 The work includes the supply and installation of DDC controllers, instrumentation, control devices, conduit, wiring, tubing and other devices as necessary to provide a complete system of BAS controls, compliant with these specifications.
- .3 Supply, install and configure all software, programming and databases; set up equipment operating schedules; and perform system activation functions as identified within these specifications, to provide a complete and fully operational BAS.
- .4 Provide:
 - .1 Submittals,
 - .2 System Documentation,
 - .3 Acceptance Testing, and
 - .4 Instructions to Owners

1.2 Related Work

- .1 Instrumentation and Control Devices for HVAC Section 23 09 13
- .2 Sequence of Operations for HVAC Controls Section 23 09 93.1
- .3 Point Schedules for HVAC Controls Section 23 09 93.2

1.3 Work by Others

- .1 Distribution and installation of wells, flow insertion fittings, motorized valves and motorized dampers into the piping systems.

1.4 Quality Assurance

- .1 Provide a complete system of BAS controls for mechanical systems by specialty BAS firms having proof of completing three (3) projects of similar size.
- .2 The BAS equipment shall be of one manufacturer throughout and shall have service for the system from manufacturer's factory authorized service, resident in the City of Edmonton, Red Deer or Calgary.
- .3 Software engineering and support shall be resident in the City of Edmonton, Red Deer or Calgary.

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Section 23 05 00 – Common Work Results for HVAC and with the requirements outlined below.
- .2 Submit the shop drawings and technical data describing the proposed system within 90 days after award of the BAS contract. Provide sufficient detail to enable the consultant to evaluate the proposed system and determine whether the requirements of the specification will be met.
 - .1 Schematic of system architecture indicating the type and location of all digital controllers, the major system equipment monitored and controlled by each panel and how the controllers are to be networked.
 - .2 The proposed digital I/O points list including at a minimum the point mnemonic, point description, controller number and controller I/O point number.
 - .3 Equipment schedule for all hardware, valves, dampers, field instrumentation, input/output devices, transducers and actuators.
 - .4 Technical description and specifications for the primary and sub-networks.
 - .5 Schematic diagram for each mechanical system showing all input/output points, wiring diagrams for all I/O points and a written detailed operational description of control sequences. For terminal equipment controllers, submission of field point wiring diagrams for each type is adequate.
 - .6 Engineering/technical data and maintenance information for each system component, including sizing and arrangements as requested. Include calculations for control valve selections.
- .3 Shop drawings are to be submitted in an organized fashion complete with table of contents, tab sheets and sequentially numbered pages to enable easy location of information. This also applies to component data sheets.
- .4 Component data sheets shall be organized by device type with tab sheets for each section i.e. Controllers, Digital Input devices, Digital output devices, Analog input devices, Analog output devices.
- .5 The table of contents for component data sheets must indicate product description, specification I/O device type or specification section, and page number.
- .6 Component specification sheets that include more than one product shall be clearly marked to identify the applicable product(s), options and specifications.
- .7 Submit copies of the complete shop drawings to the consultant for review and approval. Partial submissions may be accepted depending on the detail and acceptance by the Consultant. Provide additional copies of the complete approved shop drawings with the O&M Manuals.

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- .8 Within 120 days after award of the contract submit printed copies of all dynamic graphic displays, proposed calibration check sheets.
 - .9 Within 180 days after award of the contract submit two (2) draft Operating and Maintenance manuals as specified in this section under System Documentation.
 - .10 BAS shop drawings shall be based on approved mechanical equipment shop drawings. The Mechanical Contractor is to provide approved mechanical equipment shop drawings to the BAS Contractor.

1.6 Owner Orientation

- .1 Formal training sessions shall commence only after "as-built" drawings have been completed, reviewed and approved by the Engineer.
- .2 Individuals who have had specific training as an instructor shall conduct training sessions.
- .3 All training sessions shall include training materials and shall follow a documented course outline.
- .4 A copy of the training materials, which shall include a detailed course outline, shall be submitted to the Engineer for approval three weeks prior to commencing any training sessions.
- .5 Any training conducted without prior approval of the Engineer shall be repeated at the discretion of the Engineer and/or will not count toward the contractors training obligations.
- .6 The BAS contractor shall provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.
- .7 The BAS contractor shall provide three (3) complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Engineer.
- .8 Provide for operator training according to the following schedule.
 - .1 A one (1) day system and component familiarization seminar/workshop during the first week of trial usage.
 - .2 A one (1) day seminar/workshop the week before the 7-day acceptance test covering all aspects of system use as follows:
 - .1 Operation of hardware components
 - .2 System software configuration
 - .3 User/system interaction
 - .4 Calibration of sensors and system
 - .5 Trouble shooting of system and components

.6 Preventative maintenance

.3 A one (1) day review workshop at one month after system acceptance.

1.7 Warranty

.1 Include warranty provisions identified in the specifications.

.2 In addition to the warranty in item .1, provide a two (2) year warranty on all items provided under this contract including but not limited to all equipment, wiring and software. The warranty period shall commence on the date of final written acceptance of the BAS system.

.3 Provide on site service including all labor, materials and software to maintain the complete control system in optimal functioning condition during the warranty period.

.4 Perform preventive maintenance (PM) during the warranty period.

.5 In addition to warranty call backs provide one (1) service and calibration inspections of a minimum four (4) of hours duration. These calls will be initiated by the Owner.

.6 The overtime premiums for weekend and overtime service calls shall be clearly identified within your proposal.

.7 The BAS contractor shall supply and install at no cost all system software updates and upgrades occurring up to 2 months prior to the expiration of the warranty period.

.8 Maintain a service log on site of all control system maintenance activities during the warranty period.

1.8 System Activation

.1 Submit control calibration and point verification check sheets to the Engineer for approval prior to any calibration of devices or end to end point verification commences. Check sheets to include:

.1 Controller identification number

.2 Controller input/output point number

.3 Control point mnemonic

.4 A complete concise English description of each point

.5 Device controlled

.6 Interlock devices

.7 Measured and displayed analog input values

.8 Analog Output zero and full scale verification

.9 End to End verification for all points

.10 Wire labels verification

- .11 Device tag verification
- .12 Date of verification
- .13 Initials of person performing verification
- .2 Submit sample control loop trend log plot, of the type to be used for demonstrating control loop tuning, to the Engineer for approval.
- .3 Verify that each hardware component has been properly installed as recommended by the manufacturer and is functioning correctly.
- .4 Calibrate all devices including sensors, transmitters, transducers, current relays, valve actuators, damper motors, etc., verifying that end to end calibration accuracy as specified has been achieved.
- .5 Ensure tight shut off and fail safe operation of valves and dampers. Hysteresis shall not be greater than 5% of the operating range.
- .6 Set damper linkages, static pressure/volume controls as required.
- .7 Set up run time capture for each digital input point.
- .8 Set up alarm point for each digital input/output pair, with delay before alarm is annunciated.
- .9 Set up deviation alarm for each control loop measured variable input with appropriate alarm interlocks, dead-bands and time delays.
- .10 Set up high and low alarm limit points for analog input points as shown on the point list.
- .11 Set up zero scale and full scale alarms for each analog input to alarm point failures.

1.9 Acceptance Testing

- .1 A final operational acceptance test of seven consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the specifications.
- .2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software. Specific testing shall include but not be limited to:
 - .1 Power Failure Restart.
 - .2 Room Temperature Reset Schedules
 - .3 Mechanical Heating

-
- .3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free test days have occurred.
 - .4 Prior to conducting the final operational acceptance testing, submit to the Engineer:
 - .1 Completed calibration and verification check sheets including airflow station calibration sheets.
 - .2 Hard copy and electronic copy on CD of final data base listings.
 - .3 If electronic copy of final database listing is not in Microsoft Word, Excel or Access format, provide a final points list to the Engineer in either Microsoft Word, Excel, or Access format.
 - .4 Hardcopy of all system Graphics.
 - .5 A signed declaration stating that all work has been completed or identifying any outstanding deficiencies and the anticipated completion date(s).
 - .5 After successful completion of the acceptance test, the Engineer will issue written acceptance of the control system.
 - .6 For all systems prior to substantial completion the BAS contractor shall successfully demonstrate the response to
 - .1 All fire alarm interlocks, shut-down sequences and fire control strategies
 - .2 All power failure interruptions
 - .7 The initiation of the Fire Alarm system into alarm mode and simulation or tripping of the main power feeders shall be performed by others.

1.10 System Documentation

- .1 Operating and Maintenance Manuals
 - .1 The BAS Operation and Maintenance Manuals shall contain operational, product data, cleaning and maintenance information on all products and equipment supplied as part of this projects BAS. The final Manuals shall accompany the Project Record Drawings and shall be in place prior to substantial performance.
 - .2 Submit a draft Manual for format review three (3) months after award of Contract and three (3) Manuals of Documentation for interim submission at 75% construction. Draft Manuals are to be complete in all aspects less control programming. Interim submission is to include all control shop drawings, programming and system descriptions. Draft and Interim Manuals are to be submitted in 3 ring binders. Final Manuals to be in catalogue type binder.

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- .3 Each manual shall be 215 mm x 280 mm capacity extension type Catalogue Binder bound in heavyweight fabricord, colour to be reviewed with the Owner prior to order and hot stamped in white lettering front and spine.
 - .4 The spine and front face of the binder shall be lettered with the following:
 - .1 Full identification title of the project
 - .2 Building Automation System
 - .3 Operation and Maintenance Manual
 - .4 Set X of Y
 - .5 Volume X of Y
 - .5 The manual shall be arranged according to the following format. Utilize colour coded laminated mylar plastic divider tabs with headings according to section.
 - .1 Table of Contents
 - .2 Introduction
 - .3 Control System Design
 - .4 Building System Descriptions
 - .5 DDC Panel Layout
 - .6 Shop Drawings
 - .7 Equipment Schedules
 - .8 Certification and Testing
 - .9 Product Manuals
 - .10 Maintenance
 - .11 Software & Certificates
 - .6 On the first page of each binder, before the table of contents identify the following:
 - .1 Prime Consultant: name, address, telephone number.
 - .2 Contractor: name, address, telephone number.
 - .3 Subcontractors: name address, telephone number.
 - .7 Table of Contents
 - .1 Include in each binder a table of contents that provides an index in order of appearance of all sections and subsections within the manual.
 - .8 Introduction
 - .1 Provide a written explanation of the layout of the manual.

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- .2 List all other control system manuals submitted for this project including all software manuals and hardware manuals. Identify the quantities of each manual provided.
 - .9 Control System Design
 - .1 Design Intent
 - .1 Explain, in this section, the design intent and give a system overview which outlines the relationships between the hardware, operating system, control software and other control components.
 - .2 Provide a detailed description of all parts, components and software in the system.
 - .3 Describe the system architecture. Provide a system configuration schematic with the location, type and model of all control panels, work stations, remote access modems, etc. and identify the major equipment monitored and controlled by each panel.
 - .4 The schematic must identify network communication protocols and communication speeds between all control panels and indicate BACnet compatibility where applicable.
 - .5 Identify the number of controllers that can be added to each network and sub-network and any maximum distance between controllers or maximum length of network without the need to add additional communication devices.
 - .6 Identify all software products provided including third party software. This shall include but not be limited to all operator workstation, graphics, controller and laptop software. For each product, indicate the number of software licenses provided, the name of the respective vendor and any software protection devices required. Indicate the number of software protection devices provided.
 - .2 Operations
 - .1 Provide an overview of the building automation system operations. Include basic instruction on:
 - .1 System access
 - .2 Alarms management (including, how and where alarms are annunciated, after-hours reporting of critical alarms, etc.)

- .3 Commonly used reports
- .4 Laptop, local and remote system access and
- .5 Basic trouble shooting directions.
- .2 These instructions are to provide a basic understanding of the system operations and are to reference specific areas of the software manuals for further detailed instructions.
- .3 Provide detailed back-up and data recovery procedures including recommended frequencies and data to be backed up. Here again refer to specific areas of product manuals where appropriate. Provide sample back-up log sheets.
- .10 Building System Descriptions
 - .1 System Design intent - Explain, in this section, the design intent and give a system overview which outlines the system components and the intended system function.
 - .2 Provide a schematic, control sequences, wiring diagram, device list and points list for each building system controlled by the BAS.
 - .3 Control sequences shall identify start-up and shut-down sequences, control loop set-points, reset schedules, system interlocks, etc.
 - .4 As built record drawings in 11" X 17" format, folded to fit into the O&M binders may be used to provide part or all of the information required for this section.
- .11 DDC Panel Layout
 - .1 Provide as-built panel layout sheets and include locations of all panels.
 - .2 Include a panel points list that identifies each point name with concise English description and termination point. Identify panel spare points.
 - .3 Identify power source for each panel including emergency/normal, UPS, panel number and circuit number.
- .12 Shop Drawings
 - .1 Insert in this section all approved shop drawings organized in the format specified in section 23 05 00 – Common Work Results for HVAC.
- .13 Equipment Schedules

-
- .1 Provide an equipment schedule for all hardware provided including valves, dampers, actuators, controllers, transducers, input/output devices and other instrumentation.
- .14 Certification and Testing
 - .1 Provide final copies of all completed calibration and verification check sheets including all airflow station calibration check sheets.
- .15 Product Manuals
 - .1 Include in this manual or within product, user manuals and technical manuals, complete and detailed instruction on the use, setup and support of all control system software and hardware provided under this project.
 - .2 Provide detailed instructions on set-up and user operations including but not limited to system access, navigation, alarms, trending, historical trending, reporting and trouble shooting.
 - .3 Provide complete detailed instruction on database structure, set-up, initialization, expansion and editing.
 - .4 Provide complete detailed instruction to enable creation, modification and implementation of control sequences.
- .16 Maintenance
 - .1 Provide a description in this section of maintenance procedures for all equipment and systems, as defined in this specification, including a schedule for recommended planned and preventative maintenance work items and intervals.
 - .2 Include a preventative maintenance program complete with suggested check list sheets.
 - .3 Provide a list of resources to call upon for maintenance and servicing of equipment which includes name, address and phone numbers for supplier and service contact for each piece of equipment.
 - .4 Include in this section a complete set of as-built drawings if not included elsewhere in this manual.
 - .5 Certification, guarantee, warranty.
- .17 Software & Certificates
 - .1 Provide original copies of all software distribution media on CDs inserted into vinyl page holders that are designed for 3 ring binders. The originals are to be provided in “Set 1” of these O&M manuals and back-up copies are to be provided in “Set 2”.

- .2 Provide software registration certificates, or other documents that verify authenticity of software.
- .3 Provide back-up copies of entire system at the time of system turn over on CDs in vinyl CD page holders designed for 3 ring binders. Backup to include complete control sequence source code.

1.11 Record Drawings

- .1 Before the certification of substantial performance will be issued the contractor must provide the Engineer with record drawings as follows:
 - .1 One electronic copy of record drawings in AutoCAD version 2000 or Visio format.
 - .2 Four (4) copies of as-built white prints in 280mmx432mm (8½" x 17") capacity blue binders bound in heavy fabricated, hot stamped in white lettering front and spine. Each is to be identified As-Built Drawings and permanently numbered 1 to 4.
 - .3 The spine shall be lettered with the full identification title of the project and the front face shall be lettered with the following on the respective binders:
 - .1 Full identification title of the project
 - .2 Prime Consultant and Sub-Consultant - full identification
 - .3 Prime Contractor - full identification
 - .4 Mechanical Contractor - full identification
 - .4 Maintain an accurate record of all deviations and changes on a record drawing set of prints. Such record is to be maintained on a day-to-day basis.
 - .5 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

2. Products

2.1 Approved Contractors & Suppliers

- .1 Tenders on the following will be accepted:
 - .1 Siemens Building Systems – APOGEE product
 - .2 Johnson Controls – Metasys product
 - .3 ESC Automation – Delta Controls product
 - .4 Serv-All – Reliable Controls

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- .2 Alternates to these approved control system products can be submitted as a separate price from the base system specified.

2.2 General

- .1 Provide control system components consisting of sensors, motorized dampers, actuators, indicating devices, and interface equipment required to operate mechanical equipment and perform functions specified.
- .2 Provide all materials and labor required to connect control components.

2.3 BAS Architecture

- .1 The BAS system shall be native BACnet, utilizing BACnet BTL approved modules.
- .2 The BAS shall be comprised of a stand-alone digital controller and other devices as specified herein.
- .3 The BAS shall incorporate the ability to access all user interface functions as specified within these documents using standard internet browsers. Operator access to the BAS shall not require any proprietary operator interface or configuration software to be loaded on the respective PC and access shall only be limited by password.
- .4 The BAS system shall incorporate BACnet native devices and they shall be ANSI/ASHRAE 135-2012 BACnet BTL compliant. For components utilized on this project, they shall include the following capabilities:
 - .1 Building Controllers – BACnet I/P with Building Controllers software (B-BC)
 - .2 Advanced Application Controllers – BACnet I/P and/or MS/TP with Advanced Application software (B-AAC)
 - .3 Third Party Devices – BACnet I/P and/or MS/TP with BACnet software
- .5 The installed system shall provide secure multilevel password access to all features, functions and data contained in the overall BAS.
- .6 Provide licenses for all software residing in the BAS system and transfer these licenses to the Owner, at no cost, prior to project completion. Provide software on CDs and/or DVDs and licenses for:
 - .1 Database creation and editing
 - .2 Engineering of the system
 - .3 Service, Troubleshooting and/or Tool software
 - .4 Trending
 - .5 Historical trending to cover all hardware and software points

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- .7 With the CDs and/or DVDs as noted above it shall not require the Owner to obtain any information, data, programs, etc. from the manufacturer and shall not require access over the internet to the manufacturer's site to perform the functionality. Provide 3 copies of the above CDs and/or DVDs.
 - .8 Downloading and Uploading
 - .1 Provide the capability to generate BAS software-based sequences, database items and associated operational definition information and user-required revisions to same, at any Operator PC, and the means to download same to the associated controller.
 - .2 Application software tool used for the generation of custom logic sequences shall be provided to the owner as part of this project.
 - .3 Provide the capability to upload BAS operating software information, database items, sequences and alarms to the designated server.

3. Execution

3.1 Electrical Work

- .1 The BAS contractor shall supply and install all line and low voltage power and control wiring for the BAS system, including all 120/1/60 emergency power wiring to power the various BAS components. Refer to Section 23 09 13 for system requirements.
- .2 For each 120/1/60 exhaust fan motor that is controlled from the BAS, the BAS contractor shall supply an electrical horsepower rated relay module, fully enclosed and turn over to the Electrical contractor for installation. The power wiring to the module and from the module to the motor shall be provided by the Electrical contractor, with the BAS contractor supplying and installing the control wiring to the BAS system.
- .3 The BAS contractor shall supply and install all necessary 120/24 transformers and power supplies for the BAS equipment and shall supply and install all conduit, wire, fittings, boxes, etc. to extend the 24 volt AC/DC power to all the BAS equipment.
- .4 Separate 120/24 volt transformers and/or power supplies shall be provided to each digital controller and transformers shall not be shared between digital controllers nor shall the transformers serving the digital controllers power the sensors, transducers, etc.

3.2 MUA Unit

- .1 The units providing make up air to the building shall be complete with integral controls to control the full functionality of the unit.
- .2 Each unit shall provide external dedicated hardware connection points to the BAS for overall monitoring and enabling of the unit.

3.3

Exhaust Fans

- .1 Refer to the points list for exhaust fans that are controlled. Provide separate control and monitoring of fans for each typical application.

3.4

Heat Recovery Unit

- .1 HRV unit shall be complete with all the necessary controls and there is no connection to the BAS. The unit is interlocked to the gun cleaning EF-2.

END OF SECTION

1. General

1.1 Scope

- .1 Control Devices and Hardware
 - .1 Control Panels
 - .2 Wire
 - .3 Conduit and Cables
 - .4 Related Accessories
 - .5 Room Sensors
 - .6 Outdoor Air Sensors
 - .7 Duct Mount Sensors

2. Products

2.1 Control Panels

- .1 Mount digital controllers in control panels with field interface equipment (i.e. relays, transducers, etc.) segregated in the panel and minimizing the electrical interference and heat to the digital controllers.
- .2 The power supplies, transformers, contactors, etc. shall be mounted in separate ventilated metal enclosures.
- .3 Control panels are to be of unitized cabinet type construction, fabricated from rolled sheet metal sheet with baked enamel finish, flush fitting, gasketed doors hung on piano type hinges and locking handles. All panels shall be CSA approved and equal to Hoffman enclosures and shall be common keyed.
- .4 Mount pilot lights and switches flush on cabinet panel face.
- .5 Mount panels on vibration free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- .6 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.
- .7 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 volt supply.
- .8 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

-
- .9 Identify all wiring by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.
 - .10 Install bonding conductor between main control and auxiliary panels complete with grounding lugs, in addition to CSA grounding requirements.
 - .11 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.
 - .12 Power for control panels shall be 120/1/60 15 amp circuits from power panel with wiring from power panel by the BAS contractor.

2.2 Wire

- .1 Control wiring for digital functions shall be 20 AWG minimum with 300 Volt insulation.
- .2 Control wiring for analog functions shall be 20 AWG minimum with 300 Volts insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.
- .3 Sensor wiring shall be 22 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

2.3 Conduits and Cables

- .1 All wiring, whether line voltage, low voltage or control wiring shall be in conduit or fully enclosed metal trays. Flexible conduit may be used for final connection of control devices. Maximum length of flexible conduit to be 1m (3 ft). Conform to Division 26 requirements for conduit, tray, fittings, junction boxes, cabinets, wire, cable and trays specifications.
- .2 Exposed plenum rated cable shall not be utilized; all wiring shall be in conduit.
- .3 Seal conduit where such conduit leaves heated areas and enters unheated area.
- .4 In the field, run low level (<30 volts) signal lines in separate conduit from high level (>30 volts) signal and power transmission lines.
- .5 In the field panel, run low level signal lines in separate conduit from high level signal and power transmission lines.
- .6 Identify each cable and wire at every termination point by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring.
- .7 Provide instrumentation complete with standard electrical conduit box for termination unless otherwise noted.

.8 Color code all conductors and conduits by permanently applied color bands. Color code shall follow base building schedule. Color code all conduit couplings orange, with orange banding on the conduits.

.9 All wiring for terminal equipment controllers including network communications, sensors and actuator wiring must be in conduit.

2.4 Related Accessories

.1 Provide and install all necessary transducers, interposing relays, interface devices, etc., to perform control functions required.

.2 It is the responsibility of the BAS Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

2.5 Thermostats and Room Sensors

.1 Provide tamper proof guards for the space sensor. Guards to be equal to BAPI-Guard.

2.6 Duct Mount Sensors

.1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

.2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

.3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

3. Execution

3.1 Installation

.1 Verify location of sensors and other exposed control sensors with drawings before installation. Locate room temperature sensors 1500mm (5 ft) above floor.

.2 Install the control panel containing the digital controller at the location as shown on the drawings.

.3 Wire "hand/off/auto" selector switches such that only automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

.4 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.

.5 Install all safety limits at the operator's level.

.6 Control System Power

- .1 Provide power to all BAS components as necessary to provide continued monitoring and control.
- .2 Power for all transducers and other instrumentation associated with a controller shall come from the same circuit that is feeding the digital controller.
- .3 Identify in the record drawings the panel and circuit number serving each controller.

END OF SECTION

1. General

- .1 This section is a module which specifies the Field Instrumentation, Sensing Devices and Actuators.
- .2 For general requirements relating to all sections see Section 23 09 00 – Instrumentation and Control for HVAC.

2. Products

2.1 General

- .1 Provide analog or digital field instrumentation devices as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the ASC and/or SCU terminal strip that conform to the input requirements.
- .2 Provide output devices and actuators which convert the digital or analog output signal from the ASC and/or SCU to activate relays or open and close valves, dampers, etc.
- .3 The end to end accuracy called for in Subsection 2.2 includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the input to the analog-to-digital convertor in the ASC and/or SCU or between the ASC and/or SCU input to the digital-to-analog convertor and the controlled variable for the full sensing range.
- .4 The letter under the "Type" column in Subsection 2.2 is the same used in the points list.
- .5 Acceptable manufacturers of sensors are indicated in Section 3.0.

2.2 Analog Input Sensors

- .1 Temperature

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct Mounted	Tp	0°C to 60°C (32°F to 140°F)	±0.5°C	
Pipe Well Mounted	Tw	0°C to 50°C (32°F to 122°F)	±0.5°C	c/w thermal wells
		0°C to 100°C (32°F to 212°F)	±0.5°C	
		50°C to 150°C (122°F to 300°F)	±0.5°C	
Averaging	Ta	-30°C to 60°C (-20°F to 140 °F)	±0.5°C	Length to suit duct side

Space Temp.	Tr	10°C to 301°C (50°F to 572°F)	±0.5°C	c/w tamper-proof cover
Outside Air	To	-50°C to 50°C (-58°F to 122°F)	±1.0°C	c/w solar-shield
Surface Temp	Ts	0°C to 50°C (32°F to 122°F)	±0.3°C	

.2 Relative Humidity

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct mounted	Hp	5 - 90% RH 0°C to 60°C (32 °F to 140 °F)	±5%	
Space	Hr	5 - 90% RH	±5%	c/w tamper-proof cover
Outside air	Ho	5 - 100% RH	±5%	c/w solar-shield

.3 Pressure

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Static-water	Ps	0 to 104 kPa (0 to 15 psi)	±2%	
		0 to 208 kPa (0 to 30 psi)	±2%	
		0 to 689 kPa (0 to 100 psi)	±2%	
		0 to 2,000 kPa (0 to 300 psi)	±2%	
		Static-air	Sp	0 to 500 Pa (0 to 2" WG)
		0 to 1,250 Pa (0 to 5" WG)	±2%	
		0 to 2,500 Pa (0 to 10" WG)	±2%	
		Instrument	Ia	0 to 150 kPa (0 to 20 psi)
Velocity pressure monitoring station – air	Vp	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±1.0%	-multi-point static & total pressure sensing element manifold -self-averaging manifold -air equalizer &

straightener
 -max. pressure loss 36 Pa @ 10 m/sec.
 -lowest sensitivity 1% of range

Flow monitoring station – water, steam	Pv	As required	±2.0%	-Paddle wheel
Fan Inlet- Air Flow Traverse Probes	Vpi	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±3.0%	Multiple total and static pressure sensors connected to a self averaging manifold. Provide steady non-pulsating signals of standard total and static pressure. Accuracy of ±3.0% of actual flow over a fan operating range of 6 to 1 capacity turn down.

.4 Electrical

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Kilowatts	kW	Various voltages		From digital metering systems
Current transmitters	Ct	As required	±0.25% full scale	

2.3 Analog Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
To damper motors	De	0 - 10 VDC 4-20 MA	±2% full scale	
To valve actuators	Ve	0 - 10 VDC 4 - 20 MA	±1% full scale	

2.4 Digital Input Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Pressure	Pd	As required	±1.5%	-adjustable setpoint

Switches				full scale	and differential
Temperature	Td	As required		±1°C	-adjustable setpoint and differential -automatic reset -normal reset for freeze protection
Current Sensing Relays	Ri	As required		N/A	-adjustable trip c/w LED Status indication.
Motor status Relays	St	As required		N/A	-auxiliary contacts
Level	Ls	N/A		N/A	
Misc Inputs	Rc	N/A		N/A	Auxiliary contacts

2.5 Digital Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Relays	Ry	N/A	N/A	Plug-in type with terminal base contacts rated at 5 amp 120 VAC.

3. Execution

3.1 General

- .1 Codes and Standards
 - .1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, latest CSA Electrical Bulletins and Division 26.
- .2 Current sensing relays shall be equal to Greystone series CS-610-75 with LED and range adjustment and provide a dry contact signal.
- .3 Static and differential air pressure transmitters shall be equal to SETRA DPT 264 series, 1.0% accuracy with a 0-10V DC and/or 4-20 ma signal for connection to the BAS.
- .4 For each static and/or differential air flow transmitter, air pressure switch, etc. connection into the ductwork provide a standard production Dwyer series 160 pitot tube, or equal, with duct clamp and gasket for sensing the total and/or static pressure.
- .5 Differential pressure transmitters shall be located in the control panel with tubing extended out to the filter modules. Install tubing in conduit.

- .6 For all the various transducers, supply and install the required transformers, power supplies, fusing, filters, etc. as required to provide the reduced voltage to the devices.

END OF SECTION

1. General

- .1 The control sequences below provide a general description of the intent of the operation of the systems to be controlled. The BAS Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 Consult with the Engineer during the shop drawing stage to finalize the control sequences for each system
- .3 On loss of building power and building power being restored, all equipment, including that on emergency power, shall be reset to nominal start up conditions and shall run through its normal start up sequence prior to returning to required operating conditions.

1.2 Systems

- .1 Make-Up Air Unit
- .2 Exhaust Fans

2. Products

Not Applicable

3. Execution

3.1 General

- .1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

3.2 Make-Up Air Unit

- .1 Make-up air unit MUA-1 is an outdoor, constant volume, 100% outside air system serving the firing range. The unit consists of an outside air intake, filter section, one (1) supply air fan complete and direct gas-fired heat exchanger.
- .2 System Start/Stop
 - .1 The Make Up Air system will be energized via the BAS and operate continuously when selected by the operator.
 - .2 The outside air damper on the Make Up Air unit shall be opened and when the damper is open the supply fan shall start, and the exhaust fan shall be indexed to operate. An end switch on the motorized damper for the exhaust air fan shall allow the exhaust fan to operate when the damper is fully open.
 - .3 When status of the exhaust fan is proven, the heating in the Make Up Air unit shall be enabled by the BAS and controls integral in the Make Up Air unit shall control the burner.

.4 Upon a signal from the Fire Alarm system, the Make Up Air system and associated exhaust fan shall be de-energized; the connection to the Fire Alarm system shall be hardwired by the Electrical contractor.

.5 The BAS control panel shall be located as shown on the drawings for ventilation system operation. The panel shall also provide status lights for unit operation, alarm and filter status.

.3 Temperature Control

.1 The make-up air unit shall be controlled by the integral controls and shall modulate the gas valve to maintain a supply air temperature setpoint. The supply air temperature setpoints shall be provided by the BAS.

.2 A space sensor shall be utilized in the BAS software to optimize the supply air setpoint to meet acceptable space conditions.

.4 Filter Operation

.1 Provide individual differential pressure sensors across the pre-filters and HEPA filters to monitor the status of the filters.

.2 Provide software limits on the differential pressure sensors to turn on a pilot light on the panel to indicate filter change requirements.

3.3 Cleaning Station

.1 The exhaust fan EF-2 and Heat Recovery unit shall be energized by a manual switch located adjacent to the cleaning station, with no connection or monitoring by the BAS.

END OF SECTION

Miscellaneous

System

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Range HEPA Filter Differential Pressure Change Filter Soor Change Filter Now	Sp Ry Ry		X X			X	X	Remote Pilot light Remote Pilot light	
Range Pre- Filter Differential Pressure Change Filter Soor Change Filter Now	Sp Ry Ry		X X				X	Remote Pilot light Remote Pilot light	

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Section 23 05 00 – Common Work Results for HVAC and with the requirements outlined below.

- .2 Submit the shop drawings and technical data describing the proposed system within 90 days after award of the BAS contract. Provide sufficient detail to enable the consultant to evaluate the proposed system and determine whether the requirements of the specification will be met.
 - .1 Schematic of system architecture indicating the type and location of all digital controllers, the major system equipment monitored and controlled by each panel and how the controllers are to be networked.
 - .2 The proposed digital I/O points list including at a minimum the point mnemonic, point description, controller number and controller I/O point number.
 - .3 Equipment schedule for all hardware, valves, dampers, field instrumentation, input/output devices, transducers and actuators.
 - .4 Technical description and specifications for the primary and sub-networks.
 - .5 Schematic diagram for each mechanical system showing all input/output points, wiring diagrams for all I/O points and a written detailed operational description of control sequences. For terminal equipment controllers, submission of field point wiring diagrams for each type is adequate.
 - .6 Engineering/technical data and maintenance information for each system component, including sizing and arrangements as requested. Include calculations for control valve selections.

- .3 Shop drawings are to be submitted in an organized fashion complete with table of contents, tab sheets and sequentially numbered pages to enable easy location of information. This also applies to component data sheets.

- .4 Component data sheets shall be organized by device type with tab sheets for each section i.e. Controllers, Digital Input devices, Digital output devices, Analog input devices, Analog output devices.

- .5 The table of contents for component data sheets must indicate product description, specification I/O device type or specification section, and page number.

- .6 Component specification sheets that include more than one product shall be clearly marked to identify the applicable product(s), options and specifications.

- .7 Submit copies of the complete shop drawings to the consultant for review and approval. Partial submissions may be accepted depending on the detail and acceptance by the Consultant. Provide additional copies of the complete approved shop drawings with the O&M Manuals.

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- .8 Within 120 days after award of the contract submit printed copies of all dynamic graphic displays, proposed calibration check sheets.
 - .9 Within 180 days after award of the contract submit two (2) draft Operating and Maintenance manuals as specified in this section under System Documentation.
 - .10 BAS shop drawings shall be based on approved mechanical equipment shop drawings. The Mechanical Contractor is to provide approved mechanical equipment shop drawings to the BAS Contractor.

1.6 Owner Orientation

- .1 Formal training sessions shall commence only after "as-built" drawings have been completed, reviewed and approved by the Engineer.
- .2 Individuals who have had specific training as an instructor shall conduct training sessions.
- .3 All training sessions shall include training materials and shall follow a documented course outline.
- .4 A copy of the training materials, which shall include a detailed course outline, shall be submitted to the Engineer for approval three weeks prior to commencing any training sessions.
- .5 Any training conducted without prior approval of the Engineer shall be repeated at the discretion of the Engineer and/or will not count toward the contractors training obligations.
- .6 The BAS contractor shall provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.
- .7 The BAS contractor shall provide three (3) complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Engineer.
- .8 Provide for operator training according to the following schedule.
 - .1 A one (1) day system and component familiarization seminar/workshop during the first week of trial usage.
 - .2 A one (1) day seminar/workshop the week before the 7-day acceptance test covering all aspects of system use as follows:
 - .1 Operation of hardware components
 - .2 System software configuration
 - .3 User/system interaction
 - .4 Calibration of sensors and system
 - .5 Trouble shooting of system and components

.6 Preventative maintenance

.3 A one (1) day review workshop at one month after system acceptance.

1.7 Warranty

.1 Include warranty provisions identified in the specifications.

.2 In addition to the warranty in item .1, provide a two (2) year warranty on all items provided under this contract including but not limited to all equipment, wiring and software. The warranty period shall commence on the date of final written acceptance of the BAS system.

.3 Provide on site service including all labor, materials and software to maintain the complete control system in optimal functioning condition during the warranty period.

.4 Perform preventive maintenance (PM) during the warranty period.

.5 In addition to warranty call backs provide one (1) service and calibration inspections of a minimum four (4) of hours duration. These calls will be initiated by the Owner.

.6 The overtime premiums for weekend and overtime service calls shall be clearly identified within your proposal.

.7 The BAS contractor shall supply and install at no cost all system software updates and upgrades occurring up to 2 months prior to the expiration of the warranty period.

.8 Maintain a service log on site of all control system maintenance activities during the warranty period.

1.8 System Activation

.1 Submit control calibration and point verification check sheets to the Engineer for approval prior to any calibration of devices or end to end point verification commences. Check sheets to include:

.1 Controller identification number

.2 Controller input/output point number

.3 Control point mnemonic

.4 A complete concise English description of each point

.5 Device controlled

.6 Interlock devices

.7 Measured and displayed analog input values

.8 Analog Output zero and full scale verification

.9 End to End verification for all points

.10 Wire labels verification

- .11 Device tag verification
- .12 Date of verification
- .13 Initials of person performing verification
- .2 Submit sample control loop trend log plot, of the type to be used for demonstrating control loop tuning, to the Engineer for approval.
- .3 Verify that each hardware component has been properly installed as recommended by the manufacturer and is functioning correctly.
- .4 Calibrate all devices including sensors, transmitters, transducers, current relays, valve actuators, damper motors, etc., verifying that end to end calibration accuracy as specified has been achieved.
- .5 Ensure tight shut off and fail safe operation of valves and dampers. Hysteresis shall not be greater than 5% of the operating range.
- .6 Set damper linkages, static pressure/volume controls as required.
- .7 Set up run time capture for each digital input point.
- .8 Set up alarm point for each digital input/output pair, with delay before alarm is annunciated.
- .9 Set up deviation alarm for each control loop measured variable input with appropriate alarm interlocks, dead-bands and time delays.
- .10 Set up high and low alarm limit points for analog input points as shown on the point list.
- .11 Set up zero scale and full scale alarms for each analog input to alarm point failures.

1.9 Acceptance Testing

- .1 A final operational acceptance test of seven consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the specifications.
- .2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software. Specific testing shall include but not be limited to:
 - .1 Power Failure Restart.
 - .2 Room Temperature Reset Schedules
 - .3 Mechanical Heating

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- .3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free test days have occurred.
 - .4 Prior to conducting the final operational acceptance testing, submit to the Engineer:
 - .1 Completed calibration and verification check sheets including airflow station calibration sheets.
 - .2 Hard copy and electronic copy on CD of final data base listings.
 - .3 If electronic copy of final database listing is not in Microsoft Word, Excel or Access format, provide a final points list to the Engineer in either Microsoft Word, Excel, or Access format.
 - .4 Hardcopy of all system Graphics.
 - .5 A signed declaration stating that all work has been completed or identifying any outstanding deficiencies and the anticipated completion date(s).
 - .5 After successful completion of the acceptance test, the Engineer will issue written acceptance of the control system.
 - .6 For all systems prior to substantial completion the BAS contractor shall successfully demonstrate the response to
 - .1 All fire alarm interlocks, shut-down sequences and fire control strategies
 - .2 All power failure interruptions
 - .7 The initiation of the Fire Alarm system into alarm mode and simulation or tripping of the main power feeders shall be performed by others.

1.10 System Documentation

- .1 Operating and Maintenance Manuals
 - .1 The BAS Operation and Maintenance Manuals shall contain operational, product data, cleaning and maintenance information on all products and equipment supplied as part of this projects BAS. The final Manuals shall accompany the Project Record Drawings and shall be in place prior to substantial performance.
 - .2 Submit a draft Manual for format review three (3) months after award of Contract and three (3) Manuals of Documentation for interim submission at 75% construction. Draft Manuals are to be complete in all aspects less control programming. Interim submission is to include all control shop drawings, programming and system descriptions. Draft and Interim Manuals are to be submitted in 3 ring binders. Final Manuals to be in catalogue type binder.

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- .3 Each manual shall be 215 mm x 280 mm capacity extension type Catalogue Binder bound in heavyweight fabricord, colour to be reviewed with the Owner prior to order and hot stamped in white lettering front and spine.
 - .4 The spine and front face of the binder shall be lettered with the following:
 - .1 Full identification title of the project
 - .2 Building Automation System
 - .3 Operation and Maintenance Manual
 - .4 Set X of Y
 - .5 Volume X of Y
 - .5 The manual shall be arranged according to the following format. Utilize colour coded laminated mylar plastic divider tabs with headings according to section.
 - .1 Table of Contents
 - .2 Introduction
 - .3 Control System Design
 - .4 Building System Descriptions
 - .5 DDC Panel Layout
 - .6 Shop Drawings
 - .7 Equipment Schedules
 - .8 Certification and Testing
 - .9 Product Manuals
 - .10 Maintenance
 - .11 Software & Certificates
 - .6 On the first page of each binder, before the table of contents identify the following:
 - .1 Prime Consultant: name, address, telephone number.
 - .2 Contractor: name, address, telephone number.
 - .3 Subcontractors: name address, telephone number.
 - .7 Table of Contents
 - .1 Include in each binder a table of contents that provides an index in order of appearance of all sections and subsections within the manual.
 - .8 Introduction
 - .1 Provide a written explanation of the layout of the manual.

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- .2 List all other control system manuals submitted for this project including all software manuals and hardware manuals. Identify the quantities of each manual provided.
 - .9 Control System Design
 - .1 Design Intent
 - .1 Explain, in this section, the design intent and give a system overview which outlines the relationships between the hardware, operating system, control software and other control components.
 - .2 Provide a detailed description of all parts, components and software in the system.
 - .3 Describe the system architecture. Provide a system configuration schematic with the location, type and model of all control panels, work stations, remote access modems, etc. and identify the major equipment monitored and controlled by each panel.
 - .4 The schematic must identify network communication protocols and communication speeds between all control panels and indicate BACnet compatibility where applicable.
 - .5 Identify the number of controllers that can be added to each network and sub-network and any maximum distance between controllers or maximum length of network without the need to add additional communication devices.
 - .6 Identify all software products provided including third party software. This shall include but not be limited to all operator workstation, graphics, controller and laptop software. For each product, indicate the number of software licenses provided, the name of the respective vendor and any software protection devices required. Indicate the number of software protection devices provided.
 - .2 Operations
 - .1 Provide an overview of the building automation system operations. Include basic instruction on:
 - .1 System access
 - .2 Alarms management (including, how and where alarms are annunciated, after-hours reporting of critical alarms, etc.)

- .3 Commonly used reports
 - .4 Laptop, local and remote system access and
 - .5 Basic trouble shooting directions.
 - .2 These instructions are to provide a basic understanding of the system operations and are to reference specific areas of the software manuals for further detailed instructions.
 - .3 Provide detailed back-up and data recovery procedures including recommended frequencies and data to be backed up. Here again refer to specific areas of product manuals where appropriate. Provide sample back-up log sheets.
- .10 Building System Descriptions
 - .1 System Design intent - Explain, in this section, the design intent and give a system overview which outlines the system components and the intended system function.
 - .2 Provide a schematic, control sequences, wiring diagram, device list and points list for each building system controlled by the BAS.
 - .3 Control sequences shall identify start-up and shut-down sequences, control loop set-points, reset schedules, system interlocks, etc.
 - .4 As built record drawings in 11" X 17" format, folded to fit into the O&M binders may be used to provide part or all of the information required for this section.
- .11 DDC Panel Layout
 - .1 Provide as-built panel layout sheets and include locations of all panels.
 - .2 Include a panel points list that identifies each point name with concise English description and termination point. Identify panel spare points.
 - .3 Identify power source for each panel including emergency/normal, UPS, panel number and circuit number.
- .12 Shop Drawings
 - .1 Insert in this section all approved shop drawings organized in the format specified in section 23 05 00 – Common Work Results for HVAC.
- .13 Equipment Schedules

- .1 Provide an equipment schedule for all hardware provided including valves, dampers, actuators, controllers, transducers, input/output devices and other instrumentation.
- .14 Certification and Testing
 - .1 Provide final copies of all completed calibration and verification check sheets including all airflow station calibration check sheets.
- .15 Product Manuals
 - .1 Include in this manual or within product, user manuals and technical manuals, complete and detailed instruction on the use, setup and support of all control system software and hardware provided under this project.
 - .2 Provide detailed instructions on set-up and user operations including but not limited to system access, navigation, alarms, trending, historical trending, reporting and trouble shooting.
 - .3 Provide complete detailed instruction on database structure, set-up, initialization, expansion and editing.
 - .4 Provide complete detailed instruction to enable creation, modification and implementation of control sequences.
- .16 Maintenance
 - .1 Provide a description in this section of maintenance procedures for all equipment and systems, as defined in this specification, including a schedule for recommended planned and preventative maintenance work items and intervals.
 - .2 Include a preventative maintenance program complete with suggested check list sheets.
 - .3 Provide a list of resources to call upon for maintenance and servicing of equipment which includes name, address and phone numbers for supplier and service contact for each piece of equipment.
 - .4 Include in this section a complete set of as-built drawings if not included elsewhere in this manual.
 - .5 Certification, guarantee, warranty.
- .17 Software & Certificates
 - .1 Provide original copies of all software distribution media on CDs inserted into vinyl page holders that are designed for 3 ring binders. The originals are to be provided in "Set 1" of these O&M manuals and back-up copies are to be provided in "Set 2".

- .2 Provide software registration certificates, or other documents that verify authenticity of software.
- .3 Provide back-up copies of entire system at the time of system turn over on CDs in vinyl CD page holders designed for 3 ring binders. Backup to include complete control sequence source code.

1.11 Record Drawings

- .1 Before the certification of substantial performance will be issued the contractor must provide the Engineer with record drawings as follows:
 - .1 One electronic copy of record drawings in AutoCAD version 2000 or Visio format.
 - .2 Four (4) copies of as-built white prints in 280mmx432mm (8½" x 17") capacity blue binders bound in heavy fabricated, hot stamped in white lettering front and spine. Each is to be identified As-Built Drawings and permanently numbered 1 to 4.
 - .3 The spine shall be lettered with the full identification title of the project and the front face shall be lettered with the following on the respective binders:
 - .1 Full identification title of the project
 - .2 Prime Consultant and Sub-Consultant - full identification
 - .3 Prime Contractor - full identification
 - .4 Mechanical Contractor - full identification
 - .4 Maintain an accurate record of all deviations and changes on a record drawing set of prints. Such record is to be maintained on a day-to-day basis.
 - .5 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

2. Products

2.1 Approved Contractors & Suppliers

- .1 Tenders on the following will be accepted:
 - .1 Siemens Building Systems – APOGEE product
 - .2 Johnson Controls – Metasys product
 - .3 ESC Automation – Delta Controls product
 - .4 Serv-All – Reliable Controls

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- .2 Alternates to these approved control system products can be submitted as a separate price from the base system specified.

2.2 General

- .1 Provide control system components consisting of sensors, motorized dampers, actuators, indicating devices, and interface equipment required to operate mechanical equipment and perform functions specified.
- .2 Provide all materials and labor required to connect control components.

2.3 BAS Architecture

- .1 The BAS system shall be native BACnet, utilizing BACnet BTL approved modules.
- .2 The BAS shall be comprised of a stand-alone digital controller and other devices as specified herein.
- .3 The BAS shall incorporate the ability to access all user interface functions as specified within these documents using standard internet browsers. Operator access to the BAS shall not require any proprietary operator interface or configuration software to be loaded on the respective PC and access shall only be limited by password.
- .4 The BAS system shall incorporate BACnet native devices and they shall be ANSI/ASHRAE 135-2012 BACnet BTL compliant. For components utilized on this project, they shall include the following capabilities:
 - .1 Building Controllers – BACnet I/P with Building Controllers software (B-BC)
 - .2 Advanced Application Controllers – BACnet I/P and/or MS/TP with Advanced Application software (B-AAC)
 - .3 Third Party Devices – BACnet I/P and/or MS/TP with BACnet software
- .5 The installed system shall provide secure multilevel password access to all features, functions and data contained in the overall BAS.
- .6 Provide licenses for all software residing in the BAS system and transfer these licenses to the Owner, at no cost, prior to project completion. Provide software on CDs and/or DVDs and licenses for:
 - .1 Database creation and editing
 - .2 Engineering of the system
 - .3 Service, Troubleshooting and/or Tool software
 - .4 Trending
 - .5 Historical trending to cover all hardware and software points

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- .7 With the CDs and/or DVDs as noted above it shall not require the Owner to obtain any information, data, programs, etc. from the manufacturer and shall not require access over the internet to the manufacturer's site to perform the functionality. Provide 3 copies of the above CDs and/or DVDs.
 - .8 Downloading and Uploading
 - .1 Provide the capability to generate BAS software-based sequences, database items and associated operational definition information and user-required revisions to same, at any Operator PC, and the means to download same to the associated controller.
 - .2 Application software tool used for the generation of custom logic sequences shall be provided to the owner as part of this project.
 - .3 Provide the capability to upload BAS operating software information, database items, sequences and alarms to the designated server.

3. Execution

3.1 Electrical Work

- .1 The BAS contractor shall supply and install all line and low voltage power and control wiring for the BAS system, including all 120/1/60 emergency power wiring to power the various BAS components. Refer to Section 23 09 13 for system requirements.
- .2 For each 120/1/60 exhaust fan motor that is controlled from the BAS, the BAS contractor shall supply an electrical horsepower rated relay module, fully enclosed and turn over to the Electrical contractor for installation. The power wiring to the module and from the module to the motor shall be provided by the Electrical contractor, with the BAS contractor supplying and installing the control wiring to the BAS system.
- .3 The BAS contractor shall supply and install all necessary 120/24 transformers and power supplies for the BAS equipment and shall supply and install all conduit, wire, fittings, boxes, etc. to extend the 24 volt AC/DC power to all the BAS equipment.
- .4 Separate 120/24 volt transformers and/or power supplies shall be provided to each digital controller and transformers shall not be shared between digital controllers nor shall the transformers serving the digital controllers power the sensors, transducers, etc.

3.2 MUA Unit

- .1 The units providing make up air to the building shall be complete with integral controls to control the full functionality of the unit.
- .2 Each unit shall provide external dedicated hardware connection points to the BAS for overall monitoring and enabling of the unit.

3.3

Exhaust Fans

- .1 Refer to the points list for exhaust fans that are controlled. Provide separate control and monitoring of fans for each typical application.

END OF SECTION

1. General

1.1 Scope

- .1 Control Devices and Hardware
 - .1 Control Panels
 - .2 Wire
 - .3 Conduit and Cables
 - .4 Related Accessories
 - .5 Room Sensors
 - .6 Outdoor Air Sensors
 - .7 Duct Mount Sensors

2. Products

2.1 Control Panels

- .1 Mount digital controllers in control panels with field interface equipment (i.e. relays, transducers, etc.) segregated in the panel and minimizing the electrical interference and heat to the digital controllers.
- .2 The power supplies, transformers, contactors, etc. shall be mounted in separate ventilated metal enclosures.
- .3 Control panels are to be of unitized cabinet type construction, fabricated from rolled sheet metal sheet with baked enamel finish, flush fitting, gasketed doors hung on piano type hinges and locking handles. All panels shall be CSA approved and equal to Hoffman enclosures and shall be common keyed.
- .4 Mount pilot lights and switches flush on cabinet panel face.
- .5 Mount panels on vibration free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- .6 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.
- .7 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 volt supply.
- .8 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

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- .9 Identify all wiring by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.
 - .10 Install bonding conductor between main control and auxiliary panels complete with grounding lugs, in addition to CSA grounding requirements.
 - .11 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.
 - .12 Power for control panels shall be 120/1/60 15 amp circuits from power panel with wiring from power panel by the BAS contractor.

2.2 Wire

- .1 Control wiring for digital functions shall be 20 AWG minimum with 300 Volt insulation.
- .2 Control wiring for analog functions shall be 20 AWG minimum with 300 Volts insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.
- .3 Sensor wiring shall be 22 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

2.3 Conduits and Cables

- .1 All wiring, whether line voltage, low voltage or control wiring shall be in conduit or fully enclosed metal trays. Flexible conduit may be used for final connection of control devices. Maximum length of flexible conduit to be 1m (3 ft). Conform to Division 26 requirements for conduit, tray, fittings, junction boxes, cabinets, wire, cable and trays specifications.
- .2 Exposed plenum rated cable shall not be utilized; all wiring shall be in conduit.
- .3 Seal conduit where such conduit leaves heated areas and enters unheated area.
- .4 In the field, run low level (<30 volts) signal lines in separate conduit from high level (>30 volts) signal and power transmission lines.
- .5 In the field panel, run low level signal lines in separate conduit from high level signal and power transmission lines.
- .6 Identify each cable and wire at every termination point by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring.
- .7 Provide instrumentation complete with standard electrical conduit box for termination unless otherwise noted.

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- .8 Color code all conductors and conduits by permanently applied color bands. Color code shall follow base building schedule. Color code all conduit couplings orange, with orange banding on the conduits.
 - .9 All wiring for terminal equipment controllers including network communications, sensors and actuator wiring must be in conduit.

2.4 Related Accessories

- .1 Provide and install all necessary transducers, interposing relays, interface devices, etc., to perform control functions required.
- .2 It is the responsibility of the BAS Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

2.5 Thermostats and Room Sensors

- .1 Provide tamper proof guards for the space sensor. Guards to be equal to BAPI-Guard.

2.6 Duct Mount Sensors

- .1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
- .2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

3. Execution

3.1 Installation

- .1 Verify location of sensors and other exposed control sensors with drawings before installation. Locate room temperature sensors 1500mm (5 ft) above floor.
- .2 Install the control panel containing the digital controller at the location as shown on the drawings.
- .3 Wire "hand/off/auto" selector switches such that only automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.
- .4 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.
- .5 Install all safety limits at the operator's level.
- .6 Control System Power

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- .1 Provide power to all BAS components as necessary to provide continued monitoring and control.
 - .2 Power for all transducers and other instrumentation associated with a controller shall come from the same circuit that is feeding the digital controller.
 - .3 Identify in the record drawings the panel and circuit number serving each controller.

END OF SECTION

1. General

- .1 This section is a module which specifies the Field Instrumentation, Sensing Devices and Actuators.
- .2 For general requirements relating to all sections see Section 23 09 00 – Instrumentation and Control for HVAC.

2. Products

2.1 General

- .1 Provide analog or digital field instrumentation devices as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the ASC and/or SCU terminal strip that conform to the input requirements.
- .2 Provide output devices and actuators which convert the digital or analog output signal from the ASC and/or SCU to activate relays or open and close valves, dampers, etc.
- .3 The end to end accuracy called for in Subsection 2.2 includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the input to the analog-to-digital convertor in the ASC and/or SCU or between the ASC and/or SCU input to the digital-to-analog convertor and the controlled variable for the full sensing range.
- .4 The letter under the "Type" column in Subsection 2.2 is the same used in the points list.
- .5 Acceptable manufacturers of sensors are indicated in Section 3.0.

2.2 Analog Input Sensors

- .1 Temperature

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct Mounted	Tp	0°C to 60°C (32°F to 140°F)	±0.5°C	
Pipe Well Mounted	Tw	0°C to 50°C (32°F to 122°F)	±0.5°C	c/w thermal wells
		0°C to 100°C (32°F to 212°F)	±0.5°C	
		50°C to 150°C (122°F to 300°F)	±0.5°C	
Averaging	Ta	-30°C to 60°C (-20°F to 140 °F)	±0.5°C	Length to suit duct side

Space Temp.	Tr	10°C to 301°C (50°F to 572°F)	±0.5°C	c/w tamper-proof cover
Outside Air	To	-50°C to 50°C (-58°F to 122°F)	±1.0°C	c/w solar-shield
Surface Temp	Ts	0°C to 50°C (32°F to 122°F)	±0.3°C	

.2 Relative Humidity

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct mounted	Hp	5 - 90% RH 0°C to 60°C (32 °F to 140 °F)	±5%	
Space	Hr	5 - 90% RH	±5%	c/w tamper-proof cover
Outside air	Ho	5 - 100% RH	±5%	c/w solar-shield

.3 Pressure

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Static-water	Ps	0 to 104 kPa (0 to 15 psi)	±2%	
		0 to 208 kPa (0 to 30 psi)	±2%	
		0 to 689 kPa (0 to 100 psi)	±2%	
		0 to 2,000 kPa (0 to 300 psi)	±2%	
Static-air	Sp	0 to 500 Pa (0 to 2" WG)	±2%	
		0 to 1,250 Pa (0 to 5" WG)	±2%	
		0 to 2,500 Pa (0 to 10" WG)	±2%	
Instrument	Ia	0 to 150 kPa (0 to 20 psi)	±2%	
Velocity pressure monitoring station – air	Vp	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±1.0%	-multi-point static & total pressure sensing element manifold -self-averaging manifold -air equalizer &

straightener
 -max. pressure loss 36 Pa @ 10 m/sec.
 -lowest sensitivity 1% of range

Flow monitoring station – water, steam	Pv	As required	±2.0%	-Paddle wheel
Fan Inlet- Air Flow Traverse Probes	Vpi	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±3.0%	Multiple total and static pressure sensors connected to a self averaging manifold. Provide steady non-pulsating signals of standard total and static pressure. Accuracy of ±3.0% of actual flow over a fan operating range of 6 to 1 capacity turn down.

.4 Electrical

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Kilowatts	kW	Various voltages		From digital metering systems
Current transmitters	Ct	As required	±0.25% full scale	

2.3 Analog Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
To damper motors	De	0 - 10 VDC 4-20 MA	±2% full scale	
To valve actuators	Ve	0 - 10 VDC 4 - 20 MA	±1% full scale	

2.4 Digital Input Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Pressure	Pd	As required	±1.5%	-adjustable setpoint

Switches				full scale	and differential
Temperature	Td	As required		±1°C	-adjustable setpoint and differential -automatic reset -normal reset for freeze protection
Current Sensing Relays	Ri	As required		N/A	-adjustable trip c/w LED Status indication.
Motor status Relays	St	As required		N/A	-auxiliary contacts
Level	Ls	N/A		N/A	
Misc Inputs	Rc	N/A		N/A	Auxiliary contacts

2.5 Digital Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Relays	Ry	N/A	N/A	Plug-in type with terminal base contacts rated at 5 amp 120 VAC.

3. Execution

3.1 General

- .1 Codes and Standards
 - .1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, latest CSA Electrical Bulletins and Division 26.
- .2 Current sensing relays shall be equal to Greystone series CS-610-75 with LED and range adjustment and provide a dry contact signal.
- .3 Static and differential air pressure transmitters shall be equal to SETRA DPT 264 series, 1.0% accuracy with a 0-10V DC and/or 4-20 ma signal for connection to the BAS.
- .4 For each static and/or differential air flow transmitter, air pressure switch, etc. connection into the ductwork provide a standard production Dwyer series 160 pitot tube, or equal, with duct clamp and gasket for sensing the total and/or static pressure.
- .5 Differential pressure transmitters shall be located in the control panel with tubing extended out to the filter modules. Install tubing in conduit.

- .6 For all the various transducers, supply and install the required transformers, power supplies, fusing, filters, etc. as required to provide the reduced voltage to the devices.

END OF SECTION

1. General

- .1 The control sequences below provide a general description of the intent of the operation of the systems to be controlled. The BAS Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 Consult with the Engineer during the shop drawing stage to finalize the control sequences for each system
- .3 The BAS Contractor shall ensure that all end devices and sensors are on
- .4 On loss of building power and building power being restored, all equipment, including that on emergency power, shall be reset to nominal start up conditions and shall run through its normal start up sequence prior to returning to required operating conditions.

1.2 Systems

- .1 Make-Up Air Unit
- .2 Exhaust Fans

2. Products

Not Applicable

3. Execution

3.1 General

- .1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

3.2 Make-Up Air Unit

- .1 Make-up air unit MUA-1 is an outdoor, constant volume, 100% outside air system serving the firing range. The unit consists of an outside air intake, filter section, one (1) supply air fan complete and direct gas-fired heat exchanger.
- .2 System Start/Stop
 - .1 The Make Up Air system will be energized via the BAS and operate continuously when selected by the operator.
 - .2 The outside air damper on the Make Up Air unit shall be opened and when the damper is open the supply fan shall start, and the exhaust fan shall be indexed to operate. An end switch on the motorized damper for the exhaust air fan shall allow the exhaust fan to operate when the damper is fully open.

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- .3 When status of the exhaust fan is proven, the heating in the Make Up Air unit shall be enabled by the BAS and controls integral in the Make Up Air unit shall control the burner.
 - .4 Upon a signal from the Fire Alarm system, the Make Up Air system and associated exhaust fan shall be de-energized; the connection to the Fire Alarm system shall be hardwired by the Electrical contractor.
 - .5 The BAS control panel shall be located in the firing range control room for ventilation system operation. The panel shall also provide status lights for unit operation, alarm and filter status.

.3 Temperature Control

- .1 The make-up air unit shall be controlled by the integral controls and shall modulate the gas valve to maintain a supply air temperature setpoint. The supply air temperature setpoints shall be provided by the BAS.
- .2 A space sensor shall be utilized in the BAS software to optimize the supply air setpoint to meet acceptable space conditions.

.4 Filter Operation

- .1 Provide individual differential pressure sensors across the pre-filters and HEPA filters to monitor the status of the filters.
- .2 Provide software limits on the differential pressure sensors to turn on a pilot light on the panel to indicate filter change requirements.

3.3 Cleaning Station

- .1 The exhaust fan EF-2 shall be energized by a manual switch located adjacent to the cleaning station, with no connection or monitoring by the BAS.

END OF SECTION

Miscellaneous

System

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Range HEPA Filter Differential Pressure Change Filter Soor Change Filter Now	Sp Ry Ry		X X			X		X	Remote Pilot light Remote Pilot light
Range Pre-Filter Differential Pressure Change Filter Soor Change Filter Now	Sp Ry Ry		X X					X	Remote Pilot light Remote Pilot light

1. General

1.1 Scope

- .1 Provide all materials and services as documented within these specifications and as required to furnish a complete addition to the existing DDC Building Automation System (BAS) to monitor and control the building systems referred to in this specification.
- .2 The work includes the supply and installation of DDC controllers, instrumentation, control devices, conduit, wiring, tubing and other devices as necessary to provide a complete system of BAS controls, compliant with these specifications.
- .3 Supply, install and configure all software, programming and databases; set up equipment operating schedules; and perform system activation functions as identified within these specifications, to provide a complete and fully operational BAS. Include for modification of the existing database, graphics, programming, etc. as required.
- .4 Provide:
 - .1 Submittals,
 - .2 System Documentation,
 - .3 Acceptance Testing, and
 - .4 Instructions to Owners

1.2 Related Work

- .1 Instrumentation and Control Devices for HVAC Section 23 09 13
- .2 Sequence of Operations for HVAC Controls Section 23 09 93.1
- .3 Point Schedules for HVAC Controls Section 23 09 93.2

1.3 Work by Others

- .1 Distribution and installation of wells, flow insertion fittings, motorized valves and motorized dampers into the piping systems.

1.4 Quality Assurance

- .1 The BAS equipment shall be of the same manufacturer as the existing BAS system and from manufacturer's factory authorized service, resident in the City of Edmonton.
- .2 Software engineering and support shall be resident in the City of Edmonton.

1.5 Shop Drawings

- .1 Submit shop drawings in accordance with Section 23 05 00 – Common Work Results for HVAC and with the requirements outlined below.

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- .2 Submit the shop drawings and technical data describing the proposed system within 90 days after award of the BAS contract.
 - .1 The proposed digital I/O points list including at a minimum the point mnemonic, point description, controller number and controller I/O point number.
 - .2 Equipment schedule for all hardware, valves, dampers, field instrumentation, input/output devices, transducers and actuators.
 - .3 Schematic diagram for each mechanical system showing all input/output points, wiring diagrams for all I/O points and a written detailed operational description of control sequences. For terminal equipment controllers, submission of field point wiring diagrams for each type is adequate.
 - .4 Engineering/technical data and maintenance information for each system component, including sizing and arrangements as requested. Include calculations for control valve selections.
 - .3 Shop drawings are to be submitted in an organized fashion complete with table of contents, tab sheets and sequentially numbered pages to enable easy location of information. This also applies to component data sheets.
 - .4 The table of contents for component data sheets must indicate product description, specification I/O device type or specification section, and page number.
 - .5 Component specification sheets that include more than one product shall be clearly marked to identify the applicable product(s), options and specifications.
 - .6 Submit copies of the complete shop drawings to the consultant for review and approval. Partial submissions may be accepted depending on the detail and acceptance by the Consultant. Provide additional copies of the complete approved shop drawings with the O&M Manuals.
 - .7 Within 120 days after award of the contract submit printed copies of all dynamic graphic displays, proposed calibration check sheets.
 - .8 BAS shop drawings shall be based on approved mechanical equipment shop drawings. The Mechanical Contractor is to provide approved mechanical equipment shop drawings to the BAS Contractor.

1.6 Owner Orientation

- .1 Formal training sessions shall commence only after "as-built" drawings have been completed, reviewed and approved by the Engineer.
- .2 Individuals who have had specific training as an instructor shall conduct training sessions.
- .3 All training sessions shall include training materials and shall follow a documented course outline.

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- .4 A copy of the training materials, which shall include a detailed course outline, shall be submitted to the Engineer for approval three weeks prior to commencing any training sessions.
 - .5 Any training conducted without prior approval of the Engineer shall be repeated at the discretion of the Engineer and/or will not count toward the contractors training obligations.
 - .6 The BAS contractor shall provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.
 - .7 The BAS contractor shall provide three (3) complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Engineer.
 - .8 Provide for operator training according to the following schedule.
 - .1 A one (1) day system and component familiarization seminar/workshop during the first week of trial usage.
 - .2 A one (1) day seminar/workshop the week before the 7-day acceptance test covering all aspects of system use as follows:
 - .1 Operation of hardware components
 - .2 System software configuration
 - .3 User/system interaction
 - .4 Calibration of sensors and system
 - .5 Trouble shooting of system and components
 - .6 Preventative maintenance
 - .3 A one (1) day review workshop at one month after system acceptance.

1.7 Warranty

- .1 Include warranty provisions identified in the specifications.
- .2 In addition to the warranty in item .1, provide a two (2) year warranty on all items provided under this contract including but not limited to all equipment, wiring and software. The warranty period shall commence on the date of final written acceptance of the BAS system.
- .3 Provide on site service including all labor, materials and software to maintain the complete control system in optimal functioning condition during the warranty period.
- .4 Perform preventive maintenance (PM) during the warranty period.
- .5 In addition to warranty call backs provide one (1) service and calibration inspections of a minimum four (4) of hours duration. These calls will be initiated by the Owner.

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- .6 The overtime premiums for weekend and overtime service calls shall be clearly identified within your proposal.
 - .7 The BAS contractor shall supply and install at no cost all system software updates and upgrades occurring up to 2 months prior to the expiration of the warranty period.
 - .8 Maintain a service log on site of all control system maintenance activities during the warranty period.

1.8 System Activation

- .1 Submit control calibration and point verification check sheets to the Engineer for approval prior to any calibration of devices or end to end point verification commences. Check sheets to include:
 - .1 Controller identification number
 - .2 Controller input/output point number
 - .3 Control point mnemonic
 - .4 A complete concise English description of each point
 - .5 Device controlled
 - .6 Interlock devices
 - .7 Measured and displayed analog input values
 - .8 Analog Output zero and full scale verification
 - .9 End to End verification for all points
 - .10 Wire labels verification
 - .11 Device tag verification
 - .12 Date of verification
 - .13 Initials of person performing verification
- .2 Submit sample control loop trend log plot, of the type to be used for demonstrating control loop tuning, to the Engineer for approval.
- .3 Verify that each hardware component has been properly installed as recommended by the manufacturer and is functioning correctly.
- .4 Calibrate all devices including sensors, transmitters, transducers, current relays, valve actuators, damper motors, etc., verifying that end to end calibration accuracy as specified has been achieved.
- .5 Ensure tight shut off and fail safe operation of valves and dampers. Hysteresis shall not be greater than 5% of the operating range.
- .6 Set damper linkages, static pressure/volume controls as required.

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- .7 Set up run time capture for each digital input point.
 - .8 Set up alarm point for each digital input/output pair, with delay before alarm is annunciated.
 - .9 Set up deviation alarm for each control loop measured variable input with appropriate alarm interlocks, dead-bands and time delays.
 - .10 Set up high and low alarm limit points for analog input points as shown on the point list.
 - .11 Set up zero scale and full scale alarms for each analog input to alarm point failures.

1.9 Acceptance Testing

- .1 A final operational acceptance test of seven consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the specifications.
- .2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software. Specific testing shall include but not be limited to:
 - .1 Power Failure Restart.
 - .2 Room Temperature Reset Schedules
 - .3 Mechanical Heating
- .3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free test days have occurred.
- .4 Prior to conducting the final operational acceptance testing, submit to the Engineer:
 - .1 Completed calibration and verification check sheets including airflow station calibration sheets.
 - .2 Hard copy and electronic copy on CD of final data base listings.
 - .3 If electronic copy of final database listing is not in Microsoft Word, Excel or Access format, provide a final points list to the Engineer in either Microsoft Word, Excel, or Access format.
 - .4 Hardcopy of all system Graphics.
 - .5 A signed declaration stating that all work has been completed or identifying any outstanding deficiencies and the anticipated completion date(s).

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- .5 After successful completion of the acceptance test, the Engineer will issue written acceptance of the control system.
 - .6 For all systems prior to substantial completion the BAS contractor shall successfully demonstrate the response to
 - .1 All fire alarm interlocks, shut-down sequences and fire control strategies
 - .2 All power failure interruptions
 - .7 The initiation of the Fire Alarm system into alarm mode and simulation or tripping of the main power feeders shall be performed by others.

1.10 System Documentation

- .1 Operating and Maintenance Manuals
 - .1 The existing BAS Operation and Maintenance Manuals shall be updated with the new data sheets and system schematics.

1.11 Record Drawings

- .1 Before the certification of substantial performance will be issued the contractor must provide the Engineer with record drawings as follows:
 - .1 Four (4) copies of as-built white prints in 280mmx432mm (8½" x 17") capacity.

1.12 Approved Contractors & Suppliers

- .1 Tenders on the following will be accepted from:
 - .1 ServAll Mechanical using Reliable Controls

1.13 General

- .1 Provide control system components consisting of sensors, motorized dampers, actuators, indicating devices, and interface equipment required to operate mechanical equipment and perform functions specified.
- .2 Provide all materials and labor required to connect control components.

1.14 BAS Architecture

- .1 The BAS system shall be native BACnet, utilizing BACnet BTL approved modules.
- .2 The BAS shall be comprised of a stand-alone digital controller and other devices as specified herein.

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- .3 The BAS system shall incorporate BACnet native devices and they shall be ANSI/ASHRAE 135-2012 BACnet BTL compliant. For components utilized on this project, they shall include the following capabilities:
- .1 Building Controllers – BACnet I/P with Building Controllers software (B-BC)
 - .2 Advanced Application Controllers – BACnet I/P and/or MS/TP with Advanced Application software (B-AAC)
 - .3 Third Party Devices – BACnet I/P and/or MS/TP with BACnet software

2. Execution

2.1 Electrical Work

- .1 The BAS contractor shall supply and install all line and low voltage power and control wiring for the BAS system, including all 120/1/60 emergency power wiring to power the various BAS components. Refer to Section 23 09 13 for system requirements.
- .2 For each 120/1/60 exhaust fan motor that is controlled from the BAS, the BAS contractor shall supply an electrical horsepower rated relay module, fully enclosed and turn over to the Electrical contractor for installation. The power wiring to the module and from the module to the motor shall be provided by the Electrical contractor, with the BAS contractor supplying and installing the control wiring to the BAS system.
- .3 The BAS contractor shall supply and install all necessary 120/24 transformers and power supplies for the BAS equipment and shall supply and install all conduit, wire, fittings, boxes, etc. to extend the 24 volt AC/DC power to all the BAS equipment.
- .4 Separate 120/24 volt transformers and/or power supplies shall be provided to each digital controller and transformers shall not be shared between digital controllers nor shall the transformers serving the digital controllers power the sensors, transducers, etc.

2.2 MUA Unit

- .1 An existing AHU unit provides make up air to the building and is complete with digital controls to control the full functionality of the unit.

2.3 Exhaust Fans

- .1 Refer to the points list for exhaust fans that are controlled. Provide separate control and monitoring of fans for each typical application.

END OF SECTION

1. General

1.1 Scope

- .1 Control Devices and Hardware
 - .1 Control Panels
 - .2 Wire
 - .3 Conduit and Cables
 - .4 Related Accessories
 - .5 Room Sensors
 - .6 Outdoor Air Sensors
 - .7 Duct Mount Sensors

2. Products

2.1 Control Panels

- .1 Mount digital controllers in control panels with field interface equipment (i.e. relays, transducers, etc.) segregated in the panel and minimizing the electrical interference and heat to the digital controllers.
- .2 The power supplies, transformers, contactors, etc. shall be mounted in separate ventilated metal enclosures.
- .3 Control panels are to be of unitized cabinet type construction, fabricated from rolled sheet metal sheet with baked enamel finish, flush fitting, gasketed doors hung on piano type hinges and locking handles. All panels shall be CSA approved and equal to Hoffman enclosures and shall be common keyed.
- .4 Mount pilot lights and switches flush on cabinet panel face.
- .5 Mount panels on vibration free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- .6 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.
- .7 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 volt supply.
- .8 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

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- .9 Identify all wiring by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.
 - .10 Install bonding conductor between main control and auxiliary panels complete with grounding lugs, in addition to CSA grounding requirements.
 - .11 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.
 - .12 Power for control panels shall be 120/1/60 15 amp circuits from power panel with wiring from power panel by the BAS contractor.

2.2 Wire

- .1 Control wiring for digital functions shall be 20 AWG minimum with 300 Volt insulation.
- .2 Control wiring for analog functions shall be 20 AWG minimum with 300 Volts insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.
- .3 Sensor wiring shall be 22 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

2.3 Conduits and Cables

- .1 All wiring, whether line voltage, low voltage or control wiring shall be in conduit or fully enclosed metal trays. Flexible conduit may be used for final connection of control devices. Maximum length of flexible conduit to be 1m (3 ft). Conform to Division 26 requirements for conduit, tray, fittings, junction boxes, cabinets, wire, cable and trays specifications.
- .2 Exposed plenum rated cable shall not be utilized; all wiring shall be in conduit.
- .3 Seal conduit where such conduit leaves heated areas and enters unheated area.
- .4 In the field, run low level (<30 volts) signal lines in separate conduit from high level (>30 volts) signal and power transmission lines.
- .5 In the field panel, run low level signal lines in separate conduit from high level signal and power transmission lines.
- .6 Identify each cable and wire at every termination point by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring.
- .7 Provide instrumentation complete with standard electrical conduit box for termination unless otherwise noted.

.8 Color code all conductors and conduits by permanently applied color bands. Color code shall follow base building schedule. Color code all conduit couplings orange, with orange banding on the conduits.

.9 All wiring for terminal equipment controllers including network communications, sensors and actuator wiring must be in conduit.

2.4 Related Accessories

.1 Provide and install all necessary transducers, interposing relays, interface devices, etc., to perform control functions required.

.2 It is the responsibility of the BAS Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

2.5 Thermostats and Room Sensors

.1 Provide tamper proof guards for the space sensor. Guards to be equal to BAPI-Guard.

2.6 Duct Mount Sensors

.1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

.2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

.3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

3. Execution

3.1 Installation

.1 Verify location of sensors and other exposed control sensors with drawings before installation. Locate room temperature sensors 1500mm (5 ft) above floor.

.2 There is no separate control panel required; the existing ventilation switch shall be retained.

.3 Wire "hand/off/auto" selector switches such that only automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

.4 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.

.5 Install all safety limits at the operator's level.

.6 Control System Power

- .1 Provide power to all BAS components as necessary to provide continued monitoring and control.
- .2 Power for all transducers and other instrumentation associated with a controller shall come from the same circuit that is feeding the digital controller.
- .3 Identify in the record drawings the panel and circuit number serving each controller.

END OF SECTION

1. General

- .1 This section is a module which specifies the Field Instrumentation, Sensing Devices and Actuators.
- .2 For general requirements relating to all sections see Section 23 09 00 – Instrumentation and Control for HVAC.

2. Products

2.1 General

- .1 Provide analog or digital field instrumentation devices as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the ASC and/or SCU terminal strip that conform to the input requirements.
- .2 Provide output devices and actuators which convert the digital or analog output signal from the ASC and/or SCU to activate relays or open and close valves, dampers, etc.
- .3 The end to end accuracy called for in Subsection 2.2 includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the input to the analog-to-digital convertor in the ASC and/or SCU or between the ASC and/or SCU input to the digital-to-analog convertor and the controlled variable for the full sensing range.
- .4 The letter under the "Type" column in Subsection 2.2 is the same used in the points list.
- .5 Acceptable manufacturers of sensors are indicated in Section 3.0.

2.2 Analog Input Sensors

- .1 Temperature

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Duct Mounted	Tp	0°C to 60°C (32°F to 140°F)	±0.5°C	
Pipe Well Mounted	Tw	0°C to 50°C (32°F to 122°F)	±0.5°C	c/w thermal wells
		0°C to 100°C (32°F to 212°F)	±0.5°C	
		50°C to 150°C (122°F to 300°F)	±0.5°C	
Averaging	Ta	-30°C to 60°C (-20°F to 140 °F)	±0.5°C	Length to suit duct side

Space Temp.	Tr	10°C to 301°C (50°F to 572°F)	±0.5°C	c/w tamper-proof cover
Outside Air	To	-50°C to 50°C (-58°F to 122°F)	±1.0°C	c/w solar-shield
Surface Temp	Ts	0°C to 50°C (32°F to 122°F)	±0.3°C	

.2 Relative Humidity

.3	<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
	Duct mounted	Hp	5 - 90% RH 0°C to 60°C (32 °F to 140 °F)	±5%	
	Space	Hr	5 - 90% RH	±5%	c/w tamper-proof cover
	Outside air Pressure	Ho	5 - 100% RH	±5%	c/w solar-shield

	<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
	Static-water	Ps	0 to 104 kPa (0 to 15 psi)	±2%	
			0 to 208 kPa (0 to 30 psi)	±2%	
			0 to 689 kPa (0 to 100 psi)	±2%	
			0 to 2,000 kPa (0 to 300 psi)	±2%	
			Static-air	Sp	0 to 500 Pa (0 to 2" WG)
	0 to 1,250 Pa (0 to 5" WG)	±2%			
	0 to 2,500 Pa (0 to 10" WG)	±2%			
	Instrument	Ia	0 to 150 kPa (0 to 20 psi)	±2%	
	Velocity pressure monitoring station – air	Vp	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±1.0%	-multi-point static & total pressure sensing element manifold -self-averaging manifold -air equalizer & straightener

					-max. pressure loss 36 Pa @ 10 m/sec. -lowest sensitivity 1% of range
	Flow monitoring station – water, steam	Pv	As required	±2.0%	-Paddle wheel
	Fan Inlet- Air Flow Traverse Probes	Vpi	0-62.5 Pa (0-0.25" WG) 0-125 Pa (0-0.5" WG) 0-250 Pa (0-1" WG)	±3.0%	Multiple total and static pressure sensors connected to a self averaging manifold. Provide steady non-pulsating signals of standard total and static pressure. Accuracy of ±3.0% of actual flow over a fan operating range of 6 to 1 capacity turn down.

4 Electrical

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Kilowatts	kW	Various voltages		From digital metering systems
Current transmitters	Ct	As required	±0.25% full scale	

2.3 Analog Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
To damper motors	De	0 - 10 VDC 4-20 MA	±2% full scale	
To valve actuators	Ve	0 - 10 VDC 4 - 20 MA	±1% full scale	

2.4 Digital Input Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Pressure Switches	Pd	As required	±1.5% full scale	-adjustable setpoint and differential

Temperature	Td	As required	±1°C	-adjustable setpoint and differential -automatic reset -normal reset for freeze protection
Current Sensing Relays	Ri	As required	N/A	-adjustable trip c/w LED Status indication.
Motor status Relays	St	As required	N/A	-auxiliary contacts
Level	Ls	N/A	N/A	
Misc Inputs	Rc	N/A	N/A	Auxiliary contacts

2.5 Digital Output Devices

<u>Application</u>	<u>Type</u>	<u>Operating Range</u>	<u>End to End Accuracy</u>	<u>Remarks</u>
Relays	Ry	N/A	N/A	Plug-in type with terminal base contacts rated at 5 amp 120 VAC.

3. Execution

3.1 General

- .1 Codes and Standards
 - .1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, latest CSA Electrical Bulletins and Division 26.
- .2 Current sensing relays shall be equal to Greystone series CS-610-75 with LED and range adjustment and provide a dry contact signal.
- .3 Static and differential air pressure transmitters shall be equal to SETRA DPT 264 series, 1.0% accuracy with a 0-10V DC and/or 4-20 ma signal for connection to the BAS.
- .4 For each static and/or differential air flow transmitter, air pressure switch, etc. connection into the ductwork provide a standard production Dwyer series 160 pitot tube, or equal, with duct clamp and gasket for sensing the total and/or static pressure.
- .5 Differential pressure transmitters shall be located as shown on the drawings with tubing extended out to the filter modules. Install tubing in conduit.
- .6 For all the various transducers, supply and install the required transformers, power supplies, fusing, filters, etc. as required to provide the reduced voltage to the devices.

END OF SECTION

1. General

- .1 The control sequences below provide a general description of the intent of the operation of the systems to be controlled. The BAS Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 Consult with the Engineer during the shop drawing stage to finalize the control sequences for each system
- .3 On loss of building power and building power being restored, all equipment, including that on emergency power, shall be reset to nominal start up conditions and shall run through its normal start up sequence prior to returning to required operating conditions.

1.2 Systems

- .1 Make-Up Air Unit
- .2 Exhaust Fans

2. Products

Not Applicable

3. Execution

3.1 General

- .1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

3.2 Firing Range Ventilation System

- .1 The firing range is served by existing AHU unit AH06 and an updated exhaust fan AH06-EF. The existing BAS system provides the necessary interlocks.
- .2 A differential pressure sensor shall monitor the pressure between the firing range and the control room vestibule.
- .3 A VFD on the exhaust air fan shall control the exhaust air volume to maintain a pressure differential of -10 Pa (adjustable) in the firing range.

END OF SECTION

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Exhaust Fan EF-1 VFD Alarm VFE Enable VFD Fbk VFD Control Space Diff Pressure	Rc Ry Aiv Aov SP	XS JZ IT IT DPT	X	X	X		X X	XX	

The Bidding Documents are amended as noted in this Addendum, which consists of one (1) page and the following attachments:

1. Added Specifications:
No added specification sections
2. Drawings:
No added drawing sections

This addendum is issued prior to bid closing to amend the bid documents. This Addendum will form part of the Contract Documents. Include in the Bid price all such revisions which will become part of the Work. Perform all such Work in accordance with the contract documents.

Acknowledge receipt of this Addendum by reference in the Bid Form submitted by the bidding Contractors. Ensure that all parties submitting bids are aware of all items included in this addendum.

1. Specifications

- .1 Not Applicable

2. DRAWINGS

- .1 144202775.215, Edmonton, Alberta - E200 – Basement Floor Plan – Lighting, Power and System
 - .1 Delete Keynote 9 and replace with the following; "Provide and install 100A Disconnect, 80A 3 Pole Breaker and #6 AWG Cu for 40HP – 600V AH06-EF1 from BP3101 NA1 located in room 3101 on the third floor."
- .2 144202775.215, Edmonton, Alberta - E400 – Electrical Details and Mechanical Equipment Schedule
 - .1 Refer to the Mechanical Equipment Schedule;
 - .1 Unit No.; AC-1
 - .1 add to the remarks section the following; "To be supplied and installed by Mechanical and wired by Electrical".
 - .2 Unit No.; AH06-EF
 - .1 location to revise with "roof".
 - .2 Circuit revise with "BP3101 NA1".
 - .3 Remarks add the following; "Provide power for AH06-EF1 from BP3101 NA1 located in room 3101 on the third floor. VFD for AH06-EF1 to be located in room 3101, supplied and installed by Mechanical and wired by Electrical."
 - .3 Preaction system compressor
 - .1 Remarks add the following; "To be supplied and installed by Mechanical and wired by Electrical."

END OF ELECTRICAL ADDENDUM NO. E-02