Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TIMING

.1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise

.2 Provide ULC or CSA registration plates as required by respective agency

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Consultant within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems -1998.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing -2020.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB

Standard used (AABC, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 COORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

.1 Review Contract Documents before project construction is startedand confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Consultant in writing proposed procedures which vary from standard.

.3 During construction, coordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

.3 All BACnet equipment shall be provided with factory trained equipment manufacturer representative to perform on site equipment start-up including BACnet start-up assistance to the control contractor

.4 TAB Contractor shall work with controls, Ventilation, and manufacturers' reps as required for successful system balancing and setpoint adjustment throughout the phases of construction.

1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Consultant for verification of TAB reports.

1.9 START OF TAB

.1 Notify Consultant 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weatherstripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

- .1 Proper thermal overload protection in place for electrical equipment.
- .2 Air systems:
  - .1 Filters in place, clean.
  - .2 Duct systems clean.
  - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
  - .4 Correct fan rotation.
  - .5 Fire, smoke, volume control dampers installed and open.
  - .6 Coil fins combed, clean.
  - .7 Access doors, installed, closed.
  - .8 Outlets installed, volume control dampers open.
- .3 Liquid systems:
  - .1 Flushed, filled, vented.
  - .2 Correct pump rotation.
  - .3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus 10 %, minus 10 %.

.2 Hydronic systems: plus or minus 10 %.

.3 Domestic systems: plus 10%, minus 10%.

1.11 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2 % of actual values.

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Consultant list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Consultant.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.15 TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 6 copies of TAB Report to Consultant for verification and approval, in English, in D-ring binders, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by Consultant.

.2 Provide personnel and instrumentation to verify up to 30 % of reported results.

.3 Number and location of verified results as directed by Consultant.

.4 Pay costs to repeat TAB as required to satisfaction of Consultant.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Consultant, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Consultant.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of this section or TAB standards of AABC.

.2 Do TAB of air and water systems, equipment, components, controls specified in Divisions 22 and23 including but not limited to the following: DHUM-1, DHUM-2 CDDH-1, CDDH-2, RTU-1, ERV-1, ERV-2, ERV-3, EF-1, EF-2, all pumps associated with DHUM-1 and DHUM-2 dry coolers and pool heating, and domestic water recirc pump.

.3 Qualifications: personnel performing TAB current member in good standing of AABC qualified to standards of AABC.

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.

.5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.6 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

.7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

.8 Systems to be tested, adjusted, and balanced:

.1 All air handling unit system(s) modified as part of this work: Supply/return/exhaust/outdoor-air

.2 All new HRV units: Supply/return/exhaust/outdoor-air

.3 New pool dehumidification systems: Supply/return/exhaust/outdoor-air

.4 All HVAC fans

1.20 HYDRONIC SYSTEMS

.1 Standard: TAB standards of AABC.

.2 Do TAB including, but not limited to the following systems, equipment, components, controls:

.1 Measurements:

.1 Flow

.2 Pressure

.3 Temperature

.4 Specific gravity

.5 RPM

.6 Electrical Power:

.1 Voltage

.2 Current draw

.2 Location of equipment measurements:

.1 Inlet and outlet of each:

.1 Heat Exchanger (primary and secondary sides)

.2 Coil

.3 Pump

.4 PRV

.5 Control valve

.6 Make-up (water)

.7 Supply and return of each primary and secondary loop of following hydronic systems:

.1 Pool Heating Systems

.2 Glycol or dry cooler systems

.8 Other auxiliary equipment

.3 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB qualified to standards of AABC.

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.

.5 Testing and balancing contractor shall be independent from installing mechanical contractor.

1.21 DOMESTIC HOT WATER RECIRC SYSTEMS

.1 Standard: TAB standards of AABC.

.2 Do TAB including, but not limited to the following systems, equipment, components, controls:

- .1 Measurements:
  - .1 Flow
  - .2 Pressure
  - .3 Temperature
  - .4 Specific gravity
  - .5 RPM
  - .6 Electrical Power:
    - .1 Voltage
    - .2 Current draw
- .2 Location of equipment measurements:
  - .1 Inlet and outlet of each:
    - .1 Pump
    - .2 Circuit balancing valve

.3 Qualifications: personnel performing TAB current member in good standing of AABC qualified to standards of AABC.

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.

.5 Testing and balancing contractor shall be independent from installing mechanical contractor.

1.22 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:

- .1 Qualifications of TAB personnel: as for air systems specified this section.
- .2 Quality assurance: as for air systems specified this section.

.2 Building pressure conditions:

.1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

.2 TAB procedures:

.1 Pool shall be negative relative to adjacent spaces.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 22 31 13.01 METAL DUCTS - LOW PRESSURE TO 500 PA.

1.2 REFERENCES

.1 Definitions:

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - means "not concealed" as previously defined.

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

.2 Reference Standards:

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.9 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.10 ASTM C1136-12 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

.11 ASTM C1290-11, Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC ducts.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/GSB 51.10-92, Mineral Fibre Board Thermal Insulation.

.3 CAN/CGSB 51.11-92, Mineral Fibre Blanket Thermal Insulation.

.4 Green Seal Environmental Standards (GSES)

.1 Standard GS-36-00, Commercial Adhesives.

.5 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.7 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Description of equipment giving manufacturer's name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

.3 Shop Drawings:

.1 Provide drawings for items listed in this section.

.4 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: specialist in performing work of this section and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 To CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 THERMAL INSULATION

.1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

.2 Insulate all supply ducts where not acoustically lined, as scheduled herein.

.3 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.4 TIAC Code C-1: Rigid mineral fibre duct board to ASTM C612 and CGSB 51-GP-10M, minimum R value R4 per inch. Plastic corner bead glued and taped with metallic tape on all corner and edges for mechanical room ducts, plenums and exposed ductwork. Insulation with FSK facing to ASTM A1136 and factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section). Cover all exposed plenum and duct insulation from exterior to equipment with 1577CW aluminium Venture Clad Jacketing system.

.5 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C553.

2.3 ACOUSTIC INSULATION

.1 Fiber free, non-particulating, formaldehyde free, PDBE-free, low V.O.C. black flexible closed-cell elastomeric acoustic duct insulation, in sheet form for rectangular duct, and roll form for round duct, self-adhesive sheet, thickness shall be 1" unless noted otherwise.

.2 Performance:

.1 Thermal conductivity: 0.25 BTU.in.hr.ft2.0F

.2 Water absorption: 0.2%

.3 Temperature range: -297°F to 180°F

.4 Resistant to 10,000 fpm air velocity without flaking.

.3 Acceptable Material:

.1 Armacell "AP Armaflex"

.2 Approved Equal

2.4 ACCESSORIES

.1 Tape: self adhesive, 100 mm wide, aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.

.1 Acceptable Manufacturer (or approved equal):

.1 Fattal Insultape by S. Fattal Canvas Inc.

.2 Contact adhesive: quick-setting

.1 Asbestos free

.2 5m2/L

.3 Acceptable Manufacturer (or approved equal):

.1 Armstrong 520

.2 Childers CP.82

.3 Forster 85-20

.3 Lap Seal adhesive: quick-setting for joints and lap sealing of vapour barriers. water based, fire retardant type, compatible with insulation.

.1 Asbestos Free

.2 6 m2/L

.3 Acceptable Manufacturer (or approved equal):

.1 Childers CP.80

.2 Forster 85-75

.4 For Canvas:

.1 Washable adhesive for cementing canvas lagging cloth to duct insulation

.2 Use canvas on all insulated ducts in mechanical rooms and all exposed exhaust ducts.

.3 Asbestos Free

.4 1.25 m2/L

.5 Acceptable Manufacturer (or approved equal):

.1 Childers CP-52

.2 Foster 81-42W

.5 Pins.

.1 Weld pins 4 mm diameter, with 35 mm diameter head for installation through insulation. Length to suit thickness of insulation.

.2 Acceptable Manufacturer (or approved equal):

.1 Duro Dyne

.2 Clip-Pin

.3 Weld pins, 2 mm diameter, for installation prior to applying insulation. Length to suit thickness of insulation. Nylon retain clips 32 mm square.

.4 Acceptable Manufacturer (or approved equal):

.1 Duro Dyne spotter pins with spotter clips or stop clips as required

.5 Stick on pins will not be accepted.

2.5 JACKETS

.1 Apply in exposed areas on rigid duct insulation only: Venture Clad 1577 CW.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PRE-INSTALLATION REQUIREMENTS

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B

.3 Apply materials in accordance with manufacturer's instructions and as indicated.

.4 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.

.5 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Ensure hangers, and supports are outside vapour retarder jacket.

.6 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.7 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

.8 Use stand-offs for duct mounted control accessories.

.9 Apply 1 mm thick galvanized sheet metal corners to ductwork in mechanical rooms.

3.4 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: conform to following table:

Air ducts	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular or round cold and dual temperature supply	C-1	yes	50
Fresh air intake from louver to AHU/fan and exhaust ductwork from AHU/fan to louver or exterior.	C-1	yes	50
All exhaust ducts from fans to exhaust louvers.	C-1	yes	50
On square or round supply ducting from all air handling equipment unit to end of supply duct except where duct is acoustically lined.	C-2	no	25, 50 in attic
Supply, return and exhaust ducts exposed in space being served (including pool ductwork exposed in pool area and inside bleacher area serving pool)	none		
Exhaust duct 20ft from exterior	C-1	no	25
Acoustically lined ducts	none		

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

TIAC Code	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

3.5 ACOUSTIC INSULATION

.1 Install on all exposed round supply duct, return duct and transfer ducts. Install as per manufacturer's instructions. Do not install acoustic insulation within 24" of electric heating coils. All ductwork dimensions on drawings are inside clear dimensions.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 21 13.02 – Hydronic Systems Steel

.2 Section 23 21 16 – Hydronic Specialties

.3 Section 23 21 23 – Hydronic Pumps

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE 90.1-04 -SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International (ASTM)

.1 ASTM C 335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.2 ASTM C 449/C 449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.3 ASTM C 533-07, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

.4 ASTM C 547-07, Standard Specification for Mineral Fiber Pipe Insulation.

.5 ASTM C 553-02, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.6 ASTM C 612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.7 ASTM C 795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C 921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Safety Data Sheets (SDS).

.5 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.6 Thermal Insulation Association of Canada (TIAC)

.1 National Insulation Standards 2005.

.7 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide two copies WHMIS SDS - Safety Data Sheets in accordance with Sections 01 35 29.06 - Health and Safety Requirements and 01 35 43 - Environmental Procedures.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Store at temperatures and conditions recommended by manufacturer.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 Fire and smoke ratings to CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket

.1 Mineral fibre: ASTM C 547

.2 Maximum "k" factor: ASTM C 547

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket

.1 Mineral fibre: ASTM C 547

.2 Jacket: to CGSB 51-GP-52MA

.3 Maximum "k" factor: ASTM C 547

.5 TIAC Code C-1: rigid mineral fibre board, unfaced

.1 Mineral fibre: ASTM C 612

.2 Maximum "k" factor: ASTM C 612

.6 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket

.1 Mineral fibre: ASTM C 612

.2 Jacket: to CGSB 51-GP-52

.3 Maximum "k" factor: ASTM C 612

.7 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: ASTM C 553

.2 Jacket: to CGSB 51-GP-52MA

.3 Maximum "k" factor: ASTM C 553

.8 TIAC Code A.6: flexible unicellular tubular elastomer

.1 Insulation: with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52

.3 Maximum "k" factor.

.4 Certified by manufacturer free of potential stress corrosion cracking corrodents.

.9 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements

.1 Insulation: ASTM C 533

.2 Maximum "k" factor: ASTM C 533

.3 Design to permit periodic removal and re-installation.

2.3 CEMENT

.1 Thermal insulating and finish

.1 To: ASTM C 449/C 449M

.2 Air drying on mineral wool, to ASTM C 449

2.4 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CAN/CGSB 51.53 with pre-formed shapes as required

.2 Colours: to match adjacent finish paint selected by Consultant.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Thickness: 0.75 mm.

.7 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.8 Covering adhesive: compatible with insulation.

.2 ABS Plastic:

.1 One-piece moulded type with pre-formed shapes as required.

.2 Colours: White

.3 Minimum service temperatures: -40 degrees C.

.4 Maximum service temperature: 82 degrees C.

.5 Moisture vapour transmission: 0.012 perm.

.6 Thickness: 0.75 mm.

.7 Fastenings:

.1 Solvent weld adhesive compatible with insulation to seal laps and joints

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.8 Locations:

.1 For outdoor use ONLY.

.3 Aluminum:

.1 To ASTM B 209

.2 Thickness: 0.50 mm sheet.

.3 Finish: embossed or corrugated.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

.4 Stainless steel:

.1 Type: 304316.
.2 Thickness: 0.25 mm.
.3 Finish: corrugated.
.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

.1 Tape: self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

.6 Facing: 25 mm galvanized steel hexagonal wire mesh on both faces.

.7 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER MASTIC

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PRE- INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.1 Hot equipment: To TIAC code 1503-H

.2 Cold equipment: to TIAC code 1503-C

.2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

.3 Provide vapour retarder as recommended by manufacturer.

.4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

.5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports outside vapour retarder jacket.

.7 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At steam expansion joints, valves, primary flow measuring elements flanges and unions at equipment.

.2 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

3.5 INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 Hot Equipment:

.1 TIAC code A-1orC-1 with mechanical fastenings or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC code C-2 unfaced with bands and 13 mm cement precede by one layer of reinforcing mesh.

.3 Thicknesses:

.1 Domestic hot water storage tanks 25 mm

.2 Heat exchangers 50 mm

.3 Pump bodies 50 mm

.4 Air removal devices 50 mm

.3 Cold equipment:

.1 TIACA-3orC-4 with mechanical fastenings or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC C-2 faced with vapour retardant jacket and with bands and 13 mm cement preceded by one layer of reinforcing mesh.

.3 TIACA-6orC-4 with bands.

.4 Thicknesses: chillers (except factory insulated) 50 mm.

.4 Finishes:

.1 Equipment in mechanical rooms: TIAC code CEF/1 with stainless jacket.

.2 Equipment elsewhere: TIAC code CEF/2 with 13 mm cement jacket.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 22 05 15 - Plumbing Specialities and Accessories

.2 23 05 93 - Testing, Adjusting and Balancing for HVAC

.3 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems

1.2 REFERENCE STANDARDS

.1 ASTM International (ASTM)

.1 ASTM E 202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

.1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:

.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.

.1 Pump operation.

.2 Control pressure failure.

.3 Maximum heating demand.

.4 Maximum cooling demand.

.5 Fluid Cooler fan failure.

.6 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed

.2 Verification of operating, limit, safety controls.

.3 Verification of primary and secondary pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Heating system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or

.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.

.2 Test procedures:

.1 Open fully heat exchanger, heating coil and radiation control valves.

.2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

.3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

.7 Chilled water system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Adding heat from building heating system or;

.2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater that OAT. RAT to be at least 23 degrees C minimum.

.2 Test procedures:

.1 Open fully cooling coil control valves.

.2 Set thermostats on associated AHUs for maximum cooling.

.3 Set AHUs for design maximum air flow rates.

.4 Set load or demand limiters on chillers to 100%.

.5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

1.6 CONDENSER WATER AND HUMIDIFICATION SYSTEMS

.1 In addition to procedures specified above, perform following:

.1 Add chemicals once per week as required.

.2 Perform TAB as specified Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.3 Set up and adjust drip feeders, timer controls, pump strokes as required to maintain required chemical feed rates.

.4 Inject inhibitor into cooling tower sump.

1.7 GLYCOL SYSTEMS

.1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E 202.

1.8 POTABLE WATER SYSTEMS

.1 When cleaning is completed and system filled:

.1 Verify performance of equipment and systems as specified elsewhere in Division 23.

.2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.

.3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.9 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

.1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.

.2 Verification of controls, detection devices, alarm devices is specified Division 26.

.3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.

.4 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.10 SANITARY AND STORM DRAINAGE SYSTEMS

.1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.

.2 Ensure that traps are fully and permanently primed.

.3 Ensure that fixtures are properly anchored, connected to system.

.4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

.5 Cleanouts: refer to Section 22 05 15 - Plumbing Specialties and Accessories.

.6 Roof drains:

.1 Refer to Section 22 05 15 - Plumbing Specialties and Accessories.

.2 Remove caps as required.

1.11 REPORTS

.1 In accordance with Section 01 91 13 - General Commissioning Requirements, supplemented as specified herein.

1.12 TRAINING

.1 In accordance with Section 01 91 13 - General Commissioning Requirements, supplemented as specified herein.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 REFERENCE STANDARDS

.1 ASTM International (ASTM)

.1 ASTM E 202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Safety Data Sheets (SDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

Part 2 Products

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 CLEANING HYDRONIC SYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.4 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to maximum design82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 hours at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

.8 Glycol Systems:

.1 In addition to procedures specified above perform specified procedures.

.2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E 202

3.3 START-UP OF HYDRONIC SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment.

.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.8 Repeat with water at design temperature.

.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.10 Bring system up to design temperature and pressure slowly.

.11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.12 Adjust pipe supports, hangers, springs as necessary.

.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.16 Check operation of drain valves.

.17 Adjust valve stem packings as systems settle down.

.18 Fully open balancing valves (except those that are factory-set).

.19 Check operation of over-temperature protection devices on circulating pumps.

.20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 20 05 01 - Common Work Results for Mechanical

.2 23 05 15 - Common Installation Requirements for HVAC Pipework

.3 23 05 23.01 - Valves - Bronze

.4 23 05 23.02 - Valves - Cast Iron

.5 23 05 93 - Testing, Adjusting and Balancing for HVAC

.6 23 08 13 - Performance Verification HVAC Systems

.7 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems

1.2 REFERENCE STANDARDS

.1 American National Standards Institute/American Water Works Association (ANSI/AWWA)

.1 ANSI/AWWA C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.2 American Society of Mechanical Engineers (ASME)

.1 ASME B16.1, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

.2 ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.

.3 ASME B16.5, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.

.4 ASME B16.9, Factory-Made Wrought Buttwelding Fittings.

.5 ASME B18.2.1, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).

.6 ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).

.3 ASTM International (ASTM)

.1 ASTM A 47/A 47M, Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A 53/A 53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.3 ASTM A 536-, Standard Specification for Ductile Iron Castings.

.4 ASTM B 62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.5 ASTM E 202, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.4 CSA Group (CSA)

.1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.

.5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)

.1 MSS-SP-67, Butterfly Valves.

.2 MSS-SP-71-05, Grey Iron Swing Check Valves Flanged and Threaded Ends.

.3 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

.4 MSS-SP-85, Grey Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Components and accessories.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.

.1 Include special servicing requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirement and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic systems from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PIPE

.1 Dry cooler system, new standalone hydronic heating systems, and where indicated on drawings: Steel pipe to ASTM A 53/A 53M, Grade B, as follows:

.1 To NPS 6: Schedule 40.

2.2 PIPE JOINTS

.1 NPS 2 and under: screwed fittings with PTFE tape or lead-free pipe dope.

.2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.

.3 Roll grooved: standard rigid coupling to CSA B242

.4 Flanges: plain or raised face, weld neck to ANSI/AWWA C111/ A21.11.

.5 Orifice flanges: slip-on raised face, 2100 kPa.

.6 Flange gaskets: to ANSI/AWWA C111/ A21.11.

.7 Pipe thread: taper.

.8 Bolts and nuts: to ASME B18.2 and ASME B18.2.

.9 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.

.2 Pipe flanges and flanged fittings:

.1 Cast iron: to ASME B16.1, Class 125.

.2 Steel: to ASME B16.5

.3 Butt-welding fittings: steel, to ASME B16.9

.4 Unions: malleable iron, to ASTM A 47/A 47M and ASME B16.3.

.5 Fittings for roll grooved piping: malleable iron to ASTM A 47/A 47M and ductile iron to ASTM A 536.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 PIPING INSTALLATION

.1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

3.3 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and when TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.4 CLEANING, FLUSHING AND START-UP

.1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

3.5 TESTING

.1 Test system in accordance with Section 20 05 01 - Common Work Results for Mechanical.

.2 For glycol systems, retest glycol to ASTM E 202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.6 GLYCOL CHARGING

.1 Include mixing tank and positive displacement pump for glycol charging.

.2 Retest for concentration to ASTM E 202 after cleaning

3.7 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 13 - Performance Verification HVAC Systems.

3.8 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.9 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by hydronic systems installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 20 05 01 - Common Work Results for Mechanical

.2 23 05 15 - Common Installation Requirements for HVAC Pipework

.3 23 05 93 - Testing, Adjusting and Balancing for HVAC

.4 23 08 13 - Performance Verification HVAC Systems

.5 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems

1.2 REFERENCE STANDARDS

.1 ASTM International: (ASTM)

.1 ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

.2 ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

.3 ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.

.4 ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

.5 ASTM F442 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).

.6 ASTM F1970 - Standard Specification for Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems.

.2 Canadian Standards Association (CSA):

.1 CSA B137 - Thermoplastic Pressure Piping Compendium.

.2 CSA B137.6 - Chlorinated Polyvinylchloride (CPVC) Pipe, Tubing, and Fittings for Hot- and Cold-Water Distribution Systems.

.3 National Sanitation Foundation (NSF):

.1 NSF 14 - Plastics Piping System Components and Related Materials.

.2 NSF 61 - Drinking Water System Components - Health Effects.

.3 NSF 372 – Drinking Water System Components – Lead Content

.4 Underwriters Laboratories of Canada (ULC):

.1 CAN/ULC-S102.2 - Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies.

.2 CAN/ULC-S115 - Standard Method of Fire Tests of Firestop Systems

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Components and accessories.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.

.1 Include special servicing requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirement and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors ,in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic systems from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PIPING SYSTEM

.1 Pool water piping, and where indicated on drawings:

.1 Schedule 80 CPVC pressure pipe to ASTM D2464, NSF 14, and/or CSA B137.0/B137.3.

.2 Schedule 80 socket fittings shall conform to ASTM D2467 and schedule 80 threaded fittings shall conform to ASTM D2464. All fittings must be third party

certified to NSF 14. Fittings shall be reinforced with fiberglass reinforced plastic (FRP). All CPVC fittings shall be molded or fabricated from a CPVC compound compatible with the pipe material. Pressure rating for threaded piping/fittings shall be reduced by 50%. Belled end pipe socket dimensions shall conform to ASTM D2672 or F480.

.3 Flanges: Join to pipe using manufacturer approved compatible solvent weld process or threaded connection. Flanges shall be150 lb rated, 1/2" to 10" third party tested by NSF according to ASTM F1970, complete with phonographic-grooved finish providing positive seal on gasket when the bolts are properly tightened. Flange dimensions shall be in accordance with ANSI B16.5. Flange bolts shall be Stainless Steel or plated as recommended by manufacturer and certified for use with brand of pipe flange being used. Tighten bolts diametrically opposite to each other and torque to manufacturer recommended specifications with torque wrench. Gaskets: elastomeric full-faced gasket with a hardness of 50 to 70 durometer A. 1/8" thick, neoprene or other material compatible with pool water as recommended by manufacturer.

1. All valves shall be compatible with the CPVC pipe material and supplied by one manufacturer. Valves shall be CPVC, flange type, butterfly valves, and shall be complete with gear operator where used for isolation of systems.

.2 Pool water heating piping, and where indicated on drawings:

.1 Schedule 80 CPVC pipe to ASTM D1784 and cell classification below:

.1 Pipe: 24448 for NPS 1/2 to NPS 8 (DN 15 to DN 100).

.2 Fittings: 23447 for NPS 1/2 to NPS 8 (DN 15 to DN 100).

.2 All valves shall be compatible with the CPVC pipe material and supplied by one manufacturer.

2.2 SOLVENT WELD CEMENTS

.1 One-Step Cement: NPS 1/2 to NPS 2 (DN 15 to DN 50):

.1 Certified to CSA B137.6.

.2 NSF 14 & 61 certified for potable water.

.3 Colour: Yellow with optical brightener.

.2 Two-Step Cement and Primer: NPS 2-1/2 to NPS 8 (DN 65 to DN 100):

.1 Certified to CSA B137.6.

.2 NSF 14 & 61 certified for potable water.

.3 Colour: Yellow (cement) with optical brightener.

.4 Colour: Clear (primer).

.3 CPVC solvent cements volatile organic compound (VOC) emissions shall not exceed 490 g/L and meet South Coast Air Quality Management District (SCAQMD) Rule 1168/316A.

.4 CPVC primers volatile organic compound (VOC) emissions shall not exceed 550 g/L and meet South Coast Air Quality Management District (SCAQMD) Rule 1168/316A.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 PIPING INSTALLATION

.1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

3.3 CLEANING, FLUSHING AND START-UP

.1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

3.4 TESTING

.1 Test system in accordance with Section 20 05 01 - Common Work Results for Mechanical.

.2 For glycol systems, retest glycol to ASTM E 202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.5 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 13 - Performance Verification HVAC Systems.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.7 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by hydronic systems installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 22 05 05 - INSTALLATION OF PIPEWORK.

1.2 REFERENCES

.1 ASME

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.

.2 ASTM International

.1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A278/A278M-01(2011), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).

.3 ASTM A516/A516M-10, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.

.4 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.

.5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 CSA Group

.1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings for items listed in this section.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.

.3 Submit 1 copy of operation and maintenance manual as PDF via email for review. Once approved, print and submit 3 copies.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic specialties from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 FULL-ACCEPTANCE BLADDER TYPE EXPANSION TANK

.1 The pressurization system shall include a replaceable bladder-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at those components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank,

.2 The manufacturer shall have at least five years experience in the fabrication of diaphragm-type ASME expansion tanks.

.3 Vertical welded steel pressurized replaceable bladder-type expansion tank.

.4 Tank shall be constructed, tested and stamped in accordance with Section VIII, Division 1 of the ASME Code for a working pressure of (125) PSIG and air pre-charged to initial fill pressure of system. Site verify exact fill pressure.

.5 The tank shall be supported by steel legs or a base (integral ring mount) for a vertical installation or steel saddles for horizontal installations. Each tank will have a heavy-duty butyl/EPDM bladder.

.6 Performance:

	ET-1A-1	ET-1B
TOTAL SYSTEM VOLUME (USG)	**212**	**212**
MINIMUM SYSTEM TEMPERATURE (F)	**-20**	**-20**
MAXIMUM SYSTEM TEMPERATURE (F)	**114**	**114**
SYSTEM PRESSURE RANGE (PSI)	**20-75**	**20-75**
EXPANDED WATER VOLUME (USG)	**80**	**80**
TANK VOLUME AT 0.4 AF (USG)	**80**	**80**
STANDARD OF ACCEPTANCE (AMTROL MODEL)	**300-L**	**300-L**

.1 Acceptable Material (or approved equal):

.1 Amtrol
.2 Expanflex
.3 ITT
.4 Taco

2.2 AUTOMATIC AIR VENT

.1 Standard float vent: brass body and NPS 1/8 connection and rated at 310, 620, 690 kPa working pressure.

.2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.

.3 Float: solid material suitable for 115 degrees C working temperature.

.4 Acceptable Material (or approved equal)

.1 Maid-o- Mist

2.3 AIR SEPARATOR - IN-LINE

.1 Working pressure: 860 kPa (125 psig), and 2000 F vortex type cast iron air separator.

.2 Size: as indicated – supplier shall confirm flow suitability during bidding.

.3 Air separator c/w high-capacity air vent.

.4 Acceptable Material (or approved equal)

.1 Armstrong VAS series
.2 ITT B&G
.3 Taco

.5 Glycol feeder and Tank383 l (100 US Gal), mixing tank with cover, built in pump with thermal cut-out's, suction hose, integral pressure switch control (adjustable), internal check valve, cord and 3-prong plug, precharged accumulator tank with EPDM diaphragm, and manual diverter valve for air purging. Pressure pump shall be capable of running dry without damage but shall have low level cut-out. Power supply shall be 120/1/60. Unit shall be completely pre-assembled, and CSA tested and approved to C22.2 No. 68. Acceptable Material (or approved equal)

.1 Axiom SFL-100L

2.4 PIPE LINE STRAINER

.1 NPS 1/2 to 2: bronze body to ASTM B62, solder end, screwed connections, Y pattern.

.2 NPS 2 1/2 to 12: cast steel body to ASTM A278/A278M, Class 30, cast iron body to ASTM A278/A278M, Class 30 flanged connections.

.3 NPS 2 to 12: T type with ductile iron body to ASTM A536 malleable iron body to ASTM A47M, grooved ends.

.4 Blowdown connection: NPS 1.

.5 Screen: stainless steel brass with 1.19mm to 3.2mm perforations.

.6 Working pressure: 1034 kPa (150 PSI)

.7 Acceptable Material (or approved equal)

.1 Victaulic Style 732 / W732.

2.5 BALANCING VALVES

.1 Balancing valves shall be threaded or grooved, minimum 300 psig rated, Y-pattern with digital readout handwheel, connections for portable differential meter, made of brass copper alloy or ASTM A536 ductile iron body, with brass-copper alloy metal parts, EPDM O-rings, locking tamper proof setting, ¾" drain connection, able to be mounted in any position.

.2 Contractor shall ensure TAB agents has proper meter for supplied balancing valves.

.3 Provide pre-formed thermal insulation kit with polyurethane insulation.

.4 Acceptable Material (or approved equal):

.1 VICTAULIC Series 787 for sizes ½" to 2"

.2 VICTAULIC Series 789 for sizes 2 ½" to 16"

.3 Armstrong

.4 Tour Andersson

.5 IMI

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic specialties installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied

3.2 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 GENERAL

.1 Run drain lines to terminate above nearest drain.

.2 Maintain adequate clearance to permit service and maintenance.

.3 Should deviations beyond allowable clearances arise, request and follow Consultant's directive.

.4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.4 STRAINERS

.1 Install in horizontal or down flow lines.

.2 Ensure clearance for removal of basket.

.3 Install ahead of each pump.

.4 Install ahead of each automatic control valve larger than NPS 1 and radiation except at radiation and as indicated.

3.5 AIR VENTS

.1 Install at high points of systems.

.2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain or service sink.

3.6 EXPANSION TANKS

.1 Adjust expansion tank pressure to suit design criteria.

.2 Install lockshield type valve at inlet to tank.

3.7 PRESSURE SAFETY RELIEF VALVES

.1 Run discharge pipe to terminate above nearest drain.

3.8 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 22 21 13 – Hydronic Systems: Steel.

.2 Section 22 21 14 – Hydronic Specialties

1.2 REFERENCES

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE/IES Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 CSA Group

.1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.

.3 Electrical Equipment Manufacturers Association of Canada (EEMAC)

.4 National Electrical Manufacturers' Association (NEMA)

.1 NEMA MG 1-2011, Motors and Generators.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.

.3 Shop Drawings:

.1 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers. Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.

.3 Submit 3 copies of operation and maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic pumps from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 EQUIPMENT

.1 Size and select components to: CAN/CSA-B214.

2.2 SINGLE STAGE END-SUCTION CENTRIFUGAL PUMP

.1 General: 316L stainless steel pump complete with motor.

.2 Casing: 316L Stainless steel.

.3 Volute:316L stainless steel radially split, end suction, screwed suction and discharge, with drain plug and vent cock, suction and discharge pressure gauge tappings.

.4 Impeller: 316L stainless steel enclosed open type, keyed drive with locking nut or screw.

.5 Shaft: 316L SS .

.6 Coupling: flexible self-aligning.

.7 Motor: TEPE

.8 Capacity: as indicated.

.9 Approved Manufacturers:

.1 Goulds/Xylem

.2 Armstrrong

.3 TACO

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic pump installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Departmental Representative DCC Representative Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied

3.2 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 INSTALLATION

.1 Install hydronic pumps to: CAN/CSA-B214.

.2 In line circulators: install as indicated by flow arrows.

.1 Support at inlet and outlet flanges or unions.

.2 Install with bearing lubrication points accessible.

.3 Base mounted type: supply templates for anchor bolt placement.

.1 Include anchor bolts with sleeves. Place level, shim unit and grout.

.2 Align coupling in accordance with manufacturer's recommended tolerance.

.3 Check oil level and lubricate. After run-in, tighten glands.

.4 Ensure that pump body does not support piping or equipment.

.1 Provide stanchions or hangers for this purpose.

.2 Refer to manufacturer's installation instructions for details.

.5 Pipe drain tapping to floor drain.

.6 Install volute venting pet cock in accessible location.

.7 Check rotation prior to start-up.

.8 Install pressure gauge test cocks.

3.4 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements; supplemented as specified herein.

.2 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.

.2 After starting pump, check for proper, safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free-floating, no obstructions under base.

.5 Run-in pumps for 12 continuous hours minimum.

.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water-cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility.

.11 Eliminate cavitation, flashing and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

.14 Replace seals if pump used to degrease system or if pump used for temporary heat.

.15 Verify lubricating oil levels.

3.5 PERFORMANCE VERIFICATION (PV)

.1 General:

.1 Verify performance in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.

.2 Verify that manufacturer's performance curves are accurate.

.3 Ensure valves on pump suction and discharge provide tight shut-off.

.4 Net Positive Suction Head (NPSH):

.1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.

.2 Measure using procedures prescribed in Section 01 91 13 - General Commissioning (Cx) Requirements.

.3 Where procedures do not exist, discontinue PV, report to Departmental Representative DCC Representative Consultant and await instructions.

.5 Multiple Pump Installations - Series and Parallel:

.1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.

.6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.

.7 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements reports supplemented as specified herein. Reports to include:

.1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.

.2 Use Report Forms specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.

.3 Pump performance curves (family of curves).

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

.2 Section 23 81 29 - Variable Refrigerant Volume HVAC System.

1.2 REFERENCES

.1 ASME

.1 ASME B16.22-12, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.

.2 ASME B16.24-11, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500.

.3 ASME B16.26-11, Cast Copper Alloy Fittings for Flared Copper Tubes.

.4 ASME B31.5-10, Refrigeration Piping and Heat Transfer Components.

.2 ASTM International

.1 ASTM A307-12, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.

.2 ASTM B280-08, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 CSA Group

.1 CSA B52-05(R2009), B52 Package, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

.1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

.5 Standard Council of Canada

.1 CAN/CGSB-51.40-95, Flexible, Elastomeric, Unicellular Thermal Insulation, Sheet and Pipe Covering

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings:

.1 Convene pre-installation meeting 1 week prior to beginning work of this Section and on-site installation, with Contractor's representative and Consultant, in accordance with Section 01 31 00 - Project Management and Coordination to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building construction subtrades.

.4 Review manufacturer's written installation instructions and warranty requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for refrigerant piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and 01 35 43 - Environmental Procedures. Indicate VOCs for adhesive and solvents during application and curing.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for refrigerant piping for incorporation into manual.

.3 Submit 3 copies of operation and maintenance manual.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect refrigerant piping, fittings and equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.

.1 Hard copper: to ASTM B280, type ACR .

.2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

.1 Service: design pressure 2070 kPa and temperature 121 degrees C.

.2 Brazed:

.1 Fittings: wrought copper to ASME B16.22.

.2 Joints: silver solder, 15% Ag-80% Cu-5%P, copper-phosphorous, 95% Cu-5%P and non-corrosive flux.

.3 Flanged:

.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.

.2 Gaskets: suitable for service.

.3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:

.1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

2.5 INSULATION

.1 Suction line insulation: 25 mm of flexible elastomeric, unicellular insulation to CAN/CGSB-51.40. Both lines insulated separately.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for refrigerant piping installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.3 GENERAL

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 and Section 230515 - Common Installation Requirements for HVAC Pipework.

3.4 BRAZING PROCEDURES

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

3.5 PIPING INSTALLATION

.1 General:

- .1 Soft annealed copper tubing: bend without crimping or constriction
- .2 Hard drawn copper tubing: do not bend. Minimize use of fittings.

.2 Hot gas lines:

- .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
- .2 Provide trap at base of risers greater than 2400 mm high and at each 6000 mm thereafter.
- .3 Provide inverted deep trap at top of risers.
- .4 Provide double risers for compressors having capacity modulation.
  - .1 Large riser: install traps as specified.
  - .2 Small riser: size for 5.1 m3/s at minimum load. Connect upstream of traps on large riser.

3.6 PRESSURE AND LEAK TESTING

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively.

.3 Test procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.7 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

- .1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.

.3 Use copper lines of largest practical size to reduce evacuation time.

.4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.

.5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.

.6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:

.1 Twice to 14 Pa absolute and hold for 4 hours.

.2 Break vacuum with refrigerant to 14 kPa.

.3 Final to 5 Pa absolute and hold for at least 12 hours.

.4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.

.5 Submit test results to Consultant.

.7 Charging:

.1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.

.2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.

.3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

.1 Make checks and measurements as per manufacturer's operation and maintenance instructions.

.2 Record and report measurements to Consultant.

.9 Manufacturer's Field Services:

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit, immediately, to Consultant.

3.8 DEMONSTRATION

.1 Instructions:

.1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

3.9 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 20 05 01 – Common Work results for Mechanical

.2 Section 23 21 13.02 – Hydronic Systems Steel

1.2 REFERENCE STANDARDS

.1 ASME

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Safety Data Sheets (SDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC water treatment systems and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2 copies of WHMIS SDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and 01 35 43 - Environmental Procedures. Indicate VOC's for adhesive and solvents during application and curing.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for HVAC water treatment systems for incorporation into manual.

.3 Include following:

.1 Log sheets as recommended by manufacturer or Consultant.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect HVAC water treatment systems from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MANUFACTURER

.1 Equipment, chemicals, and service provided by one supplier.

2.2 WATER TREATMENT FOR HYDRONIC SYSTEMS

.1 Glycol systems: pot feeder, 25 L.

.2 Micron filter for each pot feeder:

.1 Capacity 2% of pump recirculating rate at operating pressure.

.2 Six (6) sets of filter cartridges for each type, size of micron filter.

2.3 CHEMICALS

.1 Provide 1 year's supply.

2.4 TEST EQUIPMENT

.1 Provide one set of test equipment for each system to verify performance.

.2 Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for HVAC water treatment systems installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.3 INSTALLATION

.1 Install HVAC water treatment systems in accordance with ASME Boiler and Pressure Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise

.2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.4 CLEANING OF MECHANICAL SYSTEM

.1 Provide copy of recommended cleaning procedures and chemicals for approval by Consultant.

.2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.

.3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.

.4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

.5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.5 WATER TREATMENT SERVICES

.1 Provide water treatment monitoring and consulting services for period of 1 year after system start-up. Service to include:

.1 Initial water analysis and treatment recommendations.

.2 System start-up assistance.

.3 Operating staff training.

.4 Visit plant during period of operation and as required until system stabilizes, and advise on treatment system performance.

.5 Provide necessary recording charts and log sheets for 1 year operation.

.6 Provide necessary laboratory and technical assistance.

.7 Provide clear, concise, written instructions and advice to operating staff.

3.6 FIELD QUALITY CONTROL

.1 Start-up:

.1 Start up water treatment systems in accordance with manufacturer's instructions.

.2 Commissioning:

.1 Commissioning Agency: to be installing water treatment subcontractor.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After start-up and before TAB of connected systems.

.3 Pre-commissioning Inspections: verify:

.1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.

.2 Suitability of log book.

.3 Currency and accuracy of raw initial water analysis.

.4 Required quality of treated water.

.4 Commissioning procedures - Closed Circuit Hydronic Systems:

.1 Analyze water in system.

.2 Based upon an assumed rate of loss approved by Consultant, establish rate of chemical feed.

.3 Record types, quantities of chemicals applied.

.5 Training:

.1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.

.2 Train O&M personnel in softener regeneration procedures.

.6 Certificates:

.1 Upon completion, furnish certificates confirming satisfactory installation and performance.

.7 Commissioning Reports:

.1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Consultant.

.8 Commissioning activities during Warranty Period:

.1 Check out water treatment systems on regular basis and submit written report to Consultant.

3.7 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 07 13 - DUCT INSULATION.

.2 Section 23 33 00 - AIR DUCT ACCESSORIES.

.3 Section 23 37 20 - LOUVRES, INTAKES AND VENTS.

1.2 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.2 ASTM International

.1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.

.3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Green Seal Environmental Standards (GS)

.1 GS-36-11, Standard for Adhesives for Commercial Use.

.4 National Fire Protection Association (NFPA)

.1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.3 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.

.3 IAQ Guideline for Occupied Buildings Under Construction 2007.

.6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Newfoundland and Labrador, Canada.

.4 Test and Evaluation Reports:

.1 Certification of Ratings:

.1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

.2 Construction IAQ Management Plan:

.1 Submit Indoor Air Quality (IAQ) Plan for construction pre-occupancy phases of building.

.2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect metal ducts from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 ROUND DUCTWORK

.1 Shall be spiral type with flat seem.

2.2 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C

.2 Seal classification:

.1 Class C: transverse joints and connections made air tight with gaskets, sealant tape, or combination thereof. Longitudinal seams unsealed.

2.3 SEALANT

.1 Seal all ductwork

.2 Sealant: water soluble, flexible, non toxic. Sealant to be used with woven fabric tape. Temperature range of minus 20 degrees C to plus 93 degrees C.

.3 Maximum flame spread rating: 25

.4 Smoke development rating: 50

.5 Solvent based sealant will not be accepted.

.6 Duct tape will not be accepted as primary sealant.

.7 Acceptable Manufacturer (or approved equal).

.1 Transcontinental multipurpose

.2 United Metal Unigrip

2.4 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

.2 Acceptable Manufacturer (or approved equal).

.1 Duro Dyne FT-2

2.5 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.6 FITTINGS

.1 Fabrication: to ASHRAE and SMACNA .

.2 Radiused elbows:

.1 Rectangular: centreline radius: 1.5 times width of duct.

.2 Round: centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400 mm: with single thickness turning vanes.

.2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with 45 degrees entry on branch.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Short radiused elbows.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.7 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.

.2 Fire stopping material and installation must not distort duct.

2.8 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA.

2.9 STAINLESS STEEL

.1 To ASTM A480/A480M, Type 304.

.2 Finish: number 4.

.3 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA.

.4 Joints: to ASHRAE and SMACNA be continuous inert gas welded.

2.10 ALUMINUM

.1 Used for swimming pool ductwork and in wet conditions.

.2 To ASHRAE and SMACNA. Aluminum type: 3003-H-14.

.3 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA or as indicated.

.4 Joints: to ASHRAE and SMACNA be continuous weld. Seal all joints on the inside.

.5 Slope horizontal branch ductwork down towards drain in air handler. Slope header ducts down toward risers.

.6 Fit base of risers with 150 mm deep drain sump and 32 mm drain connection, with deep seal trap and drain line to open funnel drain.

2.11 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to ASHRAE and SMACNA.

.3 Hangers: black galvanized steel angle with black galvanized steel rods to ASHRAE, SMACNA and the following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp or steel plate washer.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metal duct installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 GENERAL

.1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE, SMACNA, and as indicated.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct and Ensure diffuser is fully seated.

.3 Support risers in accordance with ASHRAE and SMACNA and as indicated.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install fire dampers and fire stop flaps to NFPA 90A

.6 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.7 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining where indicated.

.8 Install balancing dampers at all branch ducts and as indicated.

.9 Mount dampers according to damper manufacturer's recommendations.

.10 At completion of project dents in exposed ductwork will not be accepted. Dented ductwork will result in the entire length being replaced by this contractor.

3.3 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with ASHRAE SMACNA as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.4 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Dehumidifier exhaust ducts.

.3 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Weld joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.3 Slope horizontal branch ductwork down towards low point drains.

.1 Slope header ducts down toward risers.

.4 Fit base of riser with 150 mm deep drain sump and 19 mm drain connected, with deep seal trap and discharge to drain as indicated.

3.5 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA to manufacturer's recommendations.

.2 All duct joints to be sealed with duct sealant and porous tape imbedded in sealant.

.3 Bed tape in sealant and recoat with minimum of 2 coat of sealant to manufacturers recommendations.

.4 Duct tape will not be accepted.

.5 Do not insulate duct until sealant work is approved by Engineer.

.6 Aluminum supply and return ducts inside Pool area do not require sealant.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 31 13.01 – Metal Ducts – Low Pressure to 500 Pa.

1.2 REFERENCES

.1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

.5 Dampers

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect air duct accessories from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

.1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame 2 mm thick with fabric clenched by means of double locked seams.

.2 Material:

.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m^2.

.2 Material shall meet NFPA 90A and 90B and have a maximum flame spread index of 25 and a maximum smoke developed index of 50.

.3 Maximum 10" length of fabric.

.1 Acceptable Material (or approved equal)

.1 Duro-Dyne

2.3 ACCESS DOORS IN DUCTS

.1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene.

.4 Hardware:

.1 Up to 300 x 300 mm: two sash locks complete with safety chain.

.2 301 to 450 mm: four sash locks complete with safety chain.

.3 451 to 1000 mm: piano hinge and minimum two sash locks.

.4 Doors over 1000 mm: piano hinge and two handles operable from both sides.

.5 Hold open devices.

.6 300 x 300 mm glass viewing panels.

.5 Acceptable Material (or approved equal)

.1 Buensod type F-2

.2 Duro-Dyne

.6 Use Piano hinged radiused access door with double strike and catch and factory installed gasket on round ductwork.

.7 Acceptable Material (or approved equal)

.1 Nailor Model 0890

2.4 TURNING VANES

.1 Factory or shop fabricated double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

.1 1.6 mm thick steel zinc plated after manufacture.

.2 Cam lock handles with neoprene expansion plug and handle chain.

.3 28 mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

.1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.

.2 Sheet metal thickness to co-responding round duct standards.

2.7 SINGLE BLADE BALANCING DAMPERS

.1 Install in round branch ducts.

.2 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.3 Size and configuration to recommendations of SMACNA, except maximum height as indicated 100 mm.

.4 Locking quadrant with shaft extension to accommodate insulation thickness.

.5 Inside and outside nylon or bronze end bearings.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

2.8 MULTI-BLADED BALANCING DAMPERS

.1 Install in rectangular/square duct mains.

.2 Factory manufactured of material compatible with duct.

.3 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.4 Maximum blade height: as indicated 100 mm.

.5 Bearings: pin in bronze bushings or self-lubricating nylon.

.6 Linkage: shaft extension with locking quadrant.

.7 Channel frame of same material as adjacent duct, complete with angle stop.

.8 Maximum leakage: 2 % at 1000 Pa.

2.9 BACKDRAFT DAMPERS

.1 Automatic, gravity-operated, multi-blade, galvanized steel construction with nylon bearings centre-pivoted, spring assisted.

2.10 COMBINATION SMOKE AND FIRE DAMPERS

.1 Combination Smoke and Fire Dampers: arrangement Type B, listed and bear label of ULCUL, meet requirements of NFPA 92A, 92B, 101 and 105.Smoke and Fire damper

assemblies fire tested, rated and labelled in accordance with UL Standard 555S and shall be of low leakage, qualified to UL555S leakage class I.Galvanized steel frame, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.1 Smoke and Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.

.2 Smoke and Fire damper/actuator combination units: shall meet the elevated UL555S temperature rating of 121°C as a minimum and shall be rated to run at maximum operating design airflow.

.2 Damper must be rated to be with blades running horizontally (parallel to airflow) when in open position and be UL555S rated for leakage for airflow in either direction through the damper.

.3 Motorized (S/D-M): folding blade type, actuator must be of modulating type, and shall be electric, 24 Volt operation. Both damper and damper operator shall be ULC listed and labelled

.4 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

.5 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.

.6 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

.7 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.8 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.11 SMOKE DAMPERS

.1 Smoke Dampers: to be ULC or UL listed and labelled

.2 Normally closed reverse action smoke vent (S/D-RASV): folding blade type, opening by gravity upon detection of smoke, and/or from remote alarm signalling device actuated by an electro thermal link as indicated. Two flexible stainless steel blade edge seals to provide required constant sealing pressure.

.3 Normally open smoke/seal (S/D-SSSD): folding blade type, closing when actuated by means of electro thermal link and/or from remote alarm signalling device. Blade edge seals of flexible stainless steel to provide required constant sealing pressure. Provide stainless steel negator springs with locking devices to ensure positive closure for units mounted horizontally in vertical ducts.

.4 Motorized (S/D-M): folding blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled

.5 Electro thermal link (S/D-ETL): dual responsive fusible link which melts when subjected to local heat of 74 degrees C and from external electrical impulse of low power and short duration; ULC or UL listed and labelled

2.12 FIRE DAMPERS

.1 Fire dampers: Dynamic type arrangement Type B for full duct free area, with leakage Classification II and rated for 165°F listed ULC, meet requirements of authorities having jurisdiction and NFPA 90A. Fire damper assembly's fire tested in accordance with CAN/ULC-S112 and UL555.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.

.2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.

.3 Top hinged: offset, round or square; multi-blade hinged sized to maintain full duct cross section.

.4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

.5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced, c/w break away joint.

.6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.

.7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.

.8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

.9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damper HVAC manufacturer's instructions for fire dampers shall be followed.

.11 Install where shown on the drawings and where ducts pass through fire separation.

.12 Provide access doors where required for access to maintain fire dampers.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air duct accessories installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Flexible Connections:

.1 Install in following locations:

.1 Inlets and outlets to supply air units and fans.

.2 Inlets and outlets of exhaust and return air fans.

.3 As indicated.

.2 Length of connection: 100 mm.

.3 Minimum distance between metal parts when system in operation: 75 mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

.1 Ducting on sides of flexible connection to be in alignment.

.2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

.1 Size:

.1 24” x 24” for person size entry.

.2 12” x 12” for servicing entry.

.3 6” x 6” for viewing.

.4 As indicated.

.2 Locations:

.1 Fire and smoke dampers.

.2 Control dampers.

.3 Devices requiring maintenance.

.4 Required by code.

.5 Reheat coils.

.6 Elsewhere as indicated.

.3 Instrument Test Ports:

.1 General:

.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 Locations:

.1 For traverse readings:

.1 Ducted inlets to roof and wall exhausters.

.2 Inlets and outlets of other fan systems.

.3 Main and sub-main ducts.

.4 And as indicated.

.2 For temperature readings:

.1 At outside air intakes.

.2 In mixed air applications in locations as approved by Consultant.

.3 At inlet and outlet of coils.

.4 Downstream of junctions of two converging air streams of different temperatures.

.5 And as indicated.

.4 Turning Vanes:

.1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 23 05 13 - Common Motor Requirements for HVAC Equipment

.2 23 33 00 - Air Duct Accessories

1.2 REFERENCE STANDARDS

.1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)

.1 ANSI/AMCA Standard 99-2010, Standards Handbook.

.2 ANSI/ASHRAE 51-07 (ANSI/AMCA 210-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 ANSI/AMCA Standard 300-2008, Reverberant Room Method for Sound Testing of Fans.

.4 ANSI/AMCA Standard 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 The Master Painters Institute (MPI)

.1 Architectural Painting Specification Manual - current edition.

.1 MPI #18, Primer, Zinc Rich, Organic.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Provide:

.1 Fan performance curves showing point of operation, kW and efficiency.

.2 Sound rating data at point of operation.

.2 Indicate:

.1 Motors, sheaves, bearings, shaft details

.2 Minimum performance achievable with as appropriate.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.1 Provide:

.1 Matched sets of belts.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.3 List of specialized tools necessary for adjusting, repairing or replacing.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect HVAC fans from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

.2 Capacity: flow rate, total/static pressure, bhp/W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99

.4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300. Supply unit with ANSI/AMCA certified sound rating seal.

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

2.2 FANS GENERAL

.1 Motors:

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 For use with variable speed controllers.

.3 Sizes as specified.

.2 Accessories and hardware: as specified.

.3 Factory primed before assembly in colour standard to manufacturer.

.4 Scroll casing drains: as indicated.

.5 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.3 CABINET FANS - GENERAL PURPOSE

.1 Fan characteristics and construction: as centrifugal fans.

.2 Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, variable speed V-belt drive and guard inside or outside casing.

.3 Fabricate casing of zinc coated or phosphate treated steel of reinforced and braced for rigidity. Provide removable panels for access to interior. Paint uncoated, steel parts with corrosion resistant paint to MPI #18. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 50 mm thick rigid acoustic insulation, pinned and cemented, , complete with perforated metal liner complete with metal nosings on exposed edges.

2.4 IN-LINE CENTRIFUGAL FANS

.1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and drive as specified in schedules.

.2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for HVAC fans installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 FAN INSTALLATION

.1 Install fans as indicated, complete with resilient mountings specified schedules, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

.2 Provide sheaves and belts required for final air balance.

.3 Bearings and extension tubes to be easily accessible.

.4 Access doors and access panels to be easily accessible.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 20 05 01 – Common Work Results for Mechanical

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate following:

.1 Capacity.

.2 Throw and terminal velocity.

.3 Noise criteria.

.4 Pressure drop.

.5 Neck velocity.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Include:

.1 Keys for volume control adjustment.

.2 Keys for air flow pattern adjustment.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GENERAL

.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.

.2 Frames:

.1 Full perimeter gaskets.

.2 Plaster frames where set into plaster or gypsum board, and as specified.

.3 Concealed fasteners.

.3 Concealed manual volume control damper operators.

.4 Colour: As per schedule – coordinate with architect prior to ordering.

2.3 MANUFACTURED UNITS

.1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.4 SUPPLY GRILLES AND REGISTERS

.1 Refer to schedule on drawings.

2.5 RETURN AND EXHAUST GRILLES AND REGISTERS

.1 Refer to schedule on drawings.

2.6 DIFFUSERS

.1 Refer to schedule on drawings.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for diffuser, register and grille installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Install with flat head screws in countersunk holes where fastenings are visible.

.3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.

.4 Provide concealed safety chain on each grille, register and diffuser in gymnasium, multi-purpose room, and similar game rooms and elsewhere as indicated.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 20 05 01 – Common Work Results for Mechanical

1.2 REFERENCES

.1 ASTM International

.1 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.2 National Fire Protection Association (NFPA)

.1 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.4 Society of Automotive Engineers (SAE)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate following:

.1 Pressure drop.

.2 Face area.

.3 Free area.

.4 Construction.

.5 Colour.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Test Reports: submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect louvers, intakes and vents from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 FIXED LOUVRES - ALUMINUM

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T5.

.3 Blade: minimum 2.06 mm thick, angled at 40 degrees, drainable, reinforcing bosses, and located at +/- 117mm on center.

.4 Frame, head, sill and jamb: drainable, 152 mm deep one piece extruded aluminum sections, minimum 2.41 mm.

.1 Chanel frame mount without flange

.5 Mullions: located at manufacturer's standard spacing to suit wind load and other local design conditions. Mullions, if required, to be equally spaced along the width of the louver.

.6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.

.7 Screen: 12 mm x 12 mm crimped, interlocked or woven aluminum birdscreen. Minimum wire thickness to be 2 mm diameter. Screen to be complete with frame and attached to the inside face of louvers.

.8 Finish: anodized. Exact colour to be determined by comparison of manufacturers samples to existing building finishes. Expected to be either medium or dark bronze, or black.

.9 Free area: Minimum 50%.

.10 Standard of acceptance: Ventex model 2630/2635 6" deep drainable louver.

.11 Sizes (rough openings):

.1 Refer to architectural drawings for installation details.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for louvres, intakes and vents installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 In accordance with manufacturer's and SMACNA recommendations.

.2 Reinforce and brace as indicated.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 20 05 01 – Common Work Results for Mechanical

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 84-2013, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI approved).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for energy recovery equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Newfoundland and Labrador, Canada.

.2 Indicate following: Airflow, static pressure, electrical information, construction, controls, certifications, dimensions, connection sizes/locations

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Test Reports:

.1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.

.2 Provide confirmation of testing.

.6 Manufacturers' Instructions: submit manufacturer's installation instructions.

.1 Consultant will make available 1 copy of systems supplier's installation instructions.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Extra Materials:

.1 Furnish list of individual manufacturer's recommended spare parts for equipment include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.2 List of specialized tools necessary for adjusting, repairing or replacing.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect energy recovery equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

.1 Comply with ASHRAE 84

2.2 ENTHALPY TYPE AIR TO AIR ROTARY HEAT EXCHANGER (ERV-1)

.1 Capacity: as indicated.

.2 Casing: welded structural steel, galvanized after manufacture, with removable side panels.

.3 Controls: Factory installed DDC controls c/w BACnet connectivity. Unit shall be capable of performing according to consultant's written sequence (refer to EMCS sections/drawings) and not locked to a specific manufacturer sequence.

.4 Seals: adjustable at periphery of rotor, on duct divider and on purge sections.

.5 Motor: constant speed, with belt drive.

.6 Purge section, maximum cross contamination of particulates: 0.2% of supply air volume and 0.04% of exhaust air volume.

.7 Performance characteristics: as indicated.

.8 Air Tempering: Unit complete with heating (electric) and cooling (DX) coils as indicated on plans.

2.3 SENSIBLE HEAT TYPE AIR TO AIR FIXED CORE HEAT EXCHANGER (ERV-2, ERV-3)

.1 Unit shall be core-type c/w automatic recirculating defrost mode, insulated cabinet, integrated controls, and remote push-bottom timer to engage "high" speed. Refer to unit schedule on drawings.

.2 Performance characteristics: as indicated.

.3 Controls: Refer to schedule and detail on drawings for control requirements.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for energy recovery equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of adjacent ductwork with flexible connections.

.3 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils, dampers.

3.3 SITE QUALITY CONTROL

.1 Tests:

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 20 05 01 – Common Work results for Mechanical

1.2 REFERENCE STANDARDS

.1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)

.1 ANSI/AHRI 430-10, Performance Rating of Central Station Air-Handling Units.

.2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)

.1 ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

.2 ANSI/ASHRAE/IES 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.3 Green Seal (GS)

.1 GS-11-11, Standard for Paints and Coatings.

.2 GS-36-11, Standard for Adhesives for Commercial Use.

.4 Master Painters Institute (MPI)

.1 Architectural Painting Specification Manual - current edition.

.1 MPI #18.

.5 South Coast Air Quality Management District (SCAQMD)

.1 SCAQMD Rule 1113-11, Architectural Coatings.

.2 SCAQMD Rule 1168-05, Adhesives and Sealants.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for insulation, filters, adhesives, and paints and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings: Unit construction, unit performance, controls, accessories, etc.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for air handling equipment for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Provide 1 spare sets of filters.

.3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

.4 Spare filters: in addition to filters installed immediately prior to acceptance by Consultant, supply 1 complete set of filters for each filter unit or filter bank.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect air handling equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

.1 Factory assembled components to form units supplying air at designed conditions, as indicated.

.2 Certify ratings: to ANSI/AHRI 430 with AHRI seal.

.3 Horizontal and vertical type, as indicated, having air tight modular components, consisting of casing, fan section with motor and drive, filter section, damper sheating coil, cooling coil mixing box.

2.2 CASINGS

.1 Galvanized steel thickness as indicated reinforced and braced for rigidity.

2.3 DRAIN PANS

.1 Construction: stainless steel, rounded corners.

.2 Insulation: external foam type, minimum 13 mm thick.

.3 Drain connection: in bottom at low point.

.4 Installation: slope without sag minimum 1% to ensure no standing water at any time or at any point.

.5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include return bends and headers.

2.4 FANS

.1 Cabinet hung AMCA -rated for sound and performance centrifugal fans with backward inclined wheels, selected to operate in stable part of performance curve at times and self aligning split pillow block bearings.

.1 Provide internally mounted motor as indicated complete with adjustable V-belt drive and guard.

.2 Motor: to ANSI/ASHRAE/IES 90.1hpW, r/min.

.2 Maximum sound power levels, as indicated.

.3 Internally mounted motor and fan.

2.5 VIBRATION ISOLATION

.1 Flexible connections at inlet and outlet of fan: to Section 23 33 00 - Air Duct Accessories.

.2 Vibration isolators on fan built into unit.

2.6 FILTER SECTION

.1 Material to match casing. For flat type filter arrangement: as indicated.

.1 Provide access to filter through hinged door with suitable hardware.

.2 Provide blank-off plates and gaskets to prevent air bypass.

.3 Filters:

.1 Minimum Efficiency Reporting Value (MERV) value 8 filtration media to ANSI/ASHRAE 52.2, pre-filter and MERV value 13 filtration media final filter.

2.7 MIXING BOX

.1 Material to match casing and produce uniformly mixed air temperature within plus or minus 5 degrees C of design across face of outlet.

.2 Dampers for mixing boxes: Section 23 33 15 - Dampers - Operating.

2.8 COILS

.1 Capacity: as indicated.

.2 Ratings: AHRI certified.

.3 Construction:

.1 Casings: 1.5 mm thick galvanized sheet steel.

.1 Supports of galvanized steel channel double angle frames.

.2 Blank-off plates. Insulated sandwich construction.

.2 Electric Heating

.1 Complete with SCR control for heat output modulation and all safeties required to ensure coil does not operate without airflow, and integral disconnect.

.3 Direct expansion refrigerant coils:

.1 Serpentine type, arranged to prevent trapping of oil.

.1 Liquid distributors to ensure even distribution of liquid refrigerant to all circuits.

.2 Silver solder or braze joints in refrigerant tubing.

.3 Evacuate and charge coil with nitrogen and seal before sending to site.

.2 Tubes: copper.

.3 Fins: aluminum

.4 Headers: copper.

.5 Pressure tests: to Canadian Refrigeration Code. Dehydrated. Sealed with nitrogen charge.

2.9 HUMIDIFIERS

.1 In accordance with Section 23 84 13 - Humidifiers.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air handling equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Provide appropriate protection apparatus.

.2 Install units in accordance with manufacturer's instructions and as indicated.

.3 Ensure adequate clearance for servicing and maintenance.

3.3 FANS

.1 Install fan sheaves required for final air balance.

.2 Install flexible connections at fan inlet and fan outlets.

.3 Install vibration isolators.

3.4 DRIP PANS

.1 Install deep seal P-traps and trap seal primer on drip lines.

.1 Depth of water seal to be 1.5 times static pressure at this point.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 20 05 01 – Common Work Results for Mechanical

1.2 QUALITY ASSURANCE

.1 The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995/CAN/CSA-C22.2 No. 236-05 (R2009) – Heating and Cooling Equipment and bear the Listed Mark.

.2 All wiring shall be in accordance with the National Electric Code (NEC)/Canadian Electrical Code (CEC).

.3 The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

.4 The outdoor unit will be factory charged with R-410A.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Unit shall be stored and handled according to the manufacturer's recommendations.

1.4 STANDARD LIMITED WARRANTY

.1 Manufacturer shall warrant the original owner of the non-residential building, multifamily residence or residence in which the Daikin products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the "Products") will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the "installation date" which is one of the two dates below:

.1 The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit's rating plate.

.2 If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

1.5 PERFORMANCE - DESIGN BASIS

.1 The HVAC equipment basis of design is Mitsubishi. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In any event the contractor shall be responsible for all specified items and intents of this document without further compensation.

.2 Acceptable alternates: Daikin, Hitachi.

Part 2 Products

2.1 PRODUCTS

.1 SYSTEM DESCRIPTION:

.1 The variable capacity heat recovery air conditioning system shall be a Mitsubishi Variable Refrigerant Volume Series (simultaneous heat and cool model) system as specified.

.2 The system shall consist of multiple evaporators, branch selector boxes, joints and headers, a multi-pipe refrigeration distribution system using PID control and condenser unit.

.3 The condenser shall be a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant.

.4 The condensing unit may connect an indoor evaporator capacity up to 200% of the condensing unit nominal capacity. All zones are each capable of operating separately with individual temperature control.

.5 Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with each branch of the cool/heat selector box). Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.

.6 Branch selector boxes:

.1 Each branch of the branch selector box shall consist of electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units.

.2 The branch selector box shall control the operational mode of the subordinate indoor units.

.2 PERFORMANCE:

.1 As per schedule/details on drawings.

2.2 EQUIPMENT:

.1 WIRING:

.1 The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable. Refer to schematic on drawings and coordinate all site-specific requirements with purchased manufacturer.

.2 The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.

.2

.2 REFRIGERANT PIPING:

.1 Refer to specific Refrigeration piping specification section.

2.3 OUTDOOR/CONDENSING UNIT

.1 GENERAL:

.1 The condensing unit is designed specifically for use with all related indoor components.

.2 The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls.

.3 The refrigeration circuit of the condensing unit shall consist of inverter flash vapor injection scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator.

.4 High/Low pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.

.5 The condensing unit can be wired and piped with access from the left, right, rear or bottom.

.6 The connection ratio of indoor units to condensing unit shall be permitted up to 200% of nominal capacity.

.7 Each condensing system shall be able to support the connection of up to 41 indoor units, dependent on the model of the condensing unit.

.8 The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.

.9 The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

.10 To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.

.11 Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation.

.2 UNIT CABINET:

.1 The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

.3 FAN:

.1 The condensing unit shall consist of one or more propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter.

.2 The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure.

.3 The fan shall be a vertical discharge configuration.

.4 The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.

.5 The fan motor shall be provided with a fan guard to prevent contact with moving parts.

.4

.4 CONDENSER COIL:

.1 The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.

.2 The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.

.3 The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.

.4 The fins shall be coated with an anti-corrosion hydrophilic blue coating as standard from factory with a salt spray test rating of 1000hr per ASTM test standards.

.5 Provide a drain pan heater to enable adequate defrosting of the unit in defrost operation.

.6 The condensing unit shall be factory equipped with condenser coil guards on all sides.

.5 COMPRESSOR:

.1 The inverter driven compressors in the condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "K-type".

.2 The compressor's motor shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.

.3 Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

.4 Oil separators shall be standard with the equipment together with an intelligent oil management system.

.5 The compressor shall be mounted on vibration dampening rubber grommets to minimize the transmission of vibration, eliminating the standard need for external spring isolation.

.6 In the event of compressor failure, the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be manual activated to specifically address this condition for single module and manifolded systems.

.7 In the case of multiple condenser modules, combined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours. When connected to a central control system sequential start is activated for all system on each DIII network.

2.4 BRANCH SELCTOR UNITS

.1 GENERAL:

.1 These selector boxes shall be factory assembled, wired, and piped.

.2 These selector boxes must be mounted indoors.

.3 When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

.2

.2 UNIT CABINET:

.1 These units shall have a galvanized steel plate casing.

.2 Each cabinet shall house electronic expansion valves for refrigerant control per branch.

.3 The cabinet shall contain one subcooling heat exchanger per branch.

.4 The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

.3

.3 REFRIGERANT VALVES:

.1 The unit shall be furnished with electronic expansion valves per branch to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.

.2 The refrigerant connections must be of the braze type.

.3 In multi-port units, each port shall have its own electronic expansion valves. If common expansion/solenoid valves are used, redundancy must be provided.

.4 CONDENSTATE REMOVAL:

.1 Provide condensate drain as required.

2.5 INDOOR UNITS

.1

.1 Indoor units shall be part of complete package designed with corresponding outdoor unit and associated branch selector box(es). Refer to schedule and details on drawings for type of unit and required performance / controls.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:

.1 Start-up testing and verification of systems.

.2 Check-out demonstration or proper operation of components.

.3 On-site operational tests.

1.2 RELATED SECTIONS

.1 The contractor is to ensure that all related work is coordinated among all specification sections, as well as between all Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.

.2 Section 01 33 00 - Submittal Procedures.

.3 Section 01 78 00 - Closeout Submittals.

.4 Section 01 91 13 - General Commissioning (Cx) Requirements.

.5 Section 25 05 01 - EMCS: General Requirements.

1.3 DEFINITIONS

.1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

.2 AEL (Average Effectiveness Level): ratio between total test period less any system downtime accumulated within that period and test period.

.3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:

.1 Outage of main power supply in excess of back-up power sources, provided that:

.1 Automatic initiation of back-up was accomplished.

.2 Automatic shut-down and re-start of components was as specified.

.2 Failure of communications link, provided that:

.1 Controller automatically and correctly operated in stand-alone mode.

.2 Failure was not due to failure of any specified EMCS equipment.

.3 Functional failure resulting from individual sensor inputs or output devices, provided that:

.1 System recorded said fault.

.2 Equipment defaulted to fail-safe mode.

.3 AEL of total of all input sensors and output devices is at least 99 % during test period.

1.4 DESIGN REQUIREMENTS

.1 Confirm with Consultant that Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Final Report: submit report to Consultant.

.1 Include measurements, final settings and certified test results.

.2 Bear signature of commissioning technician and supervisor.

.3 Report format to be approved by Consultant before commissioning is started.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Consultant in accordance with Section 01 78 00 - Closeout Submittals.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.6 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training materials of O&M personnel for review by Consultant before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals and Section 25 05 03 – EMCS: Project Record Documents.

1.7 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 – General Commissioning (Cx) Requirements.

.2 Carry out commissioning under direction of Consultant and in presence of Consultant and Commissioning Coordinator.

.3 This Contractor shall submit a written EMCS commissioning plan to the Consultant for approval before the beginning of construction.

.4 Commissioning plan shall list equipment, devices and systems to be commissioned and shall have sample forms to fill out during commissioning, including acceptable tolerances to pass tests.

.5 Sequences of operation shall be incorporated into commissioning plan and shall be verified "line by line" in presence of Consultant.

.6 Inform, and obtain approval from, Consultant in writing at least 14 days prior to commissioning or each test. Indicate:

.1 Location and part of system to be tested or commissioned.

.2 Testing/commissioning procedures, anticipated results.

.3 Names of testing/commissioning personnel.

.7 Correct deficiencies, re-test in presence of Consultant until satisfactory performance is obtained.

.8 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.9 Load system with project software. Install software for access to EMCS via data line connection at designated site by Consultant for use during commissioning and for their use afterwards. Where high speed internet is available, use web browser software, compatible with Windows 10 with access via Microsoft Edge.

.10 Perform tests as required.

1.8 COMPLETION OF COMMISSIONING

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Consultant and Commissioning Coordinator.

1.9 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

.1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

Part 2 Products

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.

.4 Locations to be approved, readily accessible and readable.

.5 Application: to conform to normal industry standards.

Part 3 Execution

3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.

.2 Commission each system using procedures prescribed by the Commissioning Coordinator and/or Consultant.

.3 Commission integrated systems using procedures prescribed by Commissioning Coordinator and/or Consultant.

.4 Debug system software.

.5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.

.1 General: consists of field tests of equipment just prior to installation.

.2 Testing may be on site or at Contractor's premises as approved by Consultant .

.3 Configure major components to be tested in same architecture as designed system. Include all required network and control components.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).

.5 Additional instruments to include:

.1 DP transmitters.

.2 VAV supply duct SP transmitters.

.3 DP switches used for dirty filter indication and fan status.

.6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source.

.7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.

.8 Consultant to mark instruments tracking within 0.5 % in both directions as "approved for installation".

.9 Transmitters above 0.5 % error will be rejected.

.10 DP switches to open and close within 2% of setpoint.

.2 Completion Testing.

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software and provide samples of logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

.11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.

.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and Engineering units. This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Consultant and Commissioning Coordinator and provide:

.1 2 technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Consultant's acceptance signature to be on executive and applications programs.

.4 Commissioning to commence during final startup testing.

.5 O&M personnel to assist in commissioning procedures as part of training.

.6 Commissioning to be supervised by qualified supervisory personnel and Consultant.

.7 Commission systems considered as life safety systems before affected parts of the facility are occupied.

.8 Operate systems as long as necessary to commission entire project.

.9 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.

.1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

.2 Test to last at least 30 consecutive 24 hour days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.

.2 Requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

.5 Commissioning Coordinator and/or Consultant to verify reported results.

3.3 ADJUSTING

.1 Final adjusting: upon completion of commissioning as reviewed by Consultant set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

.1 Demonstrate to Commissioning Manager and/or Consultant operation of systems including sequence of operations in regular and emergency modes, under normal and

emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 91 13 – General Commissioning (Cx) Requirements.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 25 05 01 - EMCS: General Requirements.

1.3 DEFINITIONS

.1 CDL - Control Description Logic.

.2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and supplemented and modified by requirements of this Section.

.2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Consultant 30 days prior to anticipated date of beginning of training.

.1 List name of trainer, and type of visual and audio aids to be used.

.2 Show coordinated interface with other EMCS mechanical and electrical training programs.

.3 Submit reports within one week after completion of Phase 1 and Phase 2 training program that training has been satisfactorily completed.

1.5 QUALITY ASSURANCE

.1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.

.2 Consultant reserves right to approve instructors.

1.6 INSTRUCTIONS

.1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.

.2 Training to be project-specific.

1.7 TIME FOR INSTRUCTION

.1 Number of days of instruction to be as specified in this section (1 day = 7 hours including two 15 minute breaks and excluding lunch time).

1.8 TRAINING MATERIALS

.1 Provide equipment, visual and audio aids, and materials for classroom training.

.2 Supply manual for each trainee, describing in detail data included in each training program.

.1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.9 TRAINING PROGRAM

.1 To be in 2 phases over 6 month period.

.2 Phase 1: 2 day program to begin before 30 day test period at time mutually agreeable to Contractor, Consultant and Commissioning Coordinator.

.1 Train O&M personnel in functional operations and procedures to be employed for system operation.

.2 Supplement with on-the-job training during 30 day test period.

.3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.

.4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.5 Introduction to Direct Digital Controls and BACnet protocol.

.6 Identification of Control Components.

.7 Review of DDC Network Diagram for building.

.8 Review of shop drawings for building.

.9 Detailed discussion of sequences of operation

.10 Walk through of mechanical systems.

.3 Phase 2: 5 day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.

.1 Provide multiple instructors on pre-arranged schedule. Include at least

.1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.

.2 Equipment maintenance training: provide personnel with 2 days training within a 5 day period in maintenance of EMCS components, maintenance and calibration of sensors and controls.

.3 Programmers: provide personnel with 2 days training within a 5 day period in following subjects in approximate percentages of total course shown:

.1 Software and architecture: 10%
.2 Application programs: 15%
.3 Controller programming: 50%
.4 Trouble shooting and debugging:10%
.5 Colour graphic generation: 15%
.6 Display and interpret summaries
.7 Command points
.8 Modify points and point groups
.9 Define trend logs
.10 Schedule and print reports

1.10 ADDITIONAL TRAINING

.1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.11 MONITORING OF TRAINING

.1 Consultant to monitor training program and may modify schedule and content.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

1.2 RELATED SECTIONS

.1 The contractor is to ensure that all related work is coordinated among all specification sections, as well as between other Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.

.2 Section 01 33 00 - Submittal Procedures.

.3 Section 01 35 29.06 - Health and Safety Requirements.

.4 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.5 Section 01 91 13 - General Commissioning (Cx) Requirements.

.6 Section 09 91 23 - Interior Painting.

.7 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

.8 Section 25 01 12 - EMCS: Training.

.9 Section 25 05 02 - EMCS: Submittals and Review Process.

.10 Section 25 05 03 - EMCS: Project Record Documents.

.11 Section 25 05 54 - EMCS: Identification.

.12 Section 25 05 60 - EMCS: Field Installation.

.13 Section 25 08 20 - EMCS: Warranty and Maintenance.

.14 Section 25 10 01 - EMCS: Local Area Network (LAN).

.15 Section 25 30 01 - EMCS: Building Controllers

.16 Section 25 30 02 - EMCS: Field Control Devices.

.17 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.3 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI/ISA 5.5, Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).

.1 ANSI/IEEE 260.1, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE STD 135, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).

.1 CAN/CSA-Z234.1, Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).

.1 CEA-709.1-B, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus).

.1 Canadian Environmental Assessment Act (CEAA).

.2 Canadian Environmental Protection Act (CEPA).

.7 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.8 Transport Canada (TC).

.1 Transportation of Dangerous Goods Act (TDGA).

.9 National Electrical Manufacturers Association (NEMA)

1.4 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

.1 Acronyms used in EMCS.

.1 AEL - Average Effectiveness Level
.2 AI - Analog Input
.3 AO - Analog Output
.4 BACnet - Building Automation and Control Network
.5 BC(s) - Building Controller(s)
.6 BECC - Building Environmental Control Centre
.7 CAB - Canadian Automated Building (CAB) Protocol
.8 CAD - Computer Aided Design
.9 CDL - Control Description Logic
.10 CDS - Control Design Schematic
.11 COSV - Change of State or Value
.12 CPU - Central Processing Unit
.13 DI - Digital Input
.14 DO - Digital Output
.15 DP - Differential Pressure
.16 ECU - Equipment Control Unit

.17 EMCS - Energy Monitoring and Control System
.18 HVAC - Heating, Ventilation, Air Conditioning
.19 IDE - Interface Device Equipment
.20 I/O - Input/Output
.21 ISA - Industry Standard Architecture
.22 LAN - Local Area Network
.23 LCU - Local Control Unit
.24 MCU - Master Control Unit
.25 NC - Normally Closed
.26 NO - Normally Open
.27 OS - Operating System
.28 O&M - Operation and Maintenance
.29 OWS - Operator Work Station
.30 PC - Personal Computer
.31 PCI - Peripheral Control Interface
.32 PCMCIA - Personal Computer Micro-Card Interface Adapter
.33 PID - Proportional, Integral and Derivative.
.34 RAM - Random Access Memory
.35 ROM - Read Only Memory
.36 SP - Static Pressure
.37 TCU - Terminal Control Unit
.38 USB - Universal Serial Bus
.39 UPS - Uninterruptible Power Supply
.40 WAN- Wide Area Network

1.5 DEFINITIONS

.1 Point: may be logical or physical.

.1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction which related equipment (stop, start) and value or damper actuators.

.2 Point Name: composed of two parts, point identifier and point expansion.

.1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.

.1 Area descriptor: building or part of building where point is located.

.2 System descriptor: system that point is located on.

.3 Point descriptor: physical logical point description. For point identifier "area", "system" and "point" will be short forms or acronyms. Database must provide 25 character field for each point identifier.

.2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of short form or acronym used in "area", "system", and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.

.3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.

.1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.3 Point Object Type: points fall into following object types:

.1 AI (analog input)

.2 AO (analog output)

.3 DI (digital input)

.4 DO (digital output)

.5 Pulse inputs

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.

.1 Printouts: to ANSI/IEEE 260.1.

.2 Refer also to Section 25 05 54 - EMCS: Identification.

1.6 SYSTEM DESCRIPTION

.1 Maintain and protect existing Honeywell EBI control systems and wiring in areas of construction so that existing systems not slated for demolition remain operable. This includes the network wiring, control panels and all devices.

.2 Refer to control schematics, sequences of operation and related Divisions of specifications for system architecture. Refer also to EMCS System Schematics on drawings for an overview of the intent of the EMCS contract. In general, the successful EMCS vendor shall be responsible to install components, devices, wiring conduit and programming for a fully functional BAS as instructed and implied in the design documents. The successful EMCS Contractor must map points and apply correct naming convention to all points required by their own system and those points required by the Honeywell EBI system as required to produce the implied sequences and graphics associated with the full intent of these documents. All Programming shall include Memorial University standard component and system naming conventions (nomenclature information will be provided by Memorial University). The General Contractor shall carry an assigned cash allowance to, coordinate with, and work with Honeywell, to allow them to connect their existing campus EBI system to the new vendor's system through a native BACnet connection. Honeywell will interface with the successful EMCS vendor's database and will be responsible to add additional programming (if required), and must create new graphics to allow the new vendor's control system to seamlessly interface with the rest of the existing building and existing campus EBI system. Existing EBI

system and graphics must be maintained. The successful EMCS vendor will not be required to provide an on sipe PC but will be responsible for programming and commissioning their new system prior to connection with the EBI front end. The successful EMCS Contractor must coordinate with Honeywell to confirm BACnet instance ranges, and BACnet network numbers during programming in order to avoid duplication of existing.

.3 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

.1 Building Controllers.

.2 Control devices as listed in I/O point summaries and/or shown on the control drawings.

.3 Data communications equipment necessary to affect EMCS data transmission system.

.4 Field control devices.

.5 Software/Hardware complete with full documentation.

.6 Complete operating and maintenance manuals.

.7 Training of personnel.

.8 Acceptance tests, technical support during commissioning, full documentation.

.9 Wiring interface coordination of equipment supplied by others.

.10 Miscellaneous work as specified in these sections and as indicated.

.4 Design Requirements:

.1 Design and provide conduit and wiring linking elements of system.

.2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed prior to installation.

.3 Location of controllers as reviewed by Owner's Representative prior to installation.

.4 Provide utility and emergency power to EMCS.

.5 Metric references: in accordance with CAN/CSA Z234.1.

.5 Language Operating Requirements:

.1 Provide English interface to system through operator selectable access codes.

.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.

.3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.

.4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high-level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.

.6 Include, in English:

.1 Input and output commands and messages from operator-initiated functions and field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS. Point name expansions in English.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

.7 The network design to be a fully distributed network, with each primary system having its own locally mounted dedicated controller. Any failure in the network shall **not** in any way affect the control of these primary systems. Connecting hardware points from one system to more than one controller is not acceptable. Any points associated with a system are to be connected to one dedicated controller. Each dedicated controller to have a locally mounted control and display device to allow the operator to view and adjust any point on the controller.

.8 All wiring associated with the EMCS communication network as well as all control wiring and conduit associated with the EMCS at 50 volts or less. Wire and conduit above 50 volts by Electrical Division.

.9 BACnet compliance: full compliance to the BACnet standard (ANSA/ASHRAE) 135, BACnet – A Data communication Protocol for Building Automation and Control Networks is mandatory. Down to the field device level, the EMCS system must meet BACnet standards for system architecture and administration and use open communication protocols and user-friendly programming and graphics. Install the EMCS installed to communicate at the supervisory layer to the WAN using the BACnet TCP/IP protocol implemented on Ethernet.

.10 The EMCS system for this facility must be accessible by designated personnel via the existing Honeywell EBI system for scheduling, alarming, monitoring and programming purposes. The EMCS contractor must provide all the required hardware, software, gateways, etc. needed to permit connection of the EMCS to the EBI system. This shall include all hardware, software, programming, start-up and commissioning required.

.11 In areas where contract documents indicate or imply existing electric, electronic or digital devices, components and or systems are to be reused and connected to this Contractor's installed system, this Contractor shall verify correct operation and suitability of existing devices and components or systems prior to disconnection from existing control system. Report in writing to advise Consultant where existing devices, components and or systems are either non-compatible, obsolete, or inoperable requesting direction from Consultant prior to proceeding. This includes but is not limited to valves, actuators, dampers, sensors, equipment and components.

.12 Refer to TAB section for description of work associated with measuring and documenting existing valve and damper positions, VFD speed settings, etc. so that all devices can be re-energized and reset to either original or in some cases more appropriate set points and positions after new EMCS is installed. This includes but is not limited to,

air and water flows, operator positions, pressures set points, temperature set points, etc.

1.7 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Submittals and Review Process.

.2 Submit for review:

.1 Equipment list and systems manufacturers within ten (10) working days after award of contract.

.3 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 – EMCS: Submittals and Review Process. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by third party Engineer registered in Canada, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/ specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Existing devices intended for re-use: submit test report.

1.8 QUALITY ASSURANCE

.1 Controls Contractor must meet the following criteria in order to submit a bid on the work outlined in these documents and shall provide proof, in writing, of meeting each individual requirement when requested by Owner Representative, prior to award of Contract. If it is determined by the Owners Representative that a bidding Contractor has not met one or more of the following stipulations, either before or after bid period closes up until the time the contract is awarded, they are subject to being disqualified from contract award at the discretion of the Owner Representative.

.1 Have a physical office located in Newfoundland whose main line of business is retailing, installing, programming, commissioning and servicing of digital control systems, (provide proof of address).

.2 Have written authorization from the product manufacturer to sell the latest version of a direct digital control product line that they have formally represented, sold, installed, programmed, and commissioned for a minimum of 36 months immediately prior to the closing date of this tender period, (provide proof of timeline and authorization).

.3 Have a minimum of two full time employed, certified, factory trained, programmers on staff in Newfoundland. Control programmers must have a minimum of 24 months of experience programming the brand of control system being proposed for this project, (provide names and training certificate).

.4 Have a minimum of one full time employed, Licensed Electrician on staff, trained in the installation of the brand of control system being proposed for this project (provide name and proof of qualification).

.5 Have a minimum of three trained Control Service Technicians or Control Install Technicians that reside in Newfoundland, (provide list of service personnel and travel times to site).

.6 Have either an existing contract with a third-party monitoring company active for 24/7/365 days per year to receive and dispatch service calls, or have a full time employee whose main responsibility is to respond to, and dispatch service calls 24/7/365 days per year, (provide proof of monitoring capabilities).

.7 Upon award, the successful EMCS Contractor will be required to submit paperwork proving compliance with items 1 through 6 above. Non-compliant bidders will not be allowed on site.

.2 Have access to local supplies of essential parts and provide 7-year guarantee of availability of spare parts after obsolescence.

.3 Provide a 2-year manufacturer warranty on control boards starting from the date of substantial completion.

.4 Ensure factory qualified supervisory personnel continuously direct and monitor work and attend site meetings.

.5 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.6 Be able to provide factory trained personnel on site within two (2) working days notice or provide instructions on maintenance and emergency service on system within 4 hours.

.7 BACnet devices to bear BACnet testing laboratories BTL mark and listed on BACnet manufacturers association web site.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Owner's Representative with "Materials Delivery Schedule" within 2 weeks after award of contract.

.2 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.

.5 Place materials defined as hazardous or toxic in designated containers.

.6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional, Municipal, and Provincial regulations.

.7 Label location of salvaged material's storage areas and provide barriers and security devices.

.8 Ensure emptied containers are sealed and stored safely.

.9 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant Owner's Representative.

.10 Fold up metal and plastic banding, flatten and place in designated area for recycling

Part 2 Products

2.1 ACCEPTABLE SYSTEMS, MANUFACTURERS

.1 Proposed system to have communication capability utilizing BACnet Protocol.

.2 Panel to be NEMA rated to suit environmental requirements.

.3 Panels to have hinged doors equipped with standard keyed-alike cabinet locks, keyed to same key.

.4 Wiring within panels to be contained within properly sized rigid PVC slotted wall wire duct. All wiring within the wire duct to be concealed with a non-slip cover.

.5 Terminations for the connection of power wiring, communication wiring and field mounted devices to be at properly identified terminal blocks mounted within the control panel.

.6 All control panels to be provided with an internally mounted 120 volt duplex power receptacle.

.7 All control panels to be identified with permanently mounted Lamecoid tags to identify the control panel and the systems served by the control panel. Submit schedule of labels with shop drawing submission.

.8 Provide low voltage transformers in panels or elsewhere as required.

.9 Provide adaptors between metric and imperial components.

Part 3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 PAINTING

.1 Painting to be in accordance with NEMA, supplemented as follows:

.2 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.3 Restore to new condition, finished surfaces which have been damaged too extensively to be primed and touched up to make good.

.4 Clean and prime exposed hangers, racks, fastenings, and other support components.

.5 Paint all unfinished equipment installed indoors to NEMA.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process include review meetings for building Energy Monitoring and Control System (EMCS).

1.2 RELATED SECTIONS

.1 The contractor is to ensure that all related work is coordinated among all specification sections as well as between all Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

.3 Section 25 05 01 - EMCS: General Requirements.

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information.

.1 Location of local office.
.2 Description and location of installing and servicing technical staff.
.3 Location and qualifications of programming design and programming support staff.
.4 List of spare parts.
.5 Location of spare parts stock.
.6 Names of sub-contractors and site-specific key personnel.
.7 Sketch of site-specific system architecture.
.8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
.9 Descriptive brochures.
.10 Sample CDL and graphics (systems schematics).
.11 Response time for each type of command and report.
.12 Item-by-item statement of compliance.

.13 Proof of demonstrated ability of system to communicate utilizing BACnet protocol.

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Submit preliminary design document within 30 working days after contract award for review by Owner's Representative.

.3 Shop Drawings to consist electronic PDF copy of design documents, shop drawings, product data and software in compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.4 Format: PDF.

.5 Submittals shall consist of:

.1 Data sheets of all products.
.2 Wiring and piping interconnection diagrams including panel and device power, and sources.
.3 List of materials of all proposed devices and equipment.
.4 Software documentation:
.5 Sequence of operation, in text form.
.6 Application programs.
.7 Point Schedules
.8 Controls schematics and system diagrams.
.9 Project installation schedule.
.10 Names of subtrades working for EMCS contractor.
.11 Mounting support details for components installed in airflow, waterflow and steam systems.

.6 Submit shop drawings in a package which contains the various schedules and drawings which completely describe the control system installed. At a minimum the shop drawing package to contain the following items described in Section 1.5.8 to 1.5.28 as follows:

.7 Network drawing showing the network connection of all network control units, programmable control units, terminal control units and operator workstations to indicate the location of each of these elements.

.8 Schematic control diagram for each system being controlled. Where there are typical systems a drawing to be provided for each system. This drawing to be on an AB size sheet (11 x 17) and shall include a title block which includes as a minimum the drawing title, drawing number, project title, contractor's name, contractor's address, contractor's phone and fax numbers, contractor's project number and a section to provide a record for

revision information.

.9 The schematic control diagram to include a bill of materials which provides a list of all part numbers and descriptions for the control components on the drawing list to include field equipment as well as panel mounted components.

.10 The schematic control diagram to include a complete wiring diagram for all electrical connections, including motor starters, heating coils, coiling coils etc.

.11 The schematic control diagram to include a layout of the control panels for each system. This layout to show the mounting of all panel equipment, including transformers, power supplies, controllers, transducers, sensors, relays, contactors and any other panel mounted equipment.

.12 The contractor to include with the shop drawing submittal drawings, showing all wiring details for the connections of sensors, transducers, relays and contactors these details to show terminal numbers and be referenced to the appropriate schedules and drawings.

.13 The contractor to supply with the shop drawing package a complete point schedule to show every point connected to the system. This schedule to be in tabular format and provide the point identification, point type, wire tag, termination details reference, referenced drawings, device mounting location and device code numbers. Nomenclature shall match Memorial University point naming convention (University will provide documentation to the successful vendor after contract award).

.14 The point schedule to provide at a minimum the following information on the software attributes of the point:

- .1 Building ID – AQ
- .2 Tag name – ex. EPT-1
- .3 Point type – ex. AO-3
- .4 System name – ex. A/C-1
- .5 Object name – H-VLV.
- .6 Expanded ID- Heating control valve
- .7 Units of measurement - %.

.15 The point schedule to provide at a minimum the following information on the digital controller to which the point is connected:

- .1 Controller type – ex. Unitary controller
- .2 Controller address ex. 256.
- .3 Cable destination – the termination at the controller, ex. AO-1.
- .4 Terminal numbers – the termination at the controller.

.16 The point schedule to provide at minimum the following information on the control panel:

- .1 Panel identification

.2 Panel location

.3 Reference drawing

.17 The point schedule to provide at a minimum the following information on any intermediate device which may be associated with the point:

.1 Type of wiring or tubing used

.2 Device part number

.3 Location of the device.

.4 Reference details.

.18 The point schedule to provide at a minimum the following information on any field device which may be associated with the point;

.1 Type of wiring or tubing used

.2 Device part number

.3 Location of the devices

.4 Reference details

.19 The contractor to supply with the shop drawing package a complete room schedule, to show the equipment associated with the room controls. Schedule to be in tabular format and provide the room number and location, terminal unit number, part numbers for the terminal unit controller, sensors and actuators. Included on this schedule terminal unit type, size, minimum flow and maximum flow.

.20 Sequence of operation for each system controlled. Sequence to be in complete conformance with the sequence of operations included with this specification. Any changes require the approval of the Owner's Representative in writing. Sequence to include all modes of operation including fail safe, emergency and fire modes.

.21 Valve schedule including design flow, CV, size, type, actuator, pressure drop and maximum shut off pressure differential for each control valve.

.22 Damper schedule including design air flow, size, type actuator and torque requirements for each control damper.

.23 Provide one permanent, not fading, as built copy of each control drawing, enclosed by an aluminium frame with glass cover, or sealed by plastic laminate in rigid metal bound frame. To be installed at each respective control panel location.

.24 Catalogue cut sheets of all equipment used. This includes, but is not limited to DDC panels, peripherals, sensors, actuators, dampers, control air system components, etc.

.25 Range and scale information for all transmitters and sensors. This sheet to clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.

.26 Hardware data sheets for all operator workstations, local access panels, and portable

operator terminals.

.27 Software manuals for all applications programs to be provided as a part of the operator workstations, portable operator terminals, programming devices, and so forth for:

1.6 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:

.1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller including, signal levels, pressures where new EMCS ties into existing control equipment.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).

.8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

.9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

.10 Compressor schematic and sizing data if applicable.

1.7 DETAIL SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook-ups.

.4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules and terminations.

.4 Pneumatic schematics and schedules.

.5 Complete Point Name Lists.

.6 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.

.7 Software and programming details associated with each point.

.8 Manufacturer's recommended installation instructions and procedures.

.9 Input and output signal levels or pressures where new systems ties into existing control equipment.

.6 Control schematics, narrative description, CDLs fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.

.7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.

.8 Complete system CDLs including companion English language explanations on same sheet but with different font and italics. CDLs to contain specified energy optimization programs.

.9 Listing of and example of specified reports.

.10 Listing of time of day schedules.

.11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

.12 Type and size of memory with statement of spare memory capacity.

.13 Full description of software programs provided.

.14 Sample of "Operating Instructions Manual" to be used for training purposes.

.15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 – EMCS: Start-up, Verification and Commissioning.

1.8 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.

.2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).

.3 Review interface requirements of materials supplied by others.

.4 Review "Sequence of Operations".

.2 Contractor's factory trained programmer to attend meeting.

.3 Owner's Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Owner.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED SECTIONS

.1 Section 01 78 00 - Closeout Submittals.

.2 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

.3 Section 25 05 01 - EMCS: General Requirements.

.4 Section 25 05 02 - EMCS: Submittals and Review Process.

1.3 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.

.2 Submit Record Documents, As-built drawings, Operation and Maintenance Manual to Consultant in English.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.

.1 Binders to be 2/3 maximum full.

.2 Provide index to full volume in each binder.

.3 Identify contents of each manual on cover and spine.

.4 Provide Table of Contents in each manual.

.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.5 AS-BUILTS

.1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:

- .1 Changes to contract documents as well as addenda and contract extras.
- .2 Changes to interface wiring.
- .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
- .4 Locations of obscure devices to be indicated on drawings.
- .5 Listing of alarm messages.
- .6 Panel/circuit breaker number for sources of normal/emergency power.
- .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
- .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .9 Basic system design and full documentation on system configuration.

.2 Submit for final review by Consultant.

.3 Provide before acceptance 4 hard and 1 soft copy incorporating changes made during final review.

1.6 O&M MANUALS

.1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.

.2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests.

.3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.4 Functional description to include:

- .1 Functional description of theory of operation.
- .2 Design philosophy.
- .3 Specific functions of design philosophy and system.
- .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
- .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
- .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating

procedures currently implemented or planned for implementation in automatic mode.

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.

.6 Software for each Controller and single section referencing Controller common parameters and functions.

.7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware, plus diagnostics and repair/replacement of system hardware.

.8 System configuration document:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure coordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

.3 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for identification of devices, sensors, wiring, tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates, materials, colours and lettering sizes.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 25 05 01 - EMCS: General Requirements.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA C22.1, The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

1.4 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.5 SYSTEM DESCRIPTION

.1 Language Operating Requirements: provide identification for control items in English.

1.6 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process supplemented and modified by requirements of this Section.

.2 Submit to Owner's Representative for approval samples of nameplates, identification tags and list of proposed wording.

Part 2 Products

2.1 NAMEPLATES FOR PANELS

.1 Identify by plastic laminate, 3 mm thick melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core, mechanically attached with self-tapping screws.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by plastic tie.

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: minimum 5 mm high produced from laser printer in black.

.4 Data to include: point name and point address, make, model number.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Owner's Representative.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Owner's Representative.

2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 PNEUMATIC TUBING

.1 Numbered tape markings on tubing to provide uninterrupted tracing capability.

2.7 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use orange paint as outlined in Electrical specification and confirm colour with Owner's Representative during "Preliminary Design Review

Part 3 Execution

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

.1 Correct existing nameplates and legends to reflect changes made during work.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 11 00 – Summary of Work.

.2 Section 07 84 00 – Fire Stopping.

.3 Section 20 05 01 – Common Works Results for Mechanical.

.4 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

.5 Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

.6 Section 23 07 13 – Duct Insulation.

.7 Section 23 07 16 – HVAC Equipment Insulation.

.8 Section 23 21 13.01 – Hydronic Systems: Copper.

.9 Section 23 21 13.02 – Hydronic Systems: Steel.

.10 Section 23 21 13.04 – Hydronic Systems: Plastic.

.11 Section 23 23 00 – Refrigerant Piping.

.12 Section 25 05 01 – EMCS: General Requirements.

.13 Section 26 05 00 – Common Work Results for Electrical.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.2 ANSI C2, National Electrical Safety Code.

.3 ANSI/NFPA 70, National Electrical Code.

.2 Canadian Standards Association (CSA)

.1 CSA C22.1, Canadian Electrical Code, Part 1.

.2 CAN/CSA C22.3 No.1, Overhead Systems.

.3 CSA C22.3 No. 7, Underground Systems.

1.3 SYSTEM DESCRIPTION

.1 Electrical:

.1 Provide power wiring from emergency power panels where emergency power is provided to EMCS field panels. If no emergency power provided, install UPS Device. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.

.2 Hard wiring between field control devices and EMCS field panels.

.3 Communication wiring between EMCS field panels and Honeywell EBI system.

.4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.5 Refer to wiring diagrams included as part of flow diagrams. Trace existing control wiring installation and provide updated wiring schematics including additions and/or deletions to control circuits for approval by Consultant before commencing work.

.6 All control wiring 50 V and less for equipment supplied by Division 25 will be the responsibility of Division 25 - Integrated Automation Contractor. Conduit and wire associated with this is the responsibility of Division 25.

.2 Mechanical:

.1 Pipe taps required for EMCS equipment will be supplied and installed by Mechanical Piping Contractor.

.2 Wells and control valves shall be supplied by EMCS Contractor and installed by Mechanical Piping Contractor.

.3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Ventilation Contractor. Costs to be carried by designated trade.

.3 Structural:

.1 Special steelwork as required for installation of work.

1.4 PERSONNEL QUALIFICATIONS

.1 Qualified factory trained supervisory personnel to:

.1 Continuously direct and monitor all work.

.2 Attend site meetings.

1.5 EXISTING CONDITIONS

.1 Cutting and Patching: refer to Section 01 73 00 – Execution, supplemented as specified herein.

.2 Repair all surfaces damaged during execution of work.

.3 Turn over to Consultant existing materials removed from work not identified for re-use.

Part 2 Products

2.1 PIPING

.1 Domestic H&CWS: refer to Section 22 11 16 - Domestic Water Piping.

.2 Sanitary, storm water: refer to Section 22 13 16.16 - Sanitary Waste and Vent Piping – Plastic.

.3 Dry Cooler and heating water: refer to Section 23 21 13.02 – Hydronic Systems: Steel.

.4 Heating water: refer to Section 23 21 13.01 – Hydronic Systems: Copper.

.5 Pool water piping: refer to Section 23 21 13.04 – Hydronic Systems: Plastic.

.6 Refrigeration: refer to Section 23 23 00 – Refrigerant Piping.

.7 Sleeves, escutcheons: refer to Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

.8 Hangers and supports: refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

.9 Insulation: refer to Section 23 07 16 – HVAC Equipment Insulation and 23 07 13 – Duct Insulation.

2.2 SPECIAL SUPPORTS

.1 Structural grade steel, primed and painted after construction and before installation. Use galvanized or Aluminum supports in Pool area and in Pool Service areas.

2.3 WIRING

.1 As per requirements of Electrical Divisions.

.2 For 50V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.

.3 For wiring under 50 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.

.4 Sizes:

.1 120V Power supply: to match or exceed breaker, size #12 minimum.

.2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.

.3 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.

.4 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair. Wiring must be continuous without joints.

.5 More than 4 conductors: #22 minimum solid copper.

.5 Terminations:

.1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.4 CONDUIT

.1 As per requirements of Electrical Division.

.2 Electrical metallic tubing to CSA C22.2 No. 03. Flexible and liquid tight flexible metal conduit to CSA C22.2 No.56. Rigid steel threaded conduit to CSA C22.2 No. 45.

.3 Junction and pull boxes: welded steel.

.1 Surface mounting cast FS: screw-on flat covers.

.2 Flush mounting: covers with 25 mm minimum extension all round.

.4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.5 Outlet boxes: 100 mm minimum, square.

.6 Conduit boxes, fittings:

.1 Bushings and connectors: with nylon insulated throats.

.2 With push pennies to prevent entry of foreign materials.

.7 Fittings for rigid conduit:

.1 Couplings and fittings: threaded type steel.

.2 Double locknuts and insulated bushings: use on sheet metal boxes.

.3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:

.1 Connectors and couplings: steel, set screw type.

.9 Conduit, boxes cover plates, and associated fittings in Pool area and Pool Service areas shall be PVC chemical weld liquid tight:

2.5 WIRING DEVICES, COVER PLATES

.1 Conform to CSA.

.2 Receptacles:

.1 Duplex: CSA type 5-15R.

.2 Single: CSA type 5-15R.

.3 Cover plates and blank plates: finish to match other plates in area.

2.6 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.

.1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.2 Plastic with Stainless steel fasteners in Pool area.

.2 Exposed conduits or cables:

.1 50 mm diameter and smaller: one-hole steel straps.

.2 Larger than 50 mm diameter: two-hole steel straps.

.3 Plastic with Stainless steel fasteners in Pool area.

.3 Suspended support systems:

.1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.

.2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

.3 Plastic with Stainless steel fasteners in Pool area.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment, components so that manufacturers and CSA labels are visible and legible after commissioning is complete.

3.2 PIPING

.1 Match existing piping when connecting to existing systems.

.2 Domestic H&CWS: refer to Section 22 11 16 – Domestic Water Piping Copper.

.3 Sanitary, storm water: refer to Section 22 13 16.16 - Drainage Waste and Vent Piping – Plastic.

.4 Dry Cooler, chilled water and heating water: refer to Section 23 21 13.02 – Hydronic Systems: Steel.

.5 Heating water: refer to Section 23 21 13.01 – Hydronic Systems: Copper.

.6 Pool water piping: refer to Section 23 21 13.04 – Hydronic Systems: Plastic

.7 Condenser water: refer to Section 23 21 13.02 – Hydronic Systems: Steel.

.8 Refrigeration: refer to Section 23 23 00 – Refrigerant Piping.

.9 Insulation: refer to Section 23 07 16 – HVAC Equipment Insulation and 23 07 13 – Duct Insulation.

3.3 MECHANICAL PIPING

.1 Install piping in accordance with Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

3.4 SUPPORTS

.1 Install special supports as required and as indicated.

3.5 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:

.1 Electrical Divisions, this specification.

.2 CSA 22.1 Canadian Electrical Code, latest edition.

.3 ANSI/NFPA 70.

.4 ANSI C2.

.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage (above 50 V) contacts and mark to prevent accidental injury.

.3 Do underground installation to CAN/CSA C22.3 No.7, except where otherwise specified.

.4 Conform to manufacturer's recommendations for storage, handling and installation.

.5 Check factory connections and joints. Tighten where necessary to ensure continuity.

.6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.

.7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.

.8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.

.9 Install conduits, and sleeves prior to pouring of concrete.

.10 Holes through exterior wall and roofs: flash and make weatherproof.

.11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.6 CONDUIT SYSTEM

.1 Communication wiring shall be free run, neatly tied up to building structure, and run parallel or perpendicular to building grid lines above ceilings in areas in areas where ceilings exist. All communication wiring in areas without ceilings or below ceilings, (actual or implied) shall be installed in conduit. All Communication wiring inside Natorium (pool area) and pool service area shall be installed in PVC conduit. All conduit shall be coordinated with Architectural prior to installation. All wiring inside Mechanical, Electrical and other service spaces shall be run inside conduit. Provide complete system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fills not to exceed 40%. Design drawings do not show conduit layout.

.2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

.3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Consultant before starting such work. Provide complete system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

.4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.

.5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.7 Limit conduit length between pull boxes to less than 30 m.

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.9 Fastenings and supports for conduits, cables, and equipment:

.1 Provide plastic coated metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.

.2 Provide adequate support for raceways and cables, sloped vertically to equipment.

.3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Consultant.

.10 Install polypropylene fish cord in empty conduits for future use.

.11 Where conduits become blocked, remove and replace blocked sections.

.12 Pass conduits through structural members only after receipt of Consultant's written approval.

.13 Conduits may be run in flanged portion of structural steel.

.14 Group conduits wherever possible on suspended or surface channels.

.15 Pull boxes:

.1 Install in inconspicuous but accessible locations.

.2 Support boxes independently of connecting conduits.

.3 Fill boxes with paper or foam to prevent entry of construction material.

.4 Provide correct size of openings. Reducing washers not permitted.

.5 Mark location of pull boxes on record drawings.

.6 Identify AC power junction boxes, by panel and circuit breaker.

.16 Install terminal blocks or strips indicated in cabinets to Electrical Division.

.17 Install bonding conductor for 120 volt and above in conduit.

3.7 WIRING

.1 Install multiple wiring in ducts simultaneously.

.2 Do not pull spliced wiring inside conduits or ducts.

.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.4 Tests: use only qualified personnel. Demonstrate that:

.1 Circuits are continuous, free from shorts, unspecified grounds.

.2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide Consultant with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.8 WIRING DEVICES, COVER PLATES

.1 Receptacles:

.1 Install vertically in gang type outlet box when more than one receptacle is required in one location.

.2 Cover plates:

.1 Install suitable common cover plate where wiring devices are grouped.

.2 Use flush type cover plates only on flush type outlet boxes.

3.9 STARTERS, CONTROL DEVICES

.1 Install and make control connections as indicated. Power connections above 50V by Electrical Division.

.2 Install correct over-current devices.

.3 Identify each control wire, terminal for external connections with permanent number marking identical to diagram.

.4 Performance Verification:

.1 Operate switches and controls to verify functioning.

.2 Perform start and stop sequences of contactors and relays.

.3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

3.10 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.11 TESTS

.1 General:

.1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.

.2 Give 14 days written notice of intention to test.

.3 Conduct in presence of Consultant and authority having jurisdiction.

.4 Conceal work only after tests satisfactorily completed.

.5 Report results of tests to Consultant in writing.

.6 Preliminary tests:

.1 Conduct as directed to verify compliance with specified requirements.

.2 Make needed changes, adjustments, replacements.

.3 Insulation resistance tests:

.1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.

.2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Consultant and authority having jurisdiction.

3.12 IDENTIFICATION

.1 Refer to Section 25 05 54 - EMCS: Identification.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 00 - Closeout Submittals.

.3 Section 25 05 01 - EMCS: General Requirements.

1.3 REFERENCES

.1 Canada Labour Code (R.S., c. L-2)/Part I - Industrial Relations.

.2 Canadian Standards Association (CSA)

.1 CSA Z204 – Guidelines for Managing Indoor Quality in Buildings

1.4 DEFINITIONS

.1 OWS - Operator Work Station.

.2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit detailed preventative maintenance schedule for system components to Consultant.

.3 Submit detailed inspection reports Consultant.

.4 Submit dated, maintenance task lists to Consultant and include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.

.2 Device type and range.

.3 Measured value.

.4 System displayed value.

.5 Calibration detail

.6 Indication if adjustment required,

.7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.

.1 Maintain records and logs of each maintenance task on site.

.2 Organize cumulative records for each major component and for entire EMCS chronologically.

.3 Submit records to Consultant, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Consultant in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.6 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for warranty period of one year after date of substantial completion. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:

.1 Initiate service calls when EMCS is not functioning correctly.

.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

.3 Furnish Consultant with telephone number where service personnel may be reached at any time.

.4 Service personnel to be on site ready to service EMCS after receiving request for service.

.5 Perform work continuously until EMCS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:

.1 Serial number identifying component involved.

.2 Location, date and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.5 Provide system modifications in writing.

.1 No system modification, including operating parameters and control settings, to be made without prior written approval of Consultant.

1.7 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to Consultant and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures. Service contracts duration is for the warranty period.

.2 Service Contracts to include:

.1 Annual verification of field points for operation and calibration.

.2 4 visits per year.

.3 2 responses to emergency calls during day, per year.

.4 2 responses to emergency calls during silent hours, per year.

.5 Silent hours defined as 1630 h – 0800 h and on weekends and statutory holidays.

.6 Complete inventory of installed system.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Consultant as described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.

.2 Check and calibrate random sample of 10% field input/output devices in accordance with Canada Labour Code - Part I and CSA Z204.

.3 Provide dated, maintenance task lists, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.

.2 Check equipment cooling fans as required.

.3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.

.4 Review system performance with Operations Supervisor and/or Consultant to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.

.3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.

.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required (as per 3.1. 3.2).

.5 Provide mechanical adjustments, and necessary maintenance on printers.

.6 Run system software diagnostics as required.

.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.

.1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.

.1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

.2 Related Sections:

.1 Section 25 05 01 – EMCS: General Requirements.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA T529, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications.

.2 CSA T530, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA – 569-A with modifications.

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information Technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements.

.1 IEEE Std 802.3TM, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA).

.1 TIA/EIA-568, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements, Part 2 Balanced Twisted- Pair Cabling Components, Part 3 Optical Fiber Cabling Components Standard.

.2 TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS).

.1 TBITS 6.9, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings-Technical Specifications.

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01 – EMCS: General Requirements.

1.4 SYSTEM DESCRIPTION

.1 Data communication network to link existing Honeywell EMCS system and Master Control Units (MCU) in accordance with CSA T529, TIA/EIA-568, CSA T530 and TIA/EIA-569-A.

.1 Provide reliable and secure connectivity of adequate performance between different sections segments of network.

.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to included, but not limited to:

.1 EMCS-LAN.

.2 Modems.

.3 Network interface cards.

.4 Network management hardware and software.

.5 Network components necessary for complete network.

1.5 DESIGN REQUIREMENTS

.1 EMCS Local Area Network (EMCS-LAN).

.1 High Speed, high performance, local area network over MS/TP with MCUs and OWSs communicate with each other directly on peer-to-peer basis in accordance with IEEE 802.3/Ethernet Standard.

.2 EMCS-LAN to be: BACnet Protocol

.3 Each EMCS-LAN to be capable of supporting at least 50 devices.

.4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

.1 Network medium: twisted cable, shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

.2 Installed as per MUNet Spec. Refer to Architectural specification for location of MUNet spec.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for building automation controllers including:

.1 Master Control Unit (MCU).

.2 Local Control Unit (LCU)

.3 Equipment Control Unit (ECU).

.4 Terminal Control Unit (TCU).

1.2 RELATED SECTIONS

.1 Section 25 05 01 - EMCS: General Requirements.

.2 Section 25 05 02 - EMCS: Submittals and Review Process.

.3 Section 25 05 03 - EMCS: Project Records Documents.

.4 Section 25 30 02 - EMCS: Field Control Devices.

.5 Section 25 90 01 – EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.3 REFERENCES

.1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE, Applications Handbook, SI Edition.

.2 ASHRAE Standard 135 – BACnet – A Data Communications Protocol for Building Automation and Control Networks.

.3 ASHRAE Standard 135.1 Method of Test Conformance to BAC net.

.2 Canadian Standards Association (CSA)

.1 C22.2 No.205, Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE)

.1 IEEE C37.90.1, Surge Withstand Capabilities Test for Protective Relays and Relays Systems.

1.4 DEFINITIONS

.1 Acronyms used in this section include: see Section 25 05 01 - EMCS: General Requirements.

1.5 SYSTEM DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controllers quantity, and point contents to be approved by Consultant at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units:

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

.4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

1.6 DESIGN REQUIREMENTS

.1 To include:

.1 Scanning of AI and DI connected inputs for detection of change of value and processing the detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including the resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.2 Total spare capacity for MCUs and LCUs: at least 25% of each point type distributed throughout the MCUs and LCUs.

.3 Field Termination and Interface Devices.

.1 To conform to CSA C22.2 No. 205.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logic devices and associated field equipment.

.3 Lockable wall cabinet.

.4 Required communications equipment and wiring .

.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.6 Input/Output interface to accept as minimum AI, AO, DI, DO functions as specified.

.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:

.1 Convert analog signals to digital format with 12 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20 mA;

.2 0-10V DC

.3 10 K ohm.

.3 Meet IEEE C37.90.1 surge withstand capability.

.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using 12 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20 mA.

.2 0 - 10 V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Meet IEEE C37.90.1 surge withstand capability.

.3 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.

.2 Switch up to 5 amps at 220 V AC using optional interface relay.

.4 Controller's and associated hardware and software: operate in conditions of 0°C to 44°C and 20 % to 90 % non-condensing RH.

.5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.

.1 Provide for conduit entrance from top, bottom or sides of panel.

.2 ECUs to be mounted in equipment enclosures or separate enclosures.

.3 Mounting details as approved by Consultant for ceiling mounting.

.6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.7 Provide surge and low voltage protection for interconnecting wiring connections.

1.7 SUBMITTALS

.1 Make Submittals in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process.

.1 Submit product data sheets for each product item proposed for this project.

1.8 MAINTENANCE PROCEDURES

.1 Provided manufacturers recommended maintenance procedures for insertion in Section 25 05 03 – EMCS: Project Record Documents.

Part 2 Products

2.1 MASTER CONTROL UNIT (MCU)

.1 Primary function of MCU is to provide co-ordination and supervision of subordinate devices. Supervisory role shall include coordination of subordinate devices in the execution of optimization routines such as demand limiting or enthalpy control.

.2 Include high speed communication LAN Port for Peer-to-Peer communications with OWS(s) and other MCU level devices. Include support for Open System Protocols, BACnet.

.3 MCU shall have local I/O capacity as follows;

.1 To have at least 16 I/O points of which minimum to be 2AO, 6AI, 4DI, 4DO.

.2 LCUs to be added to support system functions as indicated in I/O Summary List.

.4 Central Processor Unit (CPU)

.1 Processor to consist of at minimum a 16-bit microprocessor capable of supporting software to meet specified requirements.

.2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.

.3 Minimum addressable memory to be at manufacturer's discretion but to support at least all performance and technical specifications. Memory to include:

.1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.

.2 Battery backed (72 hr minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) RAM to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS, CAB-Gateway, or locally installed floppy disk.

.4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving month/day/hour/minute/second, with rechargeable batteries for minimum 72 hr operation in event of power failure.

.5 reference or look-up tables.

2.2 LOCAL CONTROL UNIT (LCU)

.1 Provide multiple control functions for typical built-up and package HVAC, hydronic and electrical systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.3 Points of one Building System to be connected to one controller as listed in I/O Summary designations.

.4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements. As per MCU requirements (section 2.3.4) above with the following additions:

.1 Include as minimum 2 interface ports for connection to local computer terminal.

.2 Design so that shorts, opens or grounds on any input or output will not interfere with other input or output signals.

.3 Physically separate line voltage (50V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.

.4 Include power supplies for operation of LCU and associated field equipment.

.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.

.6 Provide conveniently located screw type or spade lug terminals for field wiring.

.7 LCU to have 25 % spare input and 25 % output point capacity without addition of cards, terminals, etc.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

.1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.

.1 The TCU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook.

.2 Controller to communicate directly with EMCS through EMCS LAN and provide access

from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

2.4 SOFTWARE

.1 General:

.1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.

.2 To include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.

.3 Include initial programming of all Controllers, for entire system.

.2 Program and data storage:

.1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.

.2 Maintain CDL and operating data such as setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

.3 Programming languages:

.1 Control Description Logic software to be programmed using English like or graphical, high level, general control language.

.2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed.

.4 Pseudo or calculated points:

.1 Software to have access to any value or status in controller or other networked controller so as to define and calculate pseudo point from other values/status of controller. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.

.2 Inputs and outputs for any process to be able to include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to any number of other processes (eg. cascading).

.5 Control Description Logic (CDL):

.1 Capable of generating on-line project-specific control loop algorithms (CDLs). CDLs to be software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (eg. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS or BC(s) and to tune control loops.

.3 Perform changes to CDL on-line.

.4 Control logic to have access to values or status of all points available to controller including global or common values, allowing cascading or inter-locking control.

.5 Energy optimization routines such as enthalpy control, supply temperature reset, etc. to be LCU or MCU resident functions and form part of CDL.

.6 MCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional Integral and Derivative (PID) control.

.3 Automatic control loop tuning.

.7 Control software to provide the ability to define the time between successive starts for each piece of equipment to reduce cycling of motors.

.8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.9 Power Fail Restart: Upon detection of power failure system to verify availability of emergency power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.6 Event and Alarm management: The system to use a management by exception concept for Alarm Reporting. This is a system wide requirement. This approach will ensure that only principal alarms are reported to exist OWS. Events which occur as a direct result of the primary event to be suppressed by the system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. The exception is, when an air handler which is supposed to stop or start fails to do so under the event condition.

.7 Energy management programs: The following programs shall include specific summarizing reports, to include the date stamp indicating sensor details which activated and or terminated the feature.

.1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:

.1 Time of day scheduling.

.2 Calendar based scheduling.

.3 Holiday scheduling.

.4 Temporary schedule overrides.

.5 Optimal start stop.

.6 Night setback control.

.7 Enthalpy (economizer) switchover.
.8 Peak demand limiting.
.9 Temperature compensated load rolling.
.10 Fan speed/flow rate control.
.11 Cold deck reset.
.12 Hot deck reset.
.13 Hot water reset.
.14 Chilled water reset.
.15 Condenser water reset.
.16 Chiller sequencing.
.17 Night purge.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Consultant.

.8 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 MCUs to accumulate and store automatically run-time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (e.g., kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

.1 Display analog values digitally to 1 place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.

.4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second

intervals.

2.6 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support point naming convention as defined in Section 25 05 01 – EMCS: General Requirements.

Part 3 Execution

3.1 LOCATION

.1 Location of Controllers to be approved by Consultant.

3.2 INSTALLATION

.1 Install Controllers in secure enclosures as indicated.

.2 Provide necessary power from local 120 V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use Uninterruptible Power Supply (UPS) and emergency power when equipment must operate in an emergency and coordinating mode.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Section 25 05 03 - EMCS: Project Records Documents.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI C12.7, Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13, Requirements for Instrument Transformers.

.2 Canadian Standards Association (CSA)

.1 CSA Type 1 Enclosure

.2 CSA Type 4X Enclosures

.3 CSA Type 12 Enclosures

1.3 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Include:

.1 Information as specified for each device.

.2 Manufacturer's detailed installation instructions.

.3 Pre-Installation Tests

.1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.

.4 Manufacturer's Instructions

.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 CLOSEOUT SUBMITTALS

.1 Submit operating and maintenance data for inclusion in operation and maintenance manual in accordance with Section 25 05 03 - EMCS: Project Records Documents.

Part 2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.

.3 Operating conditions: 0 - 32 °C with 10 - 90 % RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters to be unaffected by external transmitters (e.g., walkie talkies).

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in CSA 4X enclosures.

.8 Devices to be installed in user occupied space must not exceed Noise Criteria (NC) of 30. Noise generated by any device must not be detectable above space ambient conditions.

.9 Devices shall be reused where possible. Site-confirm that existing devices are operating to meet requirements of sequences and that they are compatible with new DDC system. Replace as required to ensure proper function and communication.

.10 Where existing devices are replaced, they shall meet specifications in Part 2 of this section.

2.2 TEMPERATURE SENSORS

.1 General: except for VAV box control to be resistance or thermocouple type to following requirements:

.1 Thermisters 10 K ohm, $\pm$ 0.2° C accuracy, less than 0.1° C drift over 10 year span. Power supply 5 V dc, 10-35 Vdc, 24 Vac..

.2 RTD's: 1000 ohm at 0 °C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm°C.

.3 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm as indicated.

.2 Sensors:

.1 For rooms accessible to public: wall mounting, in solltted type covers, LCD display °C or °F with guard as indicated. Dual setpoint momentary push button for night setback function, override switch, setpoint adjustment, local indication.

.2 For maintenance areas: stainless steel blank faceplate (no adjustments).

.3 General purpose duct type: suitable for insertion into ducts at any angle, insertion length 460 mm.

.4 Averaging duct type: continuous filament with minimum immersion length 6000 mm. Bend probe at field installation time to 100 mm radius at any point along probe without degradation of performance.

.5 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in CSA 4X enclosure.

.6 Immersion type: spring loaded probe, NPT ½ fitting insertion to suit pipe size.

.7 Concrete slab sensor: single point slab temperature sensor encapsulated in a thermal conductive coating, with moisture proof burial 20 AWG.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 ohm at 0 deg C, platinum resistance detector type sensors.

.2 Power supply: 575 ohms at 24 V DC into load of 575 ohms. Power supply effect less than 0.01 deg C per volt change.

.3 Output signal: 4 - 20 mA into 500 ohm maximum load.

.4 Input and output short circuit and open circuit protection.

.5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.

.6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.

.7 Maximum current to 100 ohm RTD sensor: not to exceed 22.5 mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 °C.

.10 Long term output drift: not to exceed 0.25 % of full scale/ 6 months.

.11 Transmitter ranges: Select narrowest range to suit application from following:

.1 Minus 50 °C to plus 50 °C, plus or minus 0.5 °C.

.2 0 to 100 °C, plus or minus 0.5 °C.

.3 0 to 50 °C, plus or minus 0.25 °C.

.4 0 to 25 °C, plus or minus 0.1 °C.

.5 10 to 35 °C, plus or minus 0.25°C.

2.4 HUMIDITY SENSORS

.1 Requirements:

.1 Range: 5 - 95 % RH minimum.

.2 Operating temperature range: -40°C to 85°C.

.3 Absolute accuracy:

.1 Duct sensors: plus or minus 5 %.

.2 Room sensors: plus or minus 2 % .

.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.

.5 Maintenance: by simple field method such as washing with solvent or mild detergent solution so as to remove anticipated airborne contaminants.

.6 Maximum sensor non-linearity: plus or minus 0.5% RH with defined curves.

.7 Room sensors: wall mounted as indicated.

.8 Duct mounted sensors: locate so that sensing element is between 1/3 and 2/3 distance across any duct dimension.

.9 Sensors to be unaffected by external transmitters such as walkie-talkies. Demonstrate to Departmental Representative.

.10 Power supply: 18-35 Vdc, 18-32 Vac with temperature sensor.

2.5 HUMIDITY TRANSMITTERS

.1 Requirements:

.1 Input signal: from 1000 ohm RTD.

.2 Output signal: 4 - 20 mA into 1000 ohm maximum load, 0-5 Vdc, 0-10 Vdc.

.3 Input and output short circuit and open circuit protection.

.4 Output accuracy: not to exceed 0.1 % of full span.

.5 Output linearity error: plus or minus 1.0 % maximum of full scale output.

.6 Integral zero and span adjustment.

.7 Temperature range: 0-70°C, -40°C to 85°C for outside air.

.8 Long term output drift: not to exceed 0.25 % of full scale output/ 6 months.

2.6 PRESSURE/CURRENT (P/I) TRANSMITTERS

.1 Requirements:

.1 Range: as indicated in I/O summaries.

.1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.

.2 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA, 0-5V, 0-10V.

.3 Output variations: $\pm$ 1 % full scale for supply voltage variations of plus or minus 10 %.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 1% of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 °C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Pressure ranges: see I/O Summaries.

.10 Accuracy: plus or minus 1 % of full scale.

.11 LCD Display.

2.7 DIFFERENTIAL PRESSURE (KPA) TRANSMITTERS

.1 Sensor:

.1 Field-selectable pressure ranges.

.2 Output signal: 4 - 20 mA, 0-5V, 0-10V.

.3 Accuracy at 21C:

.1 ±0.5% of range 0 to 30 Pa, 0 to 50 Pa, ±0.25 Pa AND ± 50 Pa" ranges. 0.25% all other ranges.

.2 Output variations: ± 1 % full scale for supply voltage variations of plus or minus 10 %.

.4 Integral zero and span adjustment.

.5 Over-pressure input protection: 6.89 kPa Proof, 10.34 Burst.

.6 Environmental Operation Range: -20 to 60C, 0 to 95% RH (non-condensing).

.7 Port Connection: 1 high pressure and 1 low pressure for push-on 6mm tubing.

.8 IP66, NEMA 4 enclosure.

.9 Mounting: 4 external tabs with holes for #10 screws.

.10 The unit to have a NPT connections. The enclosure shall be an integral part of the unit.

.11 LCD Display.

.12 Acceptable Products: Building Automation Products Inc. (BAPI) ALC/ZPS-LR-BB-NT-D-PA or approved equal.

.2 Outside Air Pickup Port:

.1 Wall mounted UV-resistant, flame retardant housing to protect from pressure fluctuations caused by wind gusts, suitable for environments -40 to 100C and 0 to 100% RH condensing.

.2 Acceptable Products: Building Automation Products Inc. (BAPI) ZPS-ACC10 or approved equal.

2.8 DIFFERENTIAL PRESSURE (PA) TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA in 400 ohms, 0-5V into 5K ohms minimum, 0-10 V into 10K ohms minimum.

.2 Output variations: ± 1% full scale for supply voltage variations of plus or minus 10%.

.3 Integral zero and span adjustment.

.4 Temperature effects: not to exceed plus or minus 3% full scale/ 50 °C.

.5 Output short circuit and open circuit protection.

.6 The unit to have a NPT ½ conduit connection. The enclosure shall be an integral part of the unit.

.7 Pressure ranges: see I/O Summaries.

.8 LCD Display.

2.9 FAN SYSTEM STATIC PRESSURE SENSORS

.1 As per 2.10

2.10 FAN SYSTEM STATIC PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA in 400 ohms, 0-5V into 5K ohms minimum, 0-10 V into 10K ohms minimum.

.2 Output variations: ± 1% full scale for supply voltage variations of plus or minus 10%.

.3 Integral zero and span adjustment.

.4 Temperature effects: not to exceed plus or minus 3% full scale/ 50 °C.

.5 Output short circuit and open circuit protection.

.6 The unit to have a NPT ½ conduit connection. The enclosure shall be an integral part of the unit.

.7 Pressure ranges: see I/O Summaries.

.8 LCD Display.

2.11 DUCT SYSTEM VELOCITY PRESSURE SENSORS

.1 Requirements:

.1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.

.2 Maximum pressure loss: 37 Pa at 1000 m/s.

.3 Accuracy: plus or minus 1 % of actual duct velocity.

2.12 FAN SYSTEM VELOCITY PRESSURE TRANSMITTERS

.1 Requirements:

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

.2 Calibrated span: not to exceed 25 % of duct velocity pressure at maximum flow.

.3 Accuracy: 0.4 % of span.

.4 Repeatability: within 0.1 % of output.

.5 Linearity: within 0.5 % of span.

.6 Deadband or hysteresis: 0.1 % of span.

.7 External exposed zero and span adjustment.

.8 The unit to have a NPT ½ conduit connection. The enclosure shall be an integral part of the unit.

2.13 PRESSURE AND DIFFERENTIAL PRESSURE SENSORS AND SWITCHES

.1 Requirements:

.1 Range: as indicated in I/O summaries.

.1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.

.2 Adjustable setpoint and differential.

.3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC.

.4 Sensor assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.

.5 Accuracy: within 2% repetitive switching.

.6 Provide sensor pressure and accuracy ratings:

.1 Chilled and condenser water: 860 kPa.

.2 Hot water: 860 kPa.

.3 Low pressure steam, compressed air: 1050 kPa. Range: 0 to 200 kPa. Accuracy: plus or minus 3 kPa.

.4 Medium pressure steam, compressed air: 1050 kPa. Range: 0 to 700 kPa. Accuracy: plus or minus 7 kPa.

.5 High pressure steam: 2100 kPa. Range: 0 to 2100 kPa. Accuracy: plus or minus 14 kPa.

.6 High temperature water: 2700 kPa. Range: 0-2700 kPa. Accuracy: plus or minus 25 kPa.

.7 For fan operation: Range: 0 to 3000 Pa. Adjustable differential: 10 to 300 Pa.

.7 Provide sensors with isolation valve and snubber between sensor and pressure source on liquid service.

.8 Sensors on steam and high temperature hot water service: provide pigtail syphon.

2.14 TEMPERATURE SWITCHES

.1 Requirements:

.1 Range: see I/O summaries.

.2 Temperature sensor: liquid, vapour or bimetallic type. Operate automatically. Reset automatically, except as follows:

.1 Freeze protection: manual reset. Optional if software does not auto restart.

.2 Fire detection: manual reset. Optional if software does not auto restart.

.3 Duct Heater: high limit manual reset in addition to automatic reset.

.3 Adjustable setpoint and differential.

.4 Accuracy: plus or minus 1 °C.

.5 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.

.6 Type as follows:

.1 Room: for wall mounting on standard electrical box with or without protective guard as indicated.

.2 Duct, general purpose: insertion length = 460 mm.

.3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.

.4 Freeze detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 300 mm length.

.5 Strap-on: with helical screw stainless steel clamp.

2.15 CURRENT/PNEUMATIC (I/P) TRANSDUCERS

.1 Requirements:

.1 Input range: 4 to 20 mA.

.2 Output range: proportional 20-104 kPa.

.3 Housing: dustproof or panel mounted.

.4 Internal materials: suitable for continuous contact with industrial standard instrument air.

.5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2 % of full scale over entire range.

.6 Integral zero and span adjustment.

.7 Temperature effect: plus or minus 2.0 % full scale/ 50 °C or less.

.8 Regulated supply pressure: 206 kPa maximum.

.9 Air consumption: 16.5 ml/s maximum.

.10 Integral gauge manifold c/w gauge (0-206 kPa).

2.16 SOLENOID CONTROL AIR VALVES

.1 Coil: 120V AC or 24V DC, as indicated.

.2 Complete with manual over-ride.

.3 Shall have the capacity to pass .07 l/s air at 104 kPa differential.

2.17 AIR PRESSURE GAUGES

.1 Diameter: 38 mm minimum.

.2 Range: zero to two times operating pressure of measured pressure media to nearest standard range.

2.18 ELECTRICAL RELAYS

.1 Requirements:

.1 Double voltage, DPDT, plug-in type with termination base.

.2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.

.3 Contacts: rated at 5 amps at 120 V AC.

.4 Relay to have visual status indication

2.19 SOLID STATE RELAYS

.1 Requirements:

.1 CSA approved.

.2 Suitable to the application as recommended by manufacturer.

.3 Voltage range: 75-265 VAC

.4 Panel mounting.

.5 Suitable for AC or DC loads.

.6 Output surge absorbing element for inductive on/off loads.

.7 Input capacitor/resistor circuit for pulse noise absorption.

.8 For input inductive noise use twisted-pair wires for electromagnetic noise and shielded cable for static noise.

2.20 CURRENT TRANSDUCERS

.1 Requirements:

.1 Range: in accordance with Equipment Schedules.

.2 Purpose: measure line current and produce proportional signal in one of following ranges:

.1 4-20 mA DC.

.2 0-5 volt DC.

.3 0-10 volts DC.

.4 2-10 volts DC.

.3 Frequency insensitive from 10 - 80 hz.

.4 Accuracy to 0.5% full scale.

.5 Zero and span adjustments. Field adjustable range to suit motor applications.

.6 Adjustable mounting bracket to allow for secure/safe mounting inside the MCC or starter enclosure.

2.21 CURRENT SENSING RELAYS

.1 Requirements:

.1 Complete with metering transformer ranged to match load, plug-in base and shorting shunt to protect current transformer when relay is removed from socket.

.2 Suitable for single or 3 phase metering into single relay.

.3 To have adjustable latch level, adjustable delay on latch and minimum differential of 10 % of latch setting between latch level and release level.

.4 3-Phase application: provide for discrimination between phases.

.5 To have adjustable latch level to allow detection of worst case selection. To be powered from control circuit of motor starter being metered. Relay and base to be mounted in adjacent auxiliary cabinet only if control circuit power to be brought into auxiliary cabinet. Adjustments to be acceptable from auxiliary cabinet.

.6 Relay contacts: capable of handling 10 amps at 240 V AC.

2.22 ELECTRONIC CONTROL DAMPER OPERATORS

.1 Requirements

.1 Push-pull proportional type as indicated.

.2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.

.3 Operator: size so as to control dampers against maximum pressure or dynamic closing pressure (whichever is greater).

.4 Power requirements: 5 VA maximum at 24 V AC.

.5 Operating range: 4-20 mA. 0-10 V DC, 2-10 V DC.

2.23 CONTROL VALVES

.1 Requirements:

.1 NPS 2 and under: bronze with screwed ends.

.2 NPS 2 1/2 and over: cast iron with flanged ends.

.3 Trim: type 316 stainless steel.

.4 Leakage: 0.5 % of rated flow maximum.

.5 Two or three port as indicated. Normally Open or Normally Closed, as indicated.

.6 Flow characteristics: linear or equal percentage as indicated.

.7 Rangeability: 50:1 minimum.

.8 Performance: Capacity refer to I/O Summaries and Valve Schedule.

2.24 ELECTRONIC/ELECTRIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.

.2 Control voltage: 0-5, 0-10, 2-10V DC, or 4-20 mA.

.3 Positioning time: to suit application, 90 sec maximum.

.4 Spring return to normal position as indicated.

2.25 PANELS

.1 Either free-standing or wall mounted enameled steel cabinets with hinged and key-locked front door.

.2 To be modular multiple panels as required to handle requirements with additional space to accommodate future capacity as required by Departmental Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

2.26 ELECTRONIC AIR FLOW MEASUREMENT STATIONS AND TRANSMITTERS

.1 Each station to contain an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. The velocity sensing elements to be of the thermal, temperature compensated thermistor type, with linearizing means. The sensing elements to be distributed across the duct cross section in the quantity and pattern set forth for measurements and instruments of ASHRAE and SMACNA for the traversing of ducted air flows. The resistance to air flow through the airflow measurement station not to

exceed 20 Pa gauge at an airflow of 10 m/s. Station construction suitable for operation at airflows of up to 25 m/s over a temperature range of 5 to 50 degrees C, and accuracy plus or minus 3 percent over a range of 0.625 to 12.5 m/s scaled to air volume.

.2 Transmitters to produce a linear, temperature compensated 4-20 mAdc output corresponding to the required velocity pressure measurement. The transmitter to be a 2-wire, loop powered device with local indication where indicated. The output error of the transmitter not to exceed 0.5 percent of the calibrated measurement.

Part 3 Execution

3.1 INSTALLATION

.1 Install field control devices, conduit and wire in accordance with manufacturers recommended methods, procedures and instructions. Wiring and conduit above 50 volts by electrical Division. Coordinate requirements with Electrical Contactor.

.2 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in CSA 2 enclosures or as required for specific applications. Provide for electrolytic isolation in all cases when dissimilar metals make contact.

.3 Support field-mounted transmitters, sensors on pipe stands or channel brackets.

.4 Install wall mounted devices on plywood panel properly attached to wall.

3.2 TEMPERATURE AND HUMIDITY SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 To be readily accessible and adaptable to each type of application so as to allow for quick easy replacement and servicing without special tools or skills.

.3 Outdoor installation:

.1 Protect from solar radiation and wind effects by stainless steel shields.

.2 Install in CSA 4X enclosures.

.4 Duct installations

.1 Do not mount in dead air space.

.2 Location to be within sensor vibration and velocity limits.

.3 Securely mount extended surface sensor used to sense average temperature.

.4 Thermally isolate elements from brackets and supports so as to respond to air temperature only.

.5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors:

.1 Sensor length to be not less than 1000 mm per square metre of duct cross-sectional area.

.2 Use multiple sensors where single sensor does not meet minimum length ratio. Wire multiple sensors in series for freeze protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.4 Use either software averaging algorithm to derive overall average for control purposes or separate inputs, based on site requirements.

.6 Thermowells: install for piping installations. Where pipe diameter is less than well insertion length, locate well in elbow. Thermowell to restrict flow by less than 30%.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Use modular multiple panels if necessary to handle all requirements, with space for additional 20% PCU or FID if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller (ECU, LCU, MCU, PCU, TCU).

.3 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.4 Identify wiring and conduit clearly.

3.4 MAGNEHELIC PRESSURE INDICATORS

.1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensors (as approved by the Departmental Representative).

.2 Locations to be as indicated or specified.

3.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Install isolation valve and snubber on sensors between sensor and pressure source. In addition, protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.6 IDENTIFICATION

.1 Identify field devices properly.

.2 Refer to Section 25 05 54 - EMCS: Identification.

3.7 AIR FLOW MEASURING STATIONS

.1 Cap manifold until cleaning of ducts is completed.

3.8 TESTING

.1 Calibrate and test field devices for accuracy and performance. Submit report detailing tests performed, results obtained to Departmental Representative for approval.

Departmental Representative will verify results at random. Provide testing equipment and manpower necessary for this verification.

3.9 COMMISSIONING

.1 Refer to Section 25 08 20 - EMCS: Warranty and Maintenance.

END OF SECTION

Part 1 GENERAL

1.1 DESIGN DOCUMENTATION

.1 Design documentation for each system to include, as a minimum:

- .1 Narrative type of Sequence of Operation.
- .2 Control Description Logic (CDL).
- .3 Input/Output Summary Schedules.
- .4 Schematics.

1.2 EMCS LANGUAGE DESIGN CRITERIA

.1 Language: refer to Section 25 05 01 EMCS: General Requirements.

.2 Levels of EMCS Language

- .1 Level 1: alarm and operational messages to convey alarm conditions or operational messages.
- .2 Level 2: full names of equipment and control points. The various systems, their equipment and components and all control points are named in accordance with this section.
- .3 Level 3: system, equipment, component and control point descriptors: unique, alphanumeric identifiers derived from full names of corresponding system component and control point.
- .4 Level 4: commands: represent various computer functions and routines.
  - .1 Operational commands - relate to building operations and building system controls.
  - .2 Computer system commands - relate to computer maintenance, upgrading or development software used to improve and maintain the application software for the building site.
- .5 Level 5: machine language. Languages specific to each manufacturer's product, used internally to perform its functions and routines.

.3 Additional Equipment, Components and/or Control Points. Where additional equipment, components and/or control points are required on specific projects, the following procedures shall be adopted:

- .1 Full names of the equipment, component and control points shall be not more than 40 characters, including numerals.
- .2 SYSTEM descriptors shall be not more than 10 alphanumeric characters. INPUT and OUTPUT descriptors shall be not more than 10 alphanumeric characters. The letters shall be based upon the English/French language full name, and should, where possible, be the first letter of each word of the full name.

.4 The descriptor shall be unique.

.5 Descriptors and expansions: System identifiers and point identifiers shall follow MUN standard conventions (standard naming convention documentation shall be provided by MUN prior to shop drawing submittal).

1.3 I/O SUMMARY SCHEDULES

.1 General:

.1 The EMCS contractor shall provide a complete I/O summary schedule similar to the one listed below, listing and describing all I/Os in detail. Contractor's standard schedule may be used provided all relevant information is provided.

.2 PCU no: identifies the PCU to which all points in the I/O Summary Schedule are wired.

.3 Building/Area: unique label given to each building forming part of a multi-building facility.

.4 Area/System Label: unique label given to each area of the building or to each system.

.1 Column 1: Point no: I/O Summary Schedule reference number.

.2 Column 2: Point label: unique label for each point in the system. Point labels may be repeated for other buildings or systems.

.3 Column 3: Description: describes the point label in expanded terms.

.4 Column 4: Type: (e.g., AI, AO, DI, DO).

.5 Column 5: Eng. Units: Describes the engineering units used (e.g., for AI, AO: C, kPa, Amp Volt. For DI, DO: OFF, ON).

.6 Column 6: Access level: Defines the level of access for varying complexity of functions. Usually associated with password feature. Usually assigned value between 0 (lowest) and 4 (highest).

.7 Column 7: Sensor type: describes in 2 or 3words.

.8 Column 8: Assoc. Point: Identifies/ describes points for purposes of alarm suppression, software interlocks.

.9 Column 9: Type: defines the type of alarm (e.g., CR = CRITICAL, CA = CAUTIONARY, M = MAINTENANCE).

.10 Column 10: DI/DO, NO/NC: defines the NORMAL condition of alarm. (NC = NORMALLY CLOSED. NO = NORMALLY OPEN).

.11 Column 11: Limits: Defines alarm levels (e.g., L2 = Low alarm, Level2. H1 = High alarm, Level1).

.12 Column 12: Alarm Mess: Defines alarm message number. This number is related to pre-composed message detailing the problem and describing the required action.

.13 Column 13: Maint Mess: defines maintenance message number. This number as related to pre-composed message detailing the problem and describing the required action.

.14 Column 14: Set Point: Defines the design set-point of the control loop.

.15 Column 15: Dead band: defines the range above or below the set-point at which no change in output signal is to occur.

.16 Column 16: Dev alarm limit: defines the limit on deviation of the measured value from the set-point (sometimes also referred to as the "error limit").

.17 Column 17: NC/NO: defines NORMAL condition when de-energized. NC - NORMALLY CLOSED. NO = NORMALLY OPEN. DA/RA: defines the form of action. DA = direct acting. RA = REVERSE ACTING.

.18 Column 18: Contacts: NO/NC: defines NORMAL condition when de-energized. NC = NORMALLY CLOSED. NO = NORMALLY OPEN.

.19 Column 19: Delay Succ starts: defines the time limits (usually in seconds). To prevent overheating of motors or equipment from frequent re-starting.

.20 Column 20: Heavy motor delay: defines the time (usually up to 60seconds). To prevent heavy electrical load from simultaneous starting of large consumption equipment.

.21 Column 21: auto-reset: A = AUTOMATIC. M=MANUAL.

.22 Column 22: Programs:

.1 Examples of Applications Programs include: Night set-back; optimum start/stop; demand limiting (load shedding).

.2 Optimization routines (e.g., chiller optimization, supply air temperature optimization, enthalpy control) should be described as part of CDL's.

.3 Parameters for all application programs should be provided separately as part of the design documentation (e.g., the Systems Operation Manual).

.4 Note requirements for computer totalization, recording, print-out of accumulated value of a point over a period of time. If totalization depends upon a number of analog points, include for pseudo energy points.

.5 Run time totals: for calculation of operation of digital points.

.6 Optimum start/stop: Example: HVAC unit to start before scheduled occupancy, based upon HVAC unit capacity, heat loss, interior and exterior environmental conditions, etc.

.1 Schedule:

INPUT/OUTPUT			SCHEDULE PCU NO.					(see 1.3.2)		
PROJECT NO.			BLDG/AREA				NAME	(see 1.3.3)		
PROJECT NAME			AREA/SYSTEM				NAME	(see 1.3.3)		
POINT IDENTIFICATION								ALARMS		
1	2	3	4	5	6	7	8	9	10	11
Point. No	Point Label	Descrip	Type	Eng. Unit	Access Level	Sensor type	Assoc Point	Type (M,CR)	DI/D0 NO/NC	Limits

MESSAGES								DI/DO		
12	13	14	15	16	17	18	19	20	21	22
Alarm Limit	Maint	Set-Point MO/MA	Dead band start	Dev. alarm delay	NO/NC DA/RA	Cont's NO/NC	Delay succ.	Heavy Motor	Auto reset	Prog

1.4 CONTROL NARRATIVE SEQUENCE OF OPERATIONS

.1 Trending, Logs, Communications and Graphics:

.1 EMCS shall capture and store all measurement and verification points, data and log alarms described and implied on design documents. EMCS shall be capable of storing all required points, trends and alarms for a period of 15 months (or more). Monitoring change of value shall be recorded with a time stamp.

.2 All set points indicated and or implied in these sequences, and in the aforementioned documents, shall be user adjustable on graphics. All requested and implied alarm points shall be included in the scope of the EMCS contractor and all volumes, flows and quantities shall be measurable in real time as well as totalized to meet the requirements and intent of the design documents. This contractor is responsible to obtain the latest version of above noted documents and shall be responsible to commission controls and assist with commissioning of other equipment associated with these controls as required to complete construction in addition to and in accordance with 01 91 13 General commissioning Requirements.

.3 Provide full and complete equipment schematics and system schematics for all heating, cooling, ventilation, domestic, and other automated devices / systems. Schematics shall utilize color graphics and flow indication with dynamic movement indicators to mirror actual systems / equipment on site. Graphics shall include all moving, measuring, reporting, controlling, modulating, and static parts required to describe full system in an easy-to-understand format and shall describe and allow adjustment by user. All user adjustable variables, setpoints, etc. shall indicate real time graphic representation of state and all locking / unlocking, on / off, manual / auto, modes etc. and shall allow user adjustment through graphic and must have dynamic links embedded to view each and every component, part, or piece in further detail with level two status information and adjustment abilities, as well as link to schedule, status, current value, trends, and

alarms. All trends and alarms shall be readily available from main screen graphic and / or at individual system level graphic.

.4 New EMCS shall be connected to existing Honeywell EBI front end system VIA a new BACnet connection. The Honeywell system shall gather information and read both existing system and new system information in real time and shall utilize gathered information as described and as implied in the sequence of operation to operate, set, and reset operating parameters of the new systems being installed as part of these design documents.

.5 Existing Honeywell system programming, and graphics shall be modified to reflect the removal of equipment, devices and systems as outlined and as implied in design documents. Maintain existing control system operation as long as possible to minimize downtime between removal of old, and installation of new systems. New equipment will be connected to and controlled by new vendor EMCS. EMCS Contractor shall remove all redundant wiring and devices associated with redundant systems in accordance with 11 74 21 Construction/Demolition Waste Management and Disposal.

.6 All set points in sequences shall be displayed on graphics and shall be user adjustable from graphics.

.2 <u>RTU-1 Sequence of Operation:</u>

.1 RTU shall be provided with built in controls and programmable HMI and must have BACnet capability for connection to BAS. Manufacturer controls shall operate all functions of operation and the DDC system shall have access to all parts of the sequence to view and reset parameters as necessary to achieve the intended sequence. Controls contractor shall supply and install components and sensors required to attain this sequence if points intended are not available through BACnet.

.2 During unoccupied hours RTU shall be off and economizer damper closed.. If space temp falls more than 3 degrees C below NSB set point. economizer, power exhaust and RTU cooling shall be locked out and unit shall energize duct coil and fan to heat space to NSB temperature then unit shall turn off.

.3 Confirm occupied period with Owner and set up a schedule accessible to Owner for adjustment.

.4 Economizer shall be enabled during occupied period only. Economizer dampers shall modulate from startup position as required to provide free cooling or free heating based on dual enthalpy calculation, otherwise remain at min air volume position as indicated on control schematic. This minimum operating position shall be set-up by the balancing contractor and start-up technician in conjunction with the controls contractor during the commissioning phase of the project. Economizer outdoor actuator shall have position feedback and shall be alarmed if damper is found to be open during unoccupied period.

.5 During occupied period RTU shall start and run continuously. Maintain supply air temperature at 21.5C (71F) at 10C (50F) OAT, and 12.7C (55F) at 24C (75F) OAT, user adjustable on graphics. Reset SAT based on space thereafter.

.6 During occupied period and on a call from CO2 space sensor outside air flow shall increase by modulating OA damper toward the open position until supply air CO2 sensor reads less than 600 PPM, then shall maintain that concentration until space sensor average reads less than 900 PPM at which point dampers shall trend toward min air volume position as indicated on control schematic. If space CO2 levels are below 700 PPM, OA dampers on RTU-1 shall trend toward air values in the previous sentence.

.7 Power exhaust fan shall operate as required to maintain space near neutral pressure. Mechanical cooling shall be enabled and modulated to maintain sat when oat is greater than 55F, user adjustable on graphics, (economizer as stage one cooling and mechanical cooling as stage two). Should supply air temperatures fall below set point and unit not be in cooling mode, heating coil in unit shall be energized and modulated with SCR to maintain required sat. Morning warm up shall be carried out with RTU heating coil and economizer fully closed. RTU on board controls shall be monitored at all times for alarms. All alarm shall be logged at operator's terminal. During occupied period on a call for heat from space, the associated baseboard heat shall be energized as final stage of heat as needed until space is at required temperature at which point BB shall be de-energized.

.8 During occupied period, should the SAT fall to 4C (39.2F) and remain for 2 minutes, the unit shall signal an alarm at the BAS panel and shut unit down.

.3 <u>ERV- 1 Sequence of Operation:</u>

.1 ERV-1 shall be provided with built in controls and programmable HMI and must have BACnet capability for connection to BAS. Manufacturer controls shall operate all functions of operation and the DDC system shall have access to all parts of the sequence to view and reset parameters as necessary to achieve the intended sequence. Controls contractor shall supply and install components and sensors required to attain this sequence if points intended are not available through BACnet.

.2 Dampers close and units shuts down during unoccupied period.

.3 Confirm occupied period with Owner and set up a schedule accessible to Owner for adjustment.

.4 Dampers open, end switch makes then start and run during occupied period.

.5 The supply and exhaust fans shall modulate in speed to maintain constant airflow by maintaining SA and EA static pressure set points (filter loading control). When not in outside air free cooling conditions, the SA temperature set point (downstream from heating coil) shall be achieved by modulating the heat wheel speed as stage one, and mechanical cooling or heating coil as stage two temperature control. The SA temperature set point shall be 21.5°C (71°f) at 10°c (50°f) OAT, and 12.7°c (55°f) at 24°c (75°f) OAT (user adjustable on graphics) and shall be reset based on space sensor averaging. Dehumidification through mechanical cooling shall be enabled, and override the SA temperature reset curve control, to maintain a maximum RA dew point temperature of 14°c (57°f). The hot gas reheat coil shall modulate as first stage to satisfy the SA temperature set point during dehumidification mode, electric coil shall modulate as stage two

heat. Heat wheel defrost shall be controlled by calculating RA humidity and heat wheel leaving exhaust air temperature to keep fresh air side of wheel above dew point frost condition. Operate dehumidification and hot gas reheat with wheel stopped to maintain 60% rh @ 21.5°C (71°F), user adjustable on graphics.

.4 ERV-2 Sequence of Operation:

.1 Dampers close and unit shut down during unoccupied period.

.2 Confirm occupied period with Owner and set up a schedule accessible to Owner for adjustment.

.3 Dampers open, end switch makes, and unit starts and runs during occupied period. Internal controls operate to maintain unit frost free. HC-1 coil is enabled to run during occupied period only and modulates to satisfy duct stat at the following set points which shall be user adjustable on graphics: 21.1°c (70.0 °f) at 10°c (50°f), 15.5°c (60.0°f) at 24°c (75°f).

.5 EF-1 Sequence of Operation:

.1 Run fan nonstop. Log an alarm id fan is not running when intended to.

.6 DH-1 Sequence of Operation (DH-2 similar):

.1 Unit shall be provided with built in controls and programmable HMI mounted on wall in Mechanical Room and must have BACnet capability for connection to BAS. Manufacturer controls shall operate all functions of operation and the DDC system shall have access to all parts of the sequence to view and reset parameters as necessary to achieve the intended sequence. Controls contractor shall supply and install components and sensors required to attain this sequence if points intended are not available through BACnet.

.2 Pool Dehumidification unit fan shall run non-stop. This unit shall control pool space temp and pool water temp. Fresh and exhaust air dampers in duct shall open when unit runs and close if unit is turned off. Built in unit controls shall operate all functions of this system. BACnet connection to BMS shall monitor, display and trend available points as needed to safely monitor system operations associated with fans, pumps, air temp, and water temp. Glycol run-around pump and controls inside air handler shall function to optimize energy recovery performance of fresh air. During periods of dehumidification, unit shall simultaneously reject heat to pool water heating and to air temp heating if required. If recovery heating is insufficient to satisfy space, on-board electric heating coil shall be modulated as required. If dehumidification recovered heat is not required in air or pool, it shall be rejected to dry cooler outside. DH-1 shall send signal through a dry contact to enable pool electric boilers if it cannot meet pool water temp set point. (electric boilers are existing).

.3 Outside air damper, exhaust air damper, and exhaust fan shall be shut down when pool is unoccupied to allow unit to run in recirc mode. Dampers shall be monitored for feedback and alarmed if not opening or closing as intended. Unit will not have a "purge" cycle, instead constant exhaust and fresh air shall be provided during all periods when pool is occupied. User shall have access on

DDC graphics to adjust pool occupied period, pool water heating temp 27.8C (82F), and discharge air temp 28.9C (84F).

.7 CP-1A and CP-1B Dry Cooler Glycol Pumps:

.1 Built into dehumidifier and controlled by dehumidifier controls.

.8 CP-2A and CP-2B Pool Heating Pumps:

.1 Run non-stop and log an alarm if pumps are not running when intended to.

.9 CP-3A and CP-3B Glycol Run Around Recovery Pumps:

.1 Built into dehumidifier and controlled by dehumidifier controls.

.10 CP-4 Domestic Hot water Recirc pump:

.1 Run during occupied period to maintain 54.4C (130F) at temp sensor near pump.

.11 Electric Unit Heaters in Fitness Ceiling:

.1 Lock out unit heater operation when OAT is above 10C (50F), user adjustable, enable at all other times. Turn on fan and heating element on call from space sensor in ceiling space to maintain 10C (50F) (user adjustable). When set point is reached, turn off heating element and continue to run fan for a further two minutes to dissipate heat. Log an alarm if heater is not running when intended. Log an alarm if space temp drops below 5C (41F) or above 35C (95F), user adjustable.

Part 2 PRODUCTS

2.1 NOT USED

.1 Not used.

Part 3 EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Division 27 and Division 28 sections.

.2 Division 01, and Specification Sections 07 84 00 - Fire Stopping.

1.2 REFERENCES

.1 Definitions:

.1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122

.2 Reference Standards:

.1 Canadian Standards Association (CSA International) Latest Edition of the following:

.2 CSA C22.1-21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.3 CSA C22.2 No. 0-M91 (R2006), General Requirements.

.4 CAN3-C235-83 (R2006) Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.5 CSA-Z462-15, Workplace Electrical Safety

.6 National Research Council of Canada

.1 National Building Code of Canada – 2015 (NBC)

.7 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3 SCOPE OR WORK

.1 The Electrical Contractor shall furnish all labour, material, tools, appliances and equipment to entirely complete and provide the operation of the electrical systems.

.2 The overall intention is to provide a functioning complete electrical installation in all aspects, and all items reasonably inferable as called for by the drawings and specifications, and by normally accepted good practice, notwithstanding that every item necessarily required may not be particularly mentioned. This Contractor shall fulfill his obligation and not take advantage of any unintentional errors or omissions, should any exist, to the detriment of the Owner's interest. The work shall include but not be limited to:

.1 Revision of Electrical service entrance

.2 Removal of existing equipment as identified within drawings.

.3 Installation of power distribution

.4 Branch circuit wiring.

.5 Lighting installation.

.6 Field house lighting upgrades.

.7 Communication systems including data/telephone horizontal wiring.

.8 Communication systems including fiber backbone to main data rack, data/telephone horizontal wiring. See drawings for approximate routing and j-hook raceway systems.

.9 Communications systems such as but not limited to: Security, CCTV.

.10 Installation of addressable Fire alarm system.

.11 Coordination with the utility company.

.12 Coordination with Owners I.T department.

.13 Coordination with other trades. See also Architectural, Structural, and Mechanical specifications and drawings.

1.4 ACTION AND INFORMATION SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit WHMIS MSDS in accordance with Construction and Hazardous Materials Section.

.3 Submit for review single line electrical diagrams under Plexiglas and locate as indicated.

.1 Electrical distribution system in main electrical room and all sub-electrical rooms.

.4 Submit for review fire alarm riser diagram, plan and zoning of building under Plexiglas at fire alarm control panel and annunciator.

.5 Shop drawings:

.1 Submit wiring diagrams, coordination drawings and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation between equipment and other trades.

.2 The contractor shall submit a list of all shop drawings to the engineer for review within 5 weekdays of project kick off meeting. The contractor shall update the list as required with new products and dates of reviews. Shop drawings will not be reviewed until complete list is provided.

.3 The contractor shall submit all shop drawings within 20 weekdays of kick off meeting. There shall be no adjustment to the contract value due to increase in product pricing. Shop drawings received outside of this schedule are not guaranteed to be reviewed within 5 weekdays and associated delays/costs will be this contractor's responsibility.

.4 Shop drawings required to be re-submitted shall be re-submitted within 10 weekdays.

.5 Shop drawings shall have the first page of each device stamped by the electrical contractor, stating they have thoroughly reviewed each device.

.6 Shop Drawings will only be accepted as PDF/Digital format. Scanned copies of Printed PDF's will not be accepted.

.7 Shop drawings shall be submitted as systems, broken out devices will not be reviewed and will be rejected.

.8 If shop drawings are rejected twice, Electrical Contractor will be invoiced at $500.00 (excluding HST) per shop drawing (per device/piece of equipment) for the required further reviews. This clause will be applied at the Engineer's discretion.

.9 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

.10 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

.11 Submit required number of copies of drawings to authority having jurisdiction.

.12 If changes are required, notify Consultant of these changes before they are made.

.13 Shop drawings not meeting the requirements of the statements above will be rejected and only reviewed once meeting the requirements listed.

.14 Providing equipment meeting the specification is the responsibility of the Contractor, the Consultant review of the shop drawings does not remove this requirement from the Contract.

.6 Certificates:

.1 Provide CSA certified equipment and material.

.2 Where CSA certified equipment or material is not available, submit such equipment and material to authority having jurisdiction for approval by a certified agency of Standard Council of Canada (SCC) before delivery to site.

.3 Submit test results of installed electrical systems and instrumentation.

.4 Permits and fees: in accordance with General Conditions of contract.

.5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.

.6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Consultant.

.7 Manufacturer's Field Reports: submit to Engineer manufacturer's written report, within 3 days of review, verifying compliance of Work of electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

.8 As-Built Drawings:

.1 Provide one (1) sets of white prints of As-Built locations of all piping, ductwork, equipment, etc. and submit for Engineer's review. After written approval by Engineer, make all corrections and certify as correct by an Officer of the Company, as actual As Built conditions, signed and dated, then return to Owner.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:

.3 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.4 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.5 Safety precautions.

.6 Procedures to be followed in event of equipment failure.

.7 Other items of instruction as recommended by manufacturer of each system or item of equipment.

.3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

.5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

.7 In addition to technical data the Electrical Contractor shall also include:

.1 Names, addresses and phone numbers of local supplier for items included in the maintenance manual

.2 Copy of reviewed shop drawings.

.3 Copy of Electrical Specifications.

.4 Names, addresses and phone numbers of Electrical Sub-contractors.

.5 Inspection certificates and verification reports.

.6 Letter or certificate of warranty.

1.6 OPERATION AND MAINTENANCE DATA

.1 Project competition the contract shall submit the following documentation:

.1 Record drawings.

.2 Operational and Maintenance Manuals.

.3 Copy of electrical permit associated with the project.

.4 Insulation/Megger Test Results. All feeder conductors are to be Megger Tested for insulation resistance utilizing the following meter: 500V meter for conductor insulation rated up to 500V; 1000V meter for conductor insulation rated above 500V.

.5 Load Balance tests on all transformers, main switchboard and distribution panels.

.6 Load tests on all electric meters.

.7 Customer metering system verification.

.8 Fire Alarm system verification.

.9 Lighting Control System.

.10 Names, addresses and telephone numbers of local suppliers foritems included in Operation and Maintenance Manuals.

.11 Copy of reviewed Shop Drawings.

.12 Name and address of Electrical Contractor.

.13 Copy of all test certificates.

.14 Copy of all final panelboard schedules.

.15 Signed of training attendance for systems as identified within the drawings.

.16 Two (3) paper copies of drawings and specifications.

.17 Include details of design elements, component function andmaintenance requirements to effectively operate, maintain or repair.

1.7 ELECTRICAL DRAWINGS

.1 The electrical drawings which constitute an integral part of this contract shall serve as working drawings. They indicate the general layout of the complete electrical system arrangements of feeders, circuits, outlets, switches, controls, panelboards, service equipment, communications, fire alarm systems, underground duct banks, overhead pole lines, power center, etc.

.2 Field verification of scale dimensions on drawings is directed since actual locations, distances, and levels will be governed by the field conditions.

.3 All discrepancies related to the electrical work shall be promptly brought to the attention of the Engineer for clarification.

1.8 EXISTING CONDITION AND EXAMINATION OF DRAWINGS

.1 The Electrical Contractor shall become completely familiar with the drawings and specifications, as well as construction methods of other trades related to the work to avoid possible interferences on the project. Should drastic changes be necessary to resolve such conflicts, this Contractor shall notify the Engineer and secure written approval and agreement on the necessary adjustments before the installation is started.

.2 Before submitting the tender, this Contractor shall visit the site and become familiar with site conditions, availability of storage space and all other factors that might influence the tender submittal.

.3 The contractor shall determine all working conditions and rigidly comply. Conditions that require special consideration include but not limited to: Dust, Noise, Vibration, Water, Working hours, Continuity of power, Access to area of work, Physical protection of Owner's facility and equipment.

.4 No extras will be allowed due to failure to account for site conditions or working conditions.

.5 The exact rough in dimensions and connection points shall be determined from shop drawings and on-site measurements.

1.9 DISCREPANCIES

.1 Bidders in preparing their tender, finding any errors, omission, or discrepancies in the drawings, specifications or other documents, or having any doubt in the intent or meaning of any part thereof, shall immediately notify the Engineer, who will send written instructions or clarification to all bidders. Where such discrepancies exist and it is evident that this Contractor could not have properly tendered without clarifications and where such clarification was not requested, not extra to the contract will be considered in order to have the installation properly made. The Owner and Engineer will not be responsible for oral instruction.

1.10 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements.

.2 Material Delivery Schedule: Provide consultant with schedule within 2 weeks after award of contract for all long delivery items.

.3 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.4 Storage and Handling Requirements:

.1 Store materials: off ground or indoors, in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect all materials from damage to finish or material.

.3 Replace defective or damaged materials with new.

.5 Packaging Waste Management: remove for reuse and recycling of pallets, crates, or packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.11 ADDENDA AND REVISIONS

.1 All addenda, instructions and revisions issued during the tendering period shall become part of the Contract Documents and shall be included in the Tender, and shall take precedence over the previous instructions.

.2 The Owner and Engineer reserve the right to make revisions to the drawings during the period of construct ion and these shall take precedence over previously issued drawings. All revisions to the work shall be executed by duly authorized change orders with the amount of addition or deduction to the contract amount approved by the Owner before the execution of any work associated with the revision is undertaken.

.3 Material quotes and hourly breakdowns are required to be submitted with all request for changes.

1.12 SYSTEM STARTUP

.1 Instruct operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 The Contractor shall provide training with all systems. Sessions shall be broken into segments which will facilitate the training of individuals in the operation of this system. Operators Manuals and Users Guides shall be provided prior to the time of training. Segments shall as a minimum, consist of the following periods:

.1 Upon completion of the installation;

.2 After six weeks use of the system and;

.3 During the last month of the warranty period.

1.13 PERMITS, FEES AND INSPECTION

.1 Submit to Electrical Inspection Department necessary number of drawings and specifications for examination and approval prior to commencement of work.

.2 Obtain an electrical work permit and pay associated fees.

.3 Notify Engineer of changes required by the Electrical Inspection Department.

1.14 WARRANTY

.1 Warranty duration: 12 calendar months following Substantial Completion.

.2 Coverage: warrant against failure to perform to characteristics as specified.

1.15 FIRE STOPPING

.1 Firestopping shall be the responsibility of Section 07 84 00 – Fire Stopping.

.2 Each sub-trade shall be responsible for identifying the number, size and location of all fire separations.

1.16 TESTING AND COMMISSIONING

.1 Electrical commissioning is to provide documented confirmation that electrical systems function in compliance with the criteria set forth in the contract documents to satisfy the operational needs of the Owner.

Part 2 Products

2.1 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates and labels for control items in English.

2.2 MATERIALS AND EQUIPMENT

.1 Provide material equipment in accordance with required sections.

.2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, for approval by a certified agency of Standard Council of Canada (SCC) before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.3 Factory assemble all control panels and component assemblies.

.4 Electrical Distribution to be one manufacturer throughout entire project.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

.2 Control wiring conduit: in accordance with Section 26 05 34 – Conduit, Conduit Fastenings and Conduit Fittings. All wiring and connections below 50 V which are related to control systems specified in mechanical sections or as shown on mechanical drawings shall not be the responsibility of this contractor unless otherwise noted.

.3 Control wiring is by Division 25 unless otherwise noted on electrical drawings. Electrical Contractor shall review Electrical drawings for specific instructions for any special requirements on conduit requirements for mechanical system installation.

2.4 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of authority having jurisdiction, inspection authorities and Engineer.

.2 Decal signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

.1 Ensure lugs, terminals and screws used for termination of wiring are suitable for copper and aluminum conductors.

2.6 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates: 3 mm thick plastic engraving sheet, matt white finish face, black core, lettering accurately aligned and engraved into core, self- adhesive type.

.2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.3 Labels: Embossed plastic labels with 6 mm high letters unless specified otherwise.

.4 Wording on nameplates to be approved by Engineer prior to manufacture.

.5 Allow for minimum of twenty-five (25) letters per nameplate.

.6 Identification to be in English.

.7 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics. Label both box and cover.

.8 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.9 Terminal cabinets and pull boxes: indicate system and voltage.

.10 Transformers: indicate capacity, primary and secondary voltages.

.11 Lamacoids installed on Panelboards, Motor Control Centers, Splitter Troughs, Transformers shall indicate the following information in the following order;

.1 Designation name of Equipment;

.2 Voltage, number of phases and wires;

.3 Designation of Power Source and Circuit number;

.4 Example:

PANEL N – 150 A
120/208V – 3PH – 4W
FED FROM PNL CDP-A, CCT #1,3,5

.12 Lamacoid labels installed on combination starters, magnetic starters, manual starters and all various system controls, control panels, and disconnect switches shall contain the following information in the following order:

.1 Designated name of equipment;

.2 Voltage, number of phases and wires;

.3 Branch circuit breaker number.

.13 All junction or pull boxes shall be marked with an indelible ink marker to designate the circuit number of enclosed wiring, the designated panel name and electrical characteristics where applicable.

.14 Install an additional Lamacoid nameplate on all or any piece of electrical equipment such as Main Switchboard, CDP Panels, Motor Control Centers and

Fusible Switches that may contain overcurrent devices that have been designated for and incorporate the interrupting capacity larger than 10kAIC.

.1 Example:

Minimum interrupting capacity of breakers in this panel is to be not less than 22kAIC	Minimum interrupting capacity of fuses installed in this MCC is to be not less than 100 kAIC

2.7 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.1 Paint outdoor electrical equipment "equipment green" finish.

.2 Paint indoor switchgear and distribution enclosures light gray to EEMAC-2Y-1.

.2 Paint outdoor electrical equipment to EEMAC Y1-1.

.3 Paint indoor electrical equipment to EEMAC 2Y-1.

.4 Confirm exact product material and sheen prior to ordering equipment.

.5 Electrical equipment colours as follows:

.1 120-240V Normal Power Panels:

.1 Pantone 14-0425 TPG Beachnut.

.2 480-600V Normal Power Panels:

.1 13-5410 TPG Iced Aqua.

.3 120-240V Essential Power Panels:

.1 18-0430 TPG Avocado.

2.8 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1–18.

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

2.9 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.3 Coordinate with Mechanical contractor for identification of controls conduits.

.4 Existing services within an area of renovation shall be color coded by this contractor if none are present.

.5 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Green	
up to 600 V	Yellow	Green
Telephone	White	
Data (includes Fiber, multimedia)	White	Yellow
Public Address System	White	Green
Door Access Control	Red	Orange
Fire Alarm	Red	
CCTV	Red	Green
Building Controls	Orange	

2.10 COORDINATION STUDY, SHORT CIRCUIT AND ARC FLASH STUDY

.1 Contractor shall arrange and obtain required information from distribution equipment provided by Owner in order to complete a full coordination study, short circuit and arc flash system of the system as a whole.

.2 Arrange for the successful manufacturing company to carry out the following:

.1 Immediately upon award of the contract and prior to the manufacture of the switchboards, prepare a set of coordination curves on KE No. 336E time current characteristic graph paper and forward electronic copies (PDF Format) to the consultant for his approval. Make any changes as directed by the consultant at no additional charge to the Owner.

.2 This shall be accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to verify protection of the various elements of the system under maximum and minimum fault conditions at the various points in the system.

.3 This shall be accompanied by supporting Arc Flash study for new equipment by this Contractor, meeting applicable codes and standards.

.3 The time-current characteristic curves for the following shall be plotted:

.1 The relays and fuses protecting the incoming service.

.2 Main and feeder protective devices at all voltage levels used in the distribution system.

.3 Protective devices associated with the largest motor in each MCC, the refrigeration compressor, and largest device in each distribution panel. (Where applicable).

.4 Transformer damage curves and cable damage curves co-operate with and obtain from the utility and other manufacturers of equipment requiring protective devices to be used in the distribution system and prepare coordination curves as soon as possible. Be responsible, along with the other manufacturers of equipment connected to the distribution system, to ensure that the proper control and protective devices are selected such that they co-ordinate with all protective devices.

.4 It shall be the responsibility of the switchgear manufacturer to examine the plans and specifications to ensure that the relays and protective devices being installed in the distribution system will provide satisfactory co-ordination.

.5 Breaker frame sizes, sensors, delay types, power fuses, limiters, and fuses shall be provided in accordance with the approved co-ordination study and circuit breaker settings where applicable shall be provided so that the circuit breakers are set accordingly.

.6 The contractor shall provide all the required information for cable lengths, sizes, coordination with utility to provide any required utility service information.

.7 The contractor shall provide the latest information to the manufacturer for the study and report from approved shop drawings and any changes to the contract.

.8 These studies are required prior to shop drawings being reviewed for appliable equipment.

Part 3 Execution

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

.2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

3.2 FIELD QUALITY CONTROL

.1 Qualifications: Electrical work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction and as per the conditions of Provincial Act respecting manpower vocational training and qualification.

.1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician to perform specific task.

.2 Permitted activities: determined based on the training level attained and demonstration of ability to perform specific duties

.2 Health and Safety Requirements: Complete construction in accordance with occupational health and safety regulations.

.3 Load Balance:

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under

normal load, as well as hour and date on which each load was measured, and voltage at time of test.

.4 Conduct following tests in accordance with various sections as required.

.1 Power distribution system including phasing, voltage, grounding and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Lighting and its control.

.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.5 Systems: fire alarm communications.

.6 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.5 Carry out tests in presence of Engineer.

.6 Voltage Tests: Ensure voltage drop at maximum potential drop of 2% for 120 V, and 208V branch circuits, 3% on feeder circuits. Voltage drop shall meet CEC and ASHRAE requirements.

.7 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.8 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.3 SITE REVIEWS

.1 The below site reviews are to review work which has been completed. Site reviews are not intended to provide Contractor with check list to complete project. Site reviews will only review work completed and not listed work yet to be completed. It is the Contractor's responsibility to ensure the required work is completed and ready for review.

.2 The following site reviews, with requirements listed below, are required to be completed by the Engineer. Contractor is required to ensure 5 working days notice is provided, provide signed letter stating the site is ready for the requested review and to schedule testing requirements from other required parties:

.1 Open Wall:
  .1 Equipment within walls are installed, labelled and ready to be closed in.
.2 Open Ceiling:
  .1 Equipment within ceiling space are installed, labelled and ready to be closed in.
.3 Substantial
  .1 All systems have been installed, tested and commissioned, with appliable reports.
.4 Final
  .1 Contractor has completed Substantial site review deficiency list

3.4 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1100 mm
.2 Receptacles:
  .1 General: 400 mm
  .2 Above top of continuous baseboard heater: 300 mm
  .3 Above top of counters or counter splash backs: 250 mm
  .4 In Mechanical Room: 1200 mm
.3 Telephone outlets: 400 mm
.4 Data outlets: 400 mm
.5 Fire alarm:
  .1 Pull stations: 1100 mm
  .2 Fire alarm horn/strobes: 2300 mm
.6 Panelboards: as required by Code
.7 Proximity card reader: 1100 mm
.8 Hand dryer: Coordinate with Architectural drawings.
.9 Exit Light: 300 mm above door frame
.10 Emergency Light: 300 mm above door frame or 3.6 m A.F.F. in gym

.4 Coordinate device heights with Architectural detail and casework elevations.

3.5 NAMEPLATES AND LABELS

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.6 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete:

.1 Sleeves through concrete: schedule 40 steel pipe, sized for freepassage of conduit, and protruding 51 mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Locate outlets in accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings.

3.7 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings.

.2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

.4 Locate light switches on latch side of doors.

.1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

3.8 SYSTEM STARTUP

.1 Instruct Consultant and operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.9 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 – Cleaning.

.3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.10 RECORD DRAWINGS

.1 Refer to Section 01 78 00 – Closeout Submittals.

.2 Two sets of white prints shall be maintained for the exclusive purpose of recording deviations from that shown on the contract drawings. One set shall be kept up to date at all times. At the completion of the project the information shall be transferred to the second set of drawings and to a set of reproducible CAD drawings. Both sets shall be turned over to the Owner.

3.11 GUARANTEE

.1 Guarantee material and workmanship to be free from defect for a period of one (1) year or longer where specified otherwise, after issuing of the certificate of substantial completion.

.2 Make good, at the Owner's convenience, all defects covered by this guarantee without additional cost to the Owner.

.3 On project competition documentation file is to be provided to the Owner, this file shall contain all warranty information.

3.12 TRAINING

.1 A technical representative for each electrical and electronic equipment system shall be responsible to provide training for the Owner on site on the proper operation and maintenance of each building system.

.2 Arrange and pay for manufacturer's factory service engineer to provide training if required.

.3 Obtain and submit written confirmation from operating personnel that satisfactory training has been received.

3.13 DEMOLITION

.1 The electrical contractor shall coordinate with the building owner and other contractors to ensure that all electrical demolition work is conducted in a safe and efficient manner.

.2 The electrical demolition contractor shall coordinate with the building owner to ensure that all existing electrical systems are disconnected and removed in a manner that minimizes disruption to the building's operations.

.3 Disconnect and remove all electrical services from the building or structure.

.4 Remove all electrical equipment, panels, and wires from the site as identified within the contract documents.

.5 All work must be performed by licensed and qualified electrical contractors in compliance with all safety codes and regulations.

.6 Demolition of Electrical Equipment.

.1 The electrical demolition contractor shall remove all electrical wiring, devices, and fixtures, including outlets, switches, lights, and conduit.

.2 The electrical demolition contractor shall remove all electrical equipment, including transformers, switchgear, distribution panels, circuit breakers, and control systems.

.3 The electrical demolition contractor shall remove any electrical systems that are no longer needed, such as obsolete or redundant systems.

.7 Identification and Isolation of Electrical Systems.

.1 The electrical demolition contractor shall identify all electrical systems that are to be disconnected or removed and shall take steps to isolate these systems from any systems that are to remain in place.

.2 The electrical demolition contractor shall properly mark and tag all electrical systems that are to be removed to ensure that they are not inadvertently reconnected.

.8 Phased Demolition.

.1 The electrical demolition contractor shall coordinate with the building owner and other contractors to schedule the demolition work in phases to minimize disruption to building operations.

.2 The electrical demolition contractor shall ensure that any electrical systems that are temporarily disconnected or removed are restored in a timely manner to minimize downtime.

.9 Protection of Existing Systems.

.1 Coordinate with the building owner and other contractors to ensure the protection of any existing electrical systems that will remain in place.

.2 Protect any remaining electrical equipment and systems during demolition work to prevent damage.

.3 Ensure that all temporary power and lighting systems are installed and functioning before any existing electrical systems are disconnected or removed.

.10 Record Keeping.

.1 Maintain detailed records of all electrical demolition work and update drawings as required.

.2 Provide a final report documenting all electrical demolition work, including any unexpected conditions, problems encountered, and resolutions implemented.

.11 Dispose of all electrical waste in accordance with local, state, and federal regulations, including hazardous waste disposal.

.12 Contractor shall include in their price for any work related to the demolition and removals of any electrical interior and exterior infrastructure as part of the contract documents.

3.14 PROCURED EQUIPMENT (EXISTING)

.1 The equipment shown on the drawing has been previously procured and will be provided by the owner. It is the contractor's responsibility to ensure that this equipment is properly

received, installed, connected, and commissioned, with the same level of care and attention as if the equipment were provided by the contractor.

.2 The contractor must ensure that all necessary start-up services are included for the identified electrical equipment, as noted to be supplied by the owner, and are properly scheduled and coordinated. The contractor must take a proactive role in assisting with the start-up personnel and ensure that the equipment is commissioned in a timely manner.

.3 It is critical that the contractor understands and respects the owner's investment in the provided equipment. Any mishandling or failure to properly install, connect, and commission the equipment that could result in damage, delays, or additional costs. Therefore, the contractor must take all necessary precautions and ensure that the provided equipment is treated with the utmost care and expertise.

.4 The following equipment has been procured including breakers as identified within the drawings by the Owner and shall be supplied to this contractor for installation and commissioning.

.1 "6DN0A", 2000A Main Switchboard.
.2 "New Hot Water" Panel.
.3 "NCB" Panel.
.4 Transformer, TX-DP1, 225kVA.
.5 "DP-1" Panel.
.6 "LP-OD" Panel.
.7 "LP-E" Panel.
.8 "LP-H" Panel.
.9 "PP1" Panel.
.10 "6DN2A" Panel.
.11 "6N2A" Panel.

3.15 CO-ORDINATTION WITH SUPPLY AUTHORITY

.1 Electrical contractor shall co-ordinate installation of Supply Authority equipment and connection of electrical service with Supply authority to minimize inconvenience to Owner and other trades.

.2 Include all customer contributions required by the Supply Authority in the tender price.

.3 Contractor shall engage the utility company on project award to avoid any project delays and coordinate new servicing area and work as required.

.1 It shall be the contractor's responsibility to carry and engage any costs associated with coordination of the utility company.

3.16 CO-ORDINATION OF POWER INTERRUPTIONS

.1 The contractor shall be responsible to coordinate any power interruptions with the User, MUN and Engineer minimum 4 weeks in advance for 1hr or less interruptions and the actual date of power interruptions shall be subject to approval of MUN. If the overall