PART 1 - GENERAL

1.1 GENERAL

.1 The "provide" in this Division shall be interpreted as "supply, install, and connect".

.2 Energy Monitoring and Control System (EMCS) shall include Direct Digital Control (DDC), Electronic Control, and Pneumatic Control of mechanical systems as specified for this project.

.3 Building Automation System (BAS) shall include the EMCS and the integration of Lighting Control, Security and Access Control, and Fire Alarm Monitoring as specified for this project.

1.2 DESCRIPTION OF SYSTEMS

.1 Extend the existing Networked DDC Control System to provide the specified control operation. The upgraded Control System shall consist of but is not limited to the following:

.1 A data communication network for Building Automation Systems (BAS) data transmission.
.2 Operator workstations and operator interface devices as specified.
.3 DDC Controllers including Master Control Units and Local Control Units and Terminal Control Units as specified.
.4 Software required to implement a complete and operational system.
.5 Input and output control devices including sensors, actuators, pneumatic piping, conduit and wiring, as required to provide the operation specified.
.6 Revisions to existing graphical user interface to reflect all alarms, setpoints, equipment, etc. as per drawings and specifications.

1.3 ACCEPTABLE SYSTEM MANUFACTURERS AND PRODUCTS

.1 System Manufacturer shall have maintained a local office within 400 kilometers of job site for at least 5 years with technical staff to provide technical information, routine and emergency maintenance on the system and all system components, and to provide training instructions to O&M staff.

.2 System Manufacturer shall have proven record of successful experience on projects of similar type and size.

.3 Within 10 working days after bid closing, the low bidder shall submit the following information for review by Departmental Representative:

.1 Location of local office.
.2 Names and phone numbers of technical staff.

.3 Specification sheets for Master Control Units, Local Control Units and Terminal Control Units.

.4 Data communication network performance information including network protocols to be used, data rate, maximum number of nodes per Local Area Network (LAN).

.5 Item-by-item statement of compliance.

.4 The proposed System Manufacturer and its products will not be considered acceptable until a satisfactory review report is issued from the Departmental Representative. Submissions with insufficient information will be returned without review

1.4 CO-ORDINATION

.1 The Control Contractor shall co-ordinate its work with Mechanical and Electrical Trades. Unless noted otherwise, the Control Contractor shall provide all interface devices, control wiring, pneumatic piping and controls as required to provide the control operation specified.

.2 Control dampers, control valves and temperature control sensing wells shall be supplied by Control Contractor and installed by Mechanical Contractor under the supervision of Control Contractor.

.3 Unless noted in Division 26, the Control Contractor shall provide line voltage and low voltage control wiring for equipment specified in Division 25. Refer to Division 26 for power wiring, starters, disconnect switches, etc., to be provided for mechanical equipment.

.4 The Control Contractor shall provide all necessary power and dedicated circuits as required from local 120 volt branch circuits panel board for all Master Control Units, Local Control Units, Terminal Control Units and Operator Workstations. Install tamper locks on breakers of circuit panel.

.5 Unless noted otherwise, all other installation work required for the complete installation of EMCS, including all interface devices, control and power wiring, controls and controlled devices shall be provided by the Control Contractor.

1.5 LOCKABLE PANELS

.1 Provide lockable panel for each MCU or LCU. All panels shall be EEMAC rated to environment requirements with hinged doors.

.2 All panels for Master Control Units shall be equipped with standard keyed-alike cabinet locks, keyed to same key.

1.6 NAMEPLATES

.1 Nameplates shall be provided for all control items listed or shown in the submittal and approved control diagrams.

.2 All panels and items mounted on panel face shall be identified by laminated plastic nameplates 3 mm thick. The lettering shall be accurately aligned and engraved into the white core. Size of nameplates shall be 20 mm by 100 mm minimum. Lettering shall be minimum 5 mm high normal black lettering.

.3 Field Sensors and Controlled Devices shall be identified by plastic encased cards attached to the device by chain.

.4 Warning signage: Each motor starter under remote automatic control (DO point on I/O Point Schedules) shall be provided with signage warning of automatic starting under control of EMCS. (i.e. "Caution - this equipment is under automatic remote control of EMCS").

1.7 SHOP DRAWINGS

.1 Submit shop drawings and product data in accordance with Section 23 05 00 of "Mechanical General Requirements". Control shop drawings must be submitted within 15 days of award of contract.

.2 Shop drawings shall include:

.1 BAS network cable layout showing cable routing, distance information and cable specifications.

.2 BAS network architecture showing all Operator Workstations, Master Control Units, Local Control Units, Terminal Control Units and all other network components.

.3 Description of network data transmission method and access method. Network performance information shall include network protocols to be used, data rate, maximum number of nodes per Local Area Network (LAN).

.4 System capacity and limits of expansion.

.5 Description of software programs included.

.6 Specification sheets for each piece of equipment or control devices to be provided.

.7 Equipment and DDC Controllers location drawings.

.8 Mechanical control schematics.

.9 Sequence of operation for each mechanical system.

.10 DDC control point schedules.

1.8 INSTALLATION AND COMPLETION TESTS

.1 Installation and Calibration:

.1 Set control points and calibrate sensors immediately after installing controls.

.2 Completion Tests:
- .1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and operation of equipment.
- .2 Check and calibrate each AI using a calibrated digital thermometer, humidistat, velometer or transducer.
- .3 Check each DI to insure proper settings and switching contacts.
- .4 Check each AO to insure proper operation of valves and dampers. Verify tight closing, input and output signals.
- .5 Check each DO to insure proper operation and lag time.
- .6 Check all operating software.
- .7 Check all application software. Provide samples of all logs and commands.
- .8 Debug all software.
- .9 The contractor shall be responsible for fine tuning and adjusting all control devices and make modifications as required to provide a fully operational EMCS.
- .10 Submit test report with checklist showing all input/output control points and all software programs.

.3 All reported results are subject to the spot check by the Commissioning Engineer and/or the Design Consultant.

.4 The Commissioning Engineer and/or the Design Consultant will select, at random, up to 30% of all reported results for verification, and a failure of selected item shall result in the rejection of the completion testing. The completion testing shall be repeated after corrective measures are carried out and continue until test results are acceptable.

1.9 SYSTEM STARTUP VERIFICATION TESTING

.1 The Contractor shall provide technical personnel and instrumentation to conduct startup verification testing.

.2 Verification:
- .1 Perform point-by-point verification of entire system.
- .2 Verify the calibration of all AI devices individually.
- .3 Verify the calibration of all DI devices individually.
- .4 Verify all AO devices are functional, start and span are correct, direction and normal positions are correct.
- .5 Verify that all DO devices operate properly and that the normal positions are correct.

.6 Verify the system sequences of operation. Simulate all modes of operation.
.7 Verify the stability of all DDC loops and optimum start/stop routines.
.8 Check each alarm separately.
.9 Verify interlocks and conditional control response.
.10 Simulate alarm conditions to check the initiating value of variable and interlock action.

.3 The contractor shall complete and submit System Startup Verification Forms. Each item on the verification forms shall be signed off as verified (yes), or not verified (no) and actual date of verification.

1.10 OPERATION AND MAINTENANCE MANUAL

.1 The manual shall be custom designed for this project and contain only information relevant to this project.

.2 One complete set of manuals shall be furnished prior to the time that system or equipment tests are performed, and the remaining manuals shall be furnished at acceptance. The manual shall provide full and complete coverage of the following subjects:
.1 Operational Requirements: This document shall describe, in concise English terms, all the functional and operational requirements for the system and its functions that have been implemented.
.2 System Operation: Complete step by step procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats; and emergency, alarm, and failure recovery. Step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes shall be provided.
.3 Maintenance: Documentation of all maintenance procedures for each and all system component including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective module.
.4 Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as Test Procedures. A provision for the measurement or observation of results, based on the previously published Test Specification, forms the Test Reports.

.5 Configuration Control: Documentation of the basic system design and configuration with provisions and procedures for planning, implementing, and recording any hardware or software modifications required during the installation, test, and operating lifetime of the system.

1.11 TRAINING

.1 Provide the services of competent instructors who will provide instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be specific to the system installed rather than being a general "canned" training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The Departmental Representative shall have the right to approve/reject the instructors based on their qualifications. A training manual shall be provided for each trainee which describes in detail the data included in each training program. All equipment and material required for classroom training shall be provided by the Contractor. Classroom training in two phases shall be conducted at control vendor's training facility. The first phase shall be for a period of 2 days prior to the completion tests. The second phase shall be for a period of 5 days following commissioning.

.2 At least 30 days prior to commencement of training, submit training program with course outline, agenda and a copy of training manual for review by the Departmental Representative.

1.12 WARRANTY AND MAINTENANCE

.1 The Contractor shall provide all services; materials and equipment necessary for the maintenance of the Automatic Control Systems for a period of 12 months concurrent with the warranty period.

.2 The Contractor shall provide three minor inspections or as required by the manufacturer and one major inspection per year, and all service for the required maintenance. Major inspection shall be scheduled in April or November. A major inspection shall involve a point by point check and/or calibration. Provide dated database log to indicate executed point to point system check.

.3 Emergency Service: The Owner will initiate service calls when there is indication that the Automatic Control System is not functioning properly. The Contractor shall have qualified personnel available during the contract period to provide service to

the "critical" overall control system components whenever required at no additional cost to the owner. The contractor shall furnish the Departmental Representative with a telephone number where the service personnel can be reached at all times. The service technician shall be on the job ready to service the control system within 4 hours after receiving a request for service. The work shall be performed continuously until the control system is back in reliable operating condition. This service shall be provided on a 24 hours basis 7 days a week.

.4 Upon completion of each inspection or emergency service, submit fully detailed report in writing to Departmental Representative.

PART 2 - PRODUCTS

2.1 GAS DETECTION SYSTEM

.1 Provide a complete installation of a gas detection system including a main control panel, sensors and audible/visual alarm devices that can be linked to a central controllers or a Building Automation System (BAS).

.2 The system shall include, but not be limited to, the following:

.1 Future expandability
.2 Display of toxic gas concentration
.3 Ability to modify alarm setpoints
.4 Oxygen, hydrogen and methane gas detection
.5 Display of alarm status.

.3 Supply and install multiple gas detectors as required to provide floor area coverage and as shown on drawings. Oxygen sensors shall be equivalent to Honeywell Analytics Model E3SM-E302 oxygen (surface mount). Hydrogen gas sensors shall be equal to Honeywell Model E3SME3H2 hydrogen gas surface mount). Methane gas sensors shall be equal to Honeywell Model E3SME3M methane gas surface mount).

.4 Transmitter will be powered by the control panel power supply rated at 24 VAC. Fully addressable gas transmitter must be capable of communicating digitally with controller through an RS-485 communication port. Gas transmitters must be installed in a true daisy chain with an end of the line resistor on the last transmitter. The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring and catalytic bead sensor for combustible gases. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of

accuracy.

.5 When placed in a network configuration the transmitter will be capable of transmitting gas concentrations through the controller. For local activation of fans or louvers (or other equipment) an on-board DPDT relay 5 A, 30 VDC or 250 VAC (resistive load) will be activated at programmable set points (and programmable time delays) through the control panel. An LCD display will provide gas concentration readings.

.6 Transmitter will be capable of operating within relative humidity ranges of 5-95% and temperature ranges of -4°F TO 104°F (-20°C TO 40°C).

.7 Unit will be certified to ANSI/UL 61010-1 label and CAN/CSA-C22.2 No. 61010-1. Transmitter must be manufactured in an ISO 9001-2000 production environment.

.8 The transmitter shall have a plug-in capability for a field replaceable gas cartridge with a smart sensor capable of self-testing. The replaceable gas cartridge shall be factory calibrated and certified to the target gas ready for operation without the requirement for site calibration.

.9 For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 DBA @ 10 ft (3 M).

Detector alarm levels are to be activated and the unit is to be installed in accordance with the following parameters:

Toxic Gases	1st Alarm Setpoint	2nd Alarm Setpoint	Mounting Height	Coverage Radius
Oxygen (02) Depletion	19.5%	---	900 mm – 1500 mm (3 ft – 5 ft) above finished floor	7 metres (23 ft.
Hydrogen (H2)	25% LEL (1% V / V)	50 % LEL (2% V / V)	900 mm (1 foot) below ceiling	7 metres (23 ft)
Propane (C3H8)	25% LEL	50% LEL	900 mm (1 foot) below ceiling	7 metres (23 ft)

.10 The control panel must be capable of communicating digitally with the networked transmitters and relay modules through three RS-485 modbus communication buses. Each communication bus must be capable of accepting a combination of up to 32 addressable transmitters, relay modules, or annunciator panels at a maximum distance of 2,000 feet. The power supply shall be of either 24 VAC OR 24 VDC.

.11 The controller will manage four internal DPDT relays at fully programmable alarm levels (and within programmable time delays) and be capable of activating multiple relay modules of eight relays each. The relay rating will be no lower than 5 A, 30 VDC OR 250 VAC (resistive load).

.12 The controller must include a self-test function that allows for the activation/ deactivation of all the programmed outputs by simulating a continuous 5% increase/decrease value until the maximum/minimum value is reached.

.13 The controller must include a real-time clock that enables operation of the outputs for a specific timeframe.

.14 The controller must also include an energy saving feature that allows for output operation on alarms set at the max, min or average value of a specific group of transmitters. This feature must also allow for the activation of outputs upon a certain number of a specific group (¾, ½, ⅓ and ¼) of transmitters reaching their alarm levels. A total of 128 groups can be assigned.

.15 The controller will be capable of communicating with an annunciator panel that can serve as a remote display panel in a secondary control room.

.16 The controller will indicate the exact concentration of gas, the gas detected, and the location of the sensor by sweeping through the network and displaying the detected levels at each point on a graphic LCD display.

.17 H. BACNET option (if required): the controller must enable BACNET™ communication through its optional bacnet output using BACNET/IP protocol over twisted-pair ethernet (10BASET) wires.

.18 VA 301 AP Annunciator Panel:

.1 Provide as indicated model VA 301 AP remote annunciator panel for remote gas detection

system status indication.

.2 The Honeywell Analytics/VUlcain 301AP remote annunciator panel must be capable of communicating digitally with the networked controller and transmitters through the rs-485 modbus communication bus network.

.3 Power requirement shall be either 17-27 VAC or 24-38 VDC, 200 MA as provided by the VA 301C central controller (or optionally from a 120/24V step down transformer).

.4 The VA 301 AP annunciator shall have 3 DPDT relays programmable and addressable via the VA 301C central controller. Relay output rating: 5 A, 30 VDC or 250 VAC (resistive load).

.5 The VA 301 C AP annunciator shall incorporate audible and visual status indicators and will indicate the exact concentration of gas, the gas detected, and the location of the sensor on the network and display the detected levels at each point on a graphic LCD display.

.6 Visual Indicators:

.1 Alarm A: RED LED

.2 Alarm B: RED LED

.3 Alarm C: RED LED

.4 Power: GREEN LED

.5 Fault: YELLOW LED

.6 TX (TRANSMITTER STATUS): YELLOW LED

.7 Display: alphanumeric backlight liquid crystal display (LCD.

.7 Audible alarm for local warning shall be A 65 DB AT 1 M (3 feet) horn/buzzer.

.8 The unit shall be fabricated of abs polycarbonate and have an enclosure rating: NEMA 4X, indoor.

.9 The unit shall have operating humidity range of 0-95% RH, non-condensing and an operating temperature range of 0 to 40°C (32 to 104°F).

.10 The unit shall be certified to: CSA C22.2 No. 205-M1983 UL 1244.

.19 Strobe and Horn:

.1 STAS or STACKSTAS for 24 VAC or 120 V AC. Strobe & horn combo unit will be capable of operating within relative humidity ranges of 0-100% and temperature ranges of -30˚F to 150˚F (-35˚ C to 66˚C) suitable for indoor or outdoor operation. Rating of horn will be no less than 85DB at 10 feet. Intensity of light will be no less than 40W (120V) and will flash at a frequency of 1 per second.

Honeywell analytics model stas. Unit will be certified by CSA.

.20 Power transformer type T100VA, T200VA, T300VA or class 2 devices type T100VAC2, T200VAC2 or T300VAC2.

.1 Transformer shall have an input voltage of 120 V AC and an output voltage of 24 V AC with a VA range of 50-300. OPERATING FREQUENCY SHALL BE 60 HZ. Unit will provide insulation systems up to 130° C (50-1300 VA). Unit will operate at sound levels of less than 40 DB. Transformers shall be of fused type.

.21 Relay modules VA301R8: Relay module will be powered by the control panel's power output or by power transformer rated at 24 volts AC OR DC (always respect minimum voltage requirements at device). Module must be capable of communicating digitally with the Vulcain controller through an RS-485/ modbus communication port.

Relay module will have eight relays rated at no lower than 5A, 30 VDC or 250 VAC (resistive load). Honeywell Analytics Model VA301R8.

.22 Detector Guards E3PT-Guard: provide protective guard for detectors as indicated. The grid is made of a 9-gauge steel wire. The guard must be designed to allow calibration without removing the guards.

.23 Splash guard NEMA 4X ENCLOSURE (AS REQUIRED): provide model “ECLAB” NEMA 4X rated splash guard for gas sensors in all areas subject to exposure to water spray.

.24 Install hazardous gas monitoring equipment including sensors, audible alarms, control panels as shown on contract drawings, and as recommended by manufacturer of equipment, and as required by authorities having jurisdiction.

Install conduit and wiring from sensors to control panel and to remote annunciator panel, alarm horns and strobes as recommended by manufacturer of equipment.

.25 Sequence of Operation:

.1 Low level alarm - if any sensor (or group of sensors as programmed detect) low level alarm concentration gas as indicated, low alarm relay is activated. Low alarm indicator lights on the main panel led lights for point in alarm.

.2 High level alarm - if hazardous gas concentrations are not cleared after 30 minutes or if gas concentration continues to rise and any sensor detects a high level alarm concentration as indicated concentration, high alarm relay is activated, high alarm indicator lights on the main panel and panel audible alarm is activated, audible alarm to sound and low level alarm contacts continue to operate.

.26 Commissioning: After installation, test and calibrate equipment to demonstrate operation of functions described above under sequence of operation by manufacturers certified service technician. Issue certificate of operational and installation compliance to facility operators.

2.2 TEMPERATURE SENSORS AND TRANSMITTERS

.1 General: temperature sensors shall be RTD platinum type, unless otherwise noted.

.2 Temperature sensors shall be of the following types.

.1 Space RTD - suitable for wall mounting, with protective guard.

.2 Duct point RTD - suitable for insertion into air ducts at any angle, insertion length of 460 mm unless otherwise as noted on schedule or drawings.

.3 Immersion RTD - Spring loaded construction with compression fitting for 20 mm NPT well mounting. Lengths of 100 mm or 150 mm unless otherwise noted.

.4 Mixed Air Averaging RTD: continuous filament with probe length of 6000 mm minimum. Maximum 6 mý cross section area per sensor. Probe to be bent, at field installation time, to a minimum radius of 100 mm at any point along the probe length without degradation in performance.

.5 Outdoor RTD: complete with noncorroding shield designed to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, probe length of 100-150 mm.

.3 Provide each sensor with a temperature transmitter having the following minimum specifications:

.1 Output signal of 4-20 mA into maximum of 500 ohm load.

.2 Combined nonlinearity, repeatability and hysteresis effects not to exceed ±0.5% of full scale output.

.3 Integral, zero and span adjustments.

.4 Temperature effect of ±1.0% full scale or less.

.4 Range of sensors to suit application and to be submitted with shop drawings.

2.3 PRESSURE/ CURRENT TRANSMITTERS

.1 Provide pressure-to-current transmitters having the following minimum specifications:

.1 Internal materials of the transducer suitable for continuous contact with industrial standard instrument air, compressed air, water or steam as applicable.

.2 Output signal of 4-20 mA into a maximum of 500 ohm load.

.3 Output variations of less than 0.2% full scale for supply voltage variations of ±10%.

.4 Combined nonlinearity, repeatability and hysteresis effects not to exceed ±0.5% of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effect of ±1.5% full scale/50°C or less.

.7 Output short circuit and open circuit protection.

.8 Over-pressure input protection to a minimum of twice rated input.

.9 Pressure ranges to suit application.

2.3 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Provide differential pressure transmitters having the following minimum specifications:

.1 Internal materials to be suitable for continuous contact with the process material measured including compressed air, water, glycol, or steam as applicable.

.2 Output signal of 4-20 mA into maximum of 500 ohm load.

.3 Output variation of less than 0.2% full scale for supply voltage variations of ±10%.

.4 Combined nonlinearity repeatability and hysteresis effects not to exceed ±0.5% of full scale output over entire range.

.5 External exposed integral zero and span adjustment.

.6 Temperature effect of ±1.5% full scale/50°C or less.

.7 Output short circuit and open circuit protection.

.8 Over-pressure input protection to a minimum of twice rated input.

.9 Differential Pressure ranges to suit application.

2.4 PRESSURE SWITCHES

.1 Provide pressure or differential pressure switches for ranges as indicated on point schedule.

.2 Pressure sensing elements shall be bourdon tube,

bellows or diaphragm type.

.3 Adjustable setpoint and differential.

.4 Pressure switches shall be snap action type rated at 120 volts, 15 amps AC or 24 volts DC.

.5 Sensor assembly shall operate automatically and reset automatically when condition returns to normal.

2.5 CONTROL RELAYS

.1 Contacts rated at 5 amps at 120 V AC.

.2 Relays to be plug in type with termination base.

2.6 CURRENT TRANSDUCER

.1 Provide current transducers with range to match load being metered.

.2 Current transducers shall measure line current and produce a proportional signal in one of the following ranges.
.1 4-20 mA dc.
.2 0-1 V dc.
.3 0-10 V dc.
.4 0-20 V dc.

2.7 CURRENT SENSING RELAY

.1 Provide adjustable current-operated solid-state relays with integral zero leakage LED for switching AC or DC circuits.

.2 The contacts shall close when the current level sensed by the internal current transformer exceeds the trip point set by the multi-turn adjustment.

.3 Range of monitored AC current to suit application and to be submitted with shop drawings.

2.8 CONTROL VALVES

.1 Provide control valves as shown on drawings or listed on valve schedule.

.2 Valves 50 mm and smaller to be bronze with screw end connections. Valve 62 mm and larger to be cast iron with flanged end connections.

.3 All trim to be 316 SST.

.4 Valves to provide tight shut-off. Maximum leakage of 0.5% of rated flow.

.5 Valves to be Normally Open, Normally Closed 2 or 3-way as shown.

.6 Valves to have linear or equal percentage flow characteristics as indicated.

.7 Rangeability of valves to be minimum 50:1.

.8 Sizing Criteria:
.1 Two-position service: Line size.
.2 Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35 kPa, whichever is greater.

.3 Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa maximum.

2.9 THREE POINT FLOATING ELECTRONIC ACTUATORS

.1 Use of three point floating actuators shall be limited to zone control dampers, radiation or terminal reheat control valves.

.2 Provide tri-state outputs from DDC controllers (two coordinated binary outputs) for control of actuators.

.3 Control algorithms shall run the three point floating actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.10 EXISTING CONTROLS

.1 Unless noted otherwise or approved by the Departmental Representative in writing, all control devices required for a complete and working EMCS System shall be new and shall be provided by the Contractor.

.2 The existing control dampers, control valves, sensors and end devices that may be reused are noted on the DDC Input/Output Point Schedules. Within 30 days of contract award the Contractor shall test and inspect for satisfactory operation all existing devices which are permitted to be reused. For those items considered nonfiction, the Contractor shall provide with the report, to support the findings, and obtain the Departmental Representative's instruction.

.3 The Contractor shall submit written requests to disconnect any controls and to obtain equipment down time. Only after receiving these requests shall such work be allowed to proceed.

.4 The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of owner equipment, or failure in reporting defective controls within 30 days of contract award.

.5 Shop drawings shall show all signal levels,

pressures, etc., where tying into existing control equipment.

.6 Where existing controls are not to be reused or not required, they shall be removed and placed in storage for future disposition as directed by the Owner.

2.11 CONDUIT AND WIRE

.1 Use type FT6 plenum rated cable for low voltage EMCS wiring in ceiling return plenum. Support FT6 cables in ceiling return plenum using cable straps and clamps screwed on to ceiling slab. Spacing to be 2M maximum. Do not use ceiling suspension wires for fastening cables. Exact routings shall suit site conditions and shall be to the approval of the Departmental Representative.

.2 Use EMT conduit for wiring in mechanical, electrical, janitor rooms or equipment rooms.

.2 Unless noted otherwise, install network cable within building in EMT conduit and install network cable between buildings in buried PVC conduit. The control contractor shall provide conduits with spare capacity not less than 50%.

.3 Field wiring for each digital input and output shall be No. 20 AWG, stranded twisted pair. For multi-conductor wire having four or more conductors, wire size shall be not less than No. 22 AWG solid copper. Analog input hall be wired with shielded No. 20 AWG, stranded twisted pair, copper wire. Analog output shall be wired with 3 shielded No. 20 AWG stranded twisted copper wires.

.4 Where conduits pass through fire rated walls or floors, provide schedule 40 steel sleeves filled with fire stopping material and approved sealant around conduits to maintain fire rating integrity.

2.12 RESPONSIBILITY FOR QUANTITIES

.1 Failure to carry the correct lengths or sizes of conduit or correct types of wire or the correct number of DDC panels is the contractor's responsibility and shall not be basis for additional charges by the contractor.

2.13 WIRING IDENTIFICATION

.1 Provide numbered tape markings on all branch control wiring, and pneumatic tubing.

.2 At all junction boxes, splitters, cabinets and outlet boxes, maintain identification system.

.3 Use colour coded wires in communication cables, matched throughout system.

.4 Identify all power sources at each panel location.

2.14 CONDUIT IDENTIFICATION

.1 Colour code all Control System conduits.

.2 Coding to be located on all conduits and cables exposed after completion of construction in all locations including suspended accessible ceilings, tunnels and shafts.

.3 Coding to be plastic tape or paint at all points where conduit or cable enters wall, ceiling, or floor, and at 15000 mm intervals.

.4 Coding to be 25 mm wide, and fluorescent orange. Colour to be confirmed by the Contractor with the Departmental Representative at commencement of the project.

2.15 MANUFACTURER'S AND CSA LABELS

.1 Manufacturers' nameplates and CSA labels to be visible and legible after equipment is installed.

PART 3 - EXECUTION

3.1 GENERAL

.1 All equipment shall be installed in according to manufacturers' published instructions.

.2 Provide programming for the system and adhere to the sequence of operation specified.

3.2 BUILDING AUTOMATION SYSTEM (BAS) NETWORK ARCHITECTURE

.1 Building Automation System (BAS) Network Architecture as shown on the Mechanical Drawings.

3.3 DDC INPUT / OUTPUT POINT SCHEDULE

.1 DDC Input/Output Point Schedule, as shown on the Mechanical Drawings.

.2 Naming convention: PWGSC Standardized Identifiers and Expansions of Building Names, System Names and Point Names shall be used for identification. Identifiers shall be not more than 10 alphanumeric characters, and Expansions shall not more than 40 characters.

.3 The Application Programs shall be assigned with the specified DDC points as indicated on the DDC

Input/Output Schedule. In addition, the Application Program shall be assigned with the following point types:

.1 Alarm Program with: all space temperature AI points, all supply air temperature AI points, all supply air and return air humidity AI points, all air filter pressure drop AI points, all supply air static pressure AI points, all AI points of heating water supply and return temperature, all AI points of chilled water supply and return temperature, all DI points of fans and pumps.

.2 Auto Start/Stop Program with: all DO points of fans and pumps.

.3 Run Time Total Program with: all DO points.

.4 Heavy Equipment Delay Program with: all DO points of motors of 15 kw and larger.

.5 PID Control Program with: all AO points of control valves (except terminal heating control valves and radiation control valves) and control dampers (except terminal zone control dampers).

.6 Analog/PI Total Program with all AI or PI points of water meters and energy meters.

.4 All DI or DO points assigned with "alarm" and "run time total" programs shall be provided with "critical" and "maintenance" alarms. All AI or AO points assigned with "alarm" program shall be provided with "critical" and "cautionary" alarms.

3.4 INSTALLATION OF SENSORS

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

.2 Sensors used in mixing plenums shall be the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

.3 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 mý of cross section area.

.4 All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.

.5 Outdoor air temperature sensors shall be installed on north wall, complete with sun shield at designated location.

.6 Building static pressure sensors: Pipe the low pressure port of the differential air static pressure sensor to the static pressure port located on the outside of the building through a high volume accumulator. Pipe the high pressure port to a location behind a thermostat cover.

.7 Supply duct static pressure sensor: Pipe the high pressure tap of the differential air static pressure sensor to the duct using a pitot tube. Pipe the low pressure port to a tee in the high pressure tap tubing of the corresponding building static pressure sensor.

3.5 SEQUENCE OF OPERATION FOR VENTILATION

.1 Relay to start stop typical exhaust fan and monitor motor operation. Relay to alarm to existing Building Automation / Management System upon fan failure.

.2 Duct temperature sensor to be located in ductwork from individual rooms and provide feedback to the existing Building Automation / Management System. Sensor to be located at mezzanine level.

.3 A “break glass” or equivalent type switch to be located outside of rooms as noted on drawings and connected to a local alarm with a horn and strobe type device. Local alarm to be connected to existing Building Automation / Management System. Switch and alarm to have lamacoid label identifying device use; wording to be as per detail on drawings.

.4 Schematic for above control wording to be per drawing.

3.6 SEQUENCE OF OPERATION FOR HEATING

.1 Plate and frame heat exchanger PHE-1 to be full flow from building heating system and glycol side (secondary) of heat exchanger to be full system flow.

.2 Circulating pumps P-CSR-105 and P-CSR-106 to start / stop on signal from new connection to existing Building Automation / Management System. Pumps to alternate on user adjustable schedule and track pump runtime on graphical interface.

.3 3-way control valves to heating coils to bypass to maintain exhaust duct temperature setpoint via duct installed sensor. Setpoint to be user adjustable through graphical interface.

.4 Duct mounted temperature sensor to shutdown room exhaust fan and alarm on low temperature. Temperature alarm to be preset.

3.7 SEQUENCE OF OEPRATION FOR GAS DETECTION CONTROL

.1 Packaged gas detection system shall monitor the following gases and alarm as indicated:
- .1 Low oxygen – alarm 19.5%.
- .2 Propane – alarm at 10% LEL.
- .3 Hydrogen – alarm at 10% LEL.

.2 On alarm condition for any gas in the room the packaged gas detection system shall activate all audible alarms and strobes. The Building Automation / Management System shall monitor the packaged gas detection system for gas levels and alarm conditions through a BACNET interface via the gas detection control controller.

END OF SECTION