TOWNSHIP OF ESQUIMALT
ESQUIMALT RECREATION CENTRE
NATATORIUM DEHUMIDIFIER UPGRADE

Mechanical Specifications

POLAR ENGINEERING

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Revision Log

VERSION	DATE	AFFECTED SECTIONS	CHANGE REQUEST #	COMMENTS	CHANGE AUTHOR
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PART 1 CONTRACTOR DELIVERABLES

1.1 DEFINITIONS

1.1.1.1 The following are definitions of words found in this specification document and associated drawings and documents:

- Provide (and tenses of provide) means supply and install complete
- Install (and tenses of install) means install and connect complete
- Supply (and tenses of supply) means supply only
- Specified (and tenses of specified) includes instructions and information in this specification document and associated documents and drawings
- Owner means TOWNSHIP OF ESQUIMALT
- Owner's Representative means DAN HENDERSON, dan.henderson@esquimalt.ca
- Consultant means Polar Engineering who has prepared the contract documents on behalf of the Owner

1.2 SHOP DRAWINGS

1.2.1.1 Submit for review, shop drawings and product data sheets indicating in detail the design, construction, and performance of products and components. Shop drawings and product data sheets shall be supplied as PDF (Portable Document Format) files.

1.2.1.2 Allow enough time for submittal review, including resubmittals. Time for review shall commence on receipt of submittal y the Consultant. Extension of the Contract Schedule will not be authorized due to failure by the Contractor to transmit submittals in advance of the Work to permit processing, including resubmittals.

1.2.1.2.1 Initial Review: Allow 10 working days for initial review of each submittal. Additional time may be required for coordination with subsequent submittals or Subconsultants.

1.2.1.2.2 Resubmittal Review: Allow 5 working days for review of each resubmittal.

1.2.1.3 Shop drawings shall include equipment performance data, piping, power, and control wiring schematics, included accessories, rated capacities, weights, and all other relevant data.

1.2.1.4 The Contractor must obtain shop drawings approved by the Consultant prior to ordering equipment.

1.2.1.5 Product alternates or substitutes which meet the same design criteria as explicitly or implicitly described in the design and tender documents must be

submitted two weeks prior to the closing date of the tender for approval by the Consultant.

1.2.1.6 Submittals shall include the following information where applicable:

- Manufacturer
- Fluid inlet/outlet temperatures
- Operating pressures
- Pressure drops
- Manufacturing material
- Pressure ratings
- CRN numbers
- Voltage and phase
- RPM
- Seals and gaskets
- Construction materials

1.2.1.7 Contractor shall provide the following submittals to the Consultant and Owner's Representative:

1.2.1.7.1 Equipment shop drawings and product data sheets, complete with piping and power and control wiring schematics, accessories, rated capacities, weights, and all other relevant data.

1.2.1.7.2 Factory inspections and test reports with O & M Manual project close-out data.

1.2.1.7.3 Site inspection and start-up report detailing all the important equipment functions required to ensure equipment performance over the entire range of operation.

1.2.1.7.4 A one-year written warranty for all workmanship dated and signed by the Contractor.

1.3 STARTUP / COMMISSIONING / BALANCING REPORTS

1.3.1.1 After successful start-up and prior to Substantial Performance, commission the mechanical work in accordance with requirements of CSA Z320, Building Commissioning. Use commissioning sheets included with the CSA Standard, and any supplemental commissioning sheets required. Provide draft TAB report to the Consultant for review of all air and water systems.

1.3.1.2 The following equipment types each require submittal of a Startup or Commissioning or Balancing Report complete with temperature readings, pressure readings, speed or position settings, and flowrates:

1.3.1.2.1 Pumps (pressure, speed, rpm, flow)

1.3.1.2.2 Balancing Valves (pressures, conditions)

1.3.1.2.3 Air Fans (pressure, speed, rpm, flow)

1.3.1.3 Submit final commissioning data sheets, project closeout documents, and other required submittals to the Consultant and Owner's Representative. Ignore items that do not pertain to this project. These submittals will include, but are not limited to:

1.3.1.3.1 Inspection Date

1.3.1.3.2 Inspection or test personnel.

1.3.1.3.3 Description of testing procedure

1.3.1.3.4 VFD speed and current of all pumps

1.3.1.3.5 Pump pressure differentials

1.3.1.3.6 VFD speed and current of all fans

1.3.1.3.7 Supply and return temperatures of all heat pumps.

1.3.1.3.8 Control system testing and verification

1.3.1.3.9 All other relevant information that may impact the performance of the system.

1.3.1.4 Furthermore, the following operating conditions shall be simulated, and the operation of the controls system checked to ensure a fully functional system.

1.3.1.4.1 All pumps fitted with VFD shall be capable of operating from 25% of the operating speed to 100% of the operating speed, including the desired setpoint.

1.3.1.4.2 All other operating conditions required to confirm the intended operation and performance of the system.

1.3.1.4.3 Refer to control sequence of operations contained within the attached drawing package for more information.

1.3.1.5 During each one of these situations, the following conditions shall be recorded and provided to the Consultant and Owner's Representative. It is the responsibility of all contractors to work together to ensure proper commissioning, but it is the responsibility of the Contractor to provide the Owner and the Consultant with the documentation below:

1.3.1.5.1 Speed and pressure differential of all pumps

1.3.1.5.2 Temperatures on the inlet and outlet of heat pump supply and return lines.

1.3.1.5.3 All other relevant information required to evaluate the performance of the system.

1.3.1.6 Final balancing and commissioning reports to be included in the O&M manual.

1.4 AS-BUILT OR RECORD DRAWINGS

1.4.1.1 One printed copy of the issued for construction drawings shall be kept onsite during construction to allow for red-line markup of detail changes.

1.4.1.2 Contractor must deliver in hardcopy (size Arch D), PDF, and AutoCAD (.dwg) formats a digitally created As-Built drawing set to the Owner at project closeout, pending Consultant review and approval.

1.4.1.3 Alternatively, the Contractor may deliver a red-line markup version of construction documents for the Consultant to create Record Drawings from.

1.4.1.3.1 The Consultant charges $500 per drawing set for this work.

1.5 OPERATION & MAINTENANCE MANUALS

1.5.1.1 Prior to application for Substantial Completion, submit all required items and documentation specified, including the following:

1.5.1.1.1 Operating and Maintenance Manuals

1.5.1.1.2 Final commissioning report

1.5.1.2 Operation and Maintenance Manuals must be provided in the following formats:

1.5.1.2.1 Submit 2 hard copies consolidated in hardcover D-ring binders

1.5.1.2.2 Submit 1 digital copy on a USB flash drive to facility staff

1.5.1.2.3 Submit 1 digital copy to the Owner's Representative

1.5.1.3 Maintenance manuals shall include:

1.5.1.3.1 The Consultant's name, street address, telephone number, and email address

1.5.1.3.2 The Contractor's name, street address, telephone number, and email address

1.5.1.3.3 All subcontractor's names, street address, telephone number, and email address

1.5.1.3.4 A copy of each "Reviewed" shop drawing or product data sheet

1.5.1.3.5 Each shop drawing shall include the manufacturer or supplier name, telephone number, and email address.

1.5.1.3.6 Each shop drawing shall include the email address for local source of parts and service.

1.5.1.4 Maintenance manuals shall include recommended maintenance and maintenance intervals, normal operating parameters, data sheets, and the expected lifespan of all mechanical, electrical, and controls equipment.

1.6 DEMONSTRATION & TRAINING

1.6.1.1 Provide training to the Owner's designated personnel in all aspects of operation and maintenance of the equipment after start-up.

1.6.1.2 All demonstrations and training shall be performed by qualified technicians employed by the equipment/system manufacturer/supplier.

1.6.1.3 The Contractor shall provide a onetime onsite training course which will include the following:

1.6.1.3.1 Coordinate with all subcontractors to ensure that training encompasses all relevant systems.

1.6.1.3.2 Record date of training and name and signature of all attendees

1.6.1.4 The Contractor shall provide a syllabus of the training session to the Owner and Consultant for approval before scheduling the training session.

1.6.1.5 Training for Facility Operations Staff shall cover the following subjects:

1.6.1.5.1 Regular and seasonal preventative maintenance procedures

1.6.1.5.2 Sequence of operations

1.6.1.5.3 Desired operating temperature/pressure ranges of equipment

1.6.1.5.4 Safety controls

1.6.1.5.5 Emergency isolation valves

1.6.1.5.6 Alarms

1.6.1.5.7 Proper use of computer control system

1.6.1.5.8 Trouble-shooting procedures

1.6.1.5.9 Primary & secondary pressure relief systems and overflows

1.6.1.5.10 All other relevant system information required for safe and efficient operation of the system.

1.6.1.6 Training for facility electricians shall cover the following subjects:

1.6.1.6.1 All electrical systems

1.6.1.6.2 Sequence of operations

1.6.1.6.3 Safety controls

END OF SECTION

PART 2 GENERAL WORK INSTRUCTIONS

2.1 GENERAL

2.1.1 REFERENCES

2.1.1.1 The General Conditions of the Contract, the Supplementary Conditions, and all Sections of Division 01 apply to and are a part of this Section of the Specification.

2.1.2 APPLICATION

2.1.2.1 This Section specifies requirements and instructions that are common to the Sections of the Specification. It is a supplement to each Section and is to be read accordingly.

2.1.3 CODES, REGULATIONS, AND STANDARDS

2.1.3.1 All Codes, Regulations, and Standards referred to in this Section and in Sections to which this Section applies are the latest edition of the Codes, Regulations, and Standards in effect at the time the building permit is obtained, or at the time of bid closing for the Project, whichever comes first.

2.1.3.2 All work is to be in accordance with requirements with Codes, Regulations, and Standards applied by governing authorities, including:

2.1.3.2.1 BC Building Code 2024

2.1.3.2.2 BC Fire Code 2024

2.1.3.2.3 Local Building Bylaws

2.1.3.2.4 Technical Safety BC (TSBC)

2.1.3.3 All electrical items associated with mechanical equipment are to be certified and bear the stamp or seal of a recognized testing agency such as CSA, UL, ULC, or ETL; or bear a stamp to indicate special electrical utility approval.

2.1.4 QUALITY ASSURANCE

2.1.4.1 All work is to be done by tradesmen who perform only the work that their certificates permit, or by apprentice tradesmen under direct on-site supervision of an experienced Industrial Training Authority Red Seal certified journeyman tradesman.

2.1.4.2 Testing and inspections not explicitly assigned to the Owner are the Contractor's responsibility. Unless otherwise indicated, provide the quality

control, testing, and commissioning services specified in this document and those required by municipal, provincial, and federal governing bodies.

2.1.4.3 All quality control services must be provided by qualified personnel or testing agency.

2.1.4.4 All quality control services must be recorded, and documentation submitted to the Owner and the Consultant for verification and approval.

2.1.4.5 All contractors and subcontractors shall identify a qualified red seal tradesmen or other qualified owner representative as the main point of contact for the Consultant and the Owner.

2.1.4.6 All welders must be Class B or A and have up to date documentation.

2.1.5 COMBUSTIBLE PIPING MATERIALS

2.1.5.1 Combustible piping, tubing and associated adhesives are permitted to be used in a building required to be of non-combustible construction provided that, except when concealed in a wall or concrete floor slab, they have a flame-spread rating not more than 25, and if used in a plenum space or "high-building" (as defined by the BC Building Code), have a smoke developed classification not more than 50, in accordance with ULC-S102.2 testing standards.

2.1.6 SEISMIC RESTRAINT SYSTEMS

2.1.6.1 Supply and install seismic restraints for all new piping and ductwork systems and all new equipment in accordance with the British Columbia Building Code.

2.1.6.2 Arrange and pay for the services of a structural supporting professional engineer registered in the province of British Columbia (Seismic Engineer) to design and certify the seismic restraints for all new mechanical systems in accordance with the British Columbia Building Code. The Seismic Engineer shall provide direction to the Contractor during installation of the seismic restraints systems and submit signed and sealed Schedules S-B and S-C for the project.

2.1.6.3 Supply and install restraint on all new piping, ductwork and equipment which is part of the mechanical systems to prevent injury or hazard to persons and equipment and to retain equipment in its normal position in the event of an earthquake.

2.1.6.4 Supply and install all seismic restraint related hardware, (including bolts and anchors) from point of attachment to equipment through to and including attachment to structure.

2.1.6.5 When equipment is mounted on concrete housekeeping pads, and/or concrete curbs the anchor bolts shall extend through the pad into the structure.

2.1.6.6 Structural integrity of packaged equipment and its internal components is the responsibility of the equipment manufacturer.

2.1.6.7 Seismic restraints may only be omitted where not required by SMACNA Guidelines.

2.1.7 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

2.1.7.1 All professional engineers retained by the Contractor to perform consulting services with regard to the work, for example, Seismic Engineer, are to be members in good standing with the local Association of Professional Engineers and are to carry and pay for errors and omissions for professional liability insurance in compliance with requirements of the governing authorities in the locale of the work.

2.1.7.2 The retained engineer's professional liability insurance is to protect the Contractor's consultants and sub-consultants, their respective servants, agents, and employees against any loss or damage resulting from the professional services rendered by the Contractor's consultants and sub-consultants, their respective servants, agents, and employees regarding the work of this Contract.

2.1.7.3 The Contractor is to meet or exceed all liability insurance requirements laid out in the Owner's contract documentation.

2.1.7.4 If the Owner's contract documentation does not contain specific liability insurance requirements, the following requirements are to be met at a minimum:

2.1.7.4.1 The Proponent shall provide and maintain Comprehensive General Liability Insurance with a minimum limit of $2,000,000 and Professional Liability with a minimum limit of $1,000,000 inclusive per occurrence, for bodily injury, death, and property damage. Such policy shall include:

- The Township and its officers, employees, officials, agents, representatives, and volunteers as Additional Insured.

2.1.7.4.2 The insurance policy is not to be cancelled or changed in any way without the insurer giving the Owner a minimum of thirty days written notice

2.1.7.4.3 Liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the location of the work

2.1.7.5 Evidence of the required liability insurance in such form as may be required shall be submitted to the Owner, the Owner's consultant, and Authorities Having Jurisdiction as required prior to commencement of the Contractor's sub-consultant services.

2.1.8 EXAMINATION OF SITE AND DOCUMENTS

2.1.8.1 When estimating the cost of the work and prior to submitting a bid for the work, carefully examine all the bid documents and visit the site to determine and review all existing site conditions that will or may affect the work and include for all such conditions in the bid price.

2.1.8.2 All freight costs for the equipment and materials related to installation and integration are to be included in the Contractor's bid price.

2.1.8.2.1 Exception: Freight cost to jobsite curb for AHU-1 is included in the cash allowance.

2.1.8.3 Contractors are to note that premium or special freight costs may be required to deliver materials to site to meet completion schedules, the cost will be borne by the Contractor.

2.1.8.4 Contractors are responsible for checking all the relevant dimensions and line routing before bidding.

2.1.8.5 Contractors are responsible for confirming available supply voltage onsite, prior to ordering of equipment.

2.1.9 DRAWINGS AND MEASUREMENTS

2.1.9.1 Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work and are not detailed installation drawings. Do not scale the drawings.

2.1.9.2 Obtain accurate dimensions from the Architectural and Structural drawings.

2.1.9.3 Take field measurements, where equipment and material dimensions are dependent upon building dimensions.

2.1.10 PERMITS AND FEES

2.1.10.1 Contractor is responsible for applying for, obtaining, and paying for all permits and inspection fees required to complete the work.

2.1.10.2 A copy of each permit and inspection report shall be provided to the Owner's Representative.

2.1.10.3 Design registration shall be completed and submitted by the Contractor as required by Technical Safety BC.

2.1.11 PAYMENT

2.1.11.1 Unless otherwise specified by the Owner's documents, the following payment section shall apply.

2.1.11.1.1 Progress payments are to be discussed and approved prior to project award and outlined in the contract with the Contractor and Owner.

2.1.11.1.2 A minimum of 10% of the total project value shall be held back during the final progress payment for deficiencies and will be paid at the earliest, subject to the deficiencies list, 55 days after the Consultant's final inspection.

2.1.11.1.3 Upon completion of the final inspection, and when the Consultant has determined the value of the holdback accounting for deficiencies, the Contractor can bill for the remaining amount.

2.1.11.1.4 Upon completion of the deficiencies and approval by the Consultant, the Contractor may bill for the remaining project amount.

2.1.11.1.5 Upon notification from the Owner or the Consultant, the Contractor has 30 days to complete any deficiencies identified onsite. After this time, the Owner can hire a third-party contractor to complete this work and the Contractor will be responsible to the Owner for any costs associated with this work.

2.1.11.2 Substantial completion will not be approved until all, but not only, of these conditions are met:

2.1.11.2.1 Work is completed to a state in which it is safe to operate the equipment by the owner and spaces effected by the work is safe to be occupied by the public.

2.1.11.2.2 Progress of the work is at the level of the 3/2/1 rule as defined in the Builders Lien Act for substantial completion.

2.1.11.2.3 Scope of work is functionally complete to the satisfaction of the owner and the consultant.

2.1.12 SCAFFOLDING, RIGGING, AND HOISTING

2.1.12.1 Supply, erect and operate all scaffolding, rigging, hoisting equipment and associated hardware required to perform the work.

2.1.12.2 Do not place major loads on any portion of the structure without approval from the Consultant.

2.1.12.3 Submit for review, rigging and hoisting plans, contemplated dates, permits, equipment, safety measures, and personnel prior to hoisting operations.

2.1.13 PHASING, HOURS OF WORK, AND NOISE CONTROL

2.1.13.1 Unless specified otherwise in Division 01, work is to be performed between the hours 8:00 AM and 5:30 PM Monday to Friday. If work is required to be performed outside the hours specified above, special permission, in writing, must be obtained from the Owner.

2.1.13.2 Phasing of the work may be required to maintain the existing building in operation. Include all costs for phasing the work including all required "off hours" premium time labour costs.

2.1.13.3 The Contractor shall instate appropriate controls to reduce nuisance noise level from affecting the areas adjacent to the work site.

2.1.14 EQUIPMENT AND SYSTEM START-UP

2.1.14.1 All equipment shall be installed and integrated with the existing systems with all the necessary piping, valves, purge points, strainers, sensors, drain ports, conduit, disconnects, control equipment, electrical, base, and piping supports as required to ensure a complete functioning system.

2.1.14.2 When installation of equipment/systems is complete prior to commissioning, perform start-up under direct on-site supervision and involvement of the equipment/system manufacturer's representative or the Consultant, make any required adjustments, document the procedures, leave the equipment/system in proper operating condition, and submit a complete set of start-up documentation sheets signed by the manufacturer/supplier and the Contractor.

2.1.15 TESTING, ADJUSTING, AND BALANCING (TAB) FOR HVAC

2.1.15.1 Contractor to employ the services of an independent TAB firm to test and balance new air systems and water systems and commission all equipment and systems as outlined below.

2.1.15.2 Provide draft TAB report to the Consultant for review of all air and water systems.

2.1.15.3 Final TAB report to be included in the O&M manual.

2.1.16 EQUIPMENT INSPECTIONS

2.1.16.1 It is the responsibility of the Contractor to make the Consultant aware of appropriate inspection dates based on work commenced onsite. The Contractor shall give the Consultant at least one week notice.

2.1.16.2 Upon substantial project completion, the Contractor shall contact the Consultant for a final inspection and deficiency list.

2.1.16.3 Upon substantial project completion, the Consultant will perform an onsite inspection and send the Contractor an inspection summary and a deficiency inspection list. All deficiencies must be addressed to the satisfaction of the Owner's Representative and Consultant before the final holdback is paid by the Owner to the Contractor.

2.1.16.4 The Contractor shall repair or replace all property and existing equipment that is damaged or disturbed during construction. Equipment and property repairs must be completed to the satisfaction of the Owner's Representative and the Consultant before the final holdback is paid to the Contractor.

2.1.17 SAFETY AND TRAFFIC

2.1.17.1 The Contractor as the Prime Contractor is responsible for all safety measures required by the Owner, municipal, provincial government, and federal government.

2.1.17.2 The Contractor shall provide all traffic control required by the Owner, municipal, provincial government, and federal government to effectively perform the work outlined in this document.

2.1.18 PROJECT SCHEDULE

2.1.18.1 Upon award of contract, the Contractor shall prepare a work schedule with all major work identified, subcontractors identified, and expected dates for consultant site inspections identified.

2.1.18.2 The schedule shall be submitted for review and approval by the Owner and the Consultant within 14 days of contract award.

2.1.19 PROJECT MEETINGS

2.1.19.1 Upon award of contract, the Contractor shall attend and chair an online monthly meeting before work commences to discuss the project schedule, the Contractor's duties, and responsibilities; and to introduce designated site personnel.

2.1.19.2 Upon commencement of work, the Contractor shall attend and chair an online weekly meeting to update the Owner and Consultant on the project status.

2.1.19.3 Contractor to prepare meeting minutes and distribute to all attendees.

2.1.19.4 Contractor to provide a project Gantt chart to the Owner's Representative and the Consultant upon project award. This Gantt chart is to be updated monthly to reflect changes in project progress. At minimum, this Gantt chart must contain:

2.1.19.4.1 Expected equipment delivery dates

2.1.19.4.2 Construction schedule

2.1.19.4.3 Required facility shutdowns and expected startup dates

2.1.19.4.4 Expected inspection dates

2.1.19.4.5 Expected project completion date

2.1.19.4.6 Other information deemed important by the Owner's Representative or Consultant

2.1.19.5 Contractor to attend and chair additional site meetings as requested by the Owner or the Consultant.

2.1.20 REQUESTS FOR INFORMATION

2.1.20.1 Obtain answers to work related queries at site meetings whenever possible, but if not possible, prepare a Request for Information (RFI) and email to the Consultant. The RFI is to include:

2.1.20.1.1 The Project name, the date, and Contractor's name and the name of the person making the query.

2.1.20.1.2 An RFI number, a drawing reference if applicable, and a detailed description of the problem for which the RFI is issued.

2.1.20.2 Consultant will endeavor to provide response to RFI within ten working days of submission. RFIs received by Consultant after 1:00 p.m. will be considered as received the following working day.

2.2 EXECUTION

2.2.1 INSTALLATION OF EQUIPMENT

2.2.1.1 Unless otherwise specified or indicated, install all equipment in accordance with the equipment manufacturer's recommendations and instructions. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.

2.2.1.2 The Contractor is responsible for transportation, off-loading, and rigging of all mechanical equipment and materials, including all costs associated with these activities.

2.2.1.2.1 Exception: Freight cost to jobsite curb for AHU-1 is included in the cash allowance.

2.2.1.3 The Contractor is responsible for all premium or special freight costs required to deliver materials and equipment to site to meet construction schedules.

2.2.1.4 Contractor to provide piping and equipment supports, anchors, sleeves, anchor bolts, restraints, and accessories as required.

2.2.1.5 Contractor to provide equipment supports, structural steel frames, housekeeping pads, and mounting accessories as required.

2.2.1.6 The Contractor is responsible for all structural and/or seismic engineering and associated costs to ensure equipment stands meet all governing codes and standards.

2.2.1.7 All systems and pieces of equipment are to be provided with all necessary piping, valves, filters, purge points, drains, vents, and disconnects required to ensure reliable operation.

2.2.1.8 All systems and pieces of equipment to be provided with all electrical components and accessories required to integrate with onsite electrical infrastructure.

2.2.1.9 All systems and pieces of equipment are to be provided with all necessary mechanical, electrical, and controls equipment required to ensure reliable operation.

2.2.1.10 Contractor responsible for providing, charging, and installing new primary/secondary fluids and inhibitors required to operate the system for the first 6 months.

2.2.1.11 Contractor responsible for updating all required pressure relief and safety systems to ensure compliance with governing codes and standards.

2.2.1.12 Contractor responsible for providing controls wiring, conduit, sensing equipment, coding, graphics, and licenses for all new/modified systems and pieces of equipment.

2.2.1.13 Contractor responsible for commissioning all new equipment and making any necessary adjustments to existing equipment to ensure safe and reliable operation.

2.2.1.14 Contractor must provide a one-year labor and material warranty (on-site) commencing from when substantial completion is granted.

2.2.1.15 Contractor is responsible for labeling all the equipment, piping, valves, and electrical per the specification document and accompanied drawings.

2.2.2 MECHANICAL WORK IDENTIFICATION

2.2.2.1 Identify all new mechanical work in accordance with existing identification standards at the site.

2.2.2.2 Identify new piping adjacent to each valve and at each piece of connecting equipment.

2.2.2.3 Provide an identification nameplate for each new piece of equipment. Secure nameplates in place with stainless steel screws unless such a practice is prohibited, in which case use epoxy cement applied to cleaned surfaces.

2.2.2.4 Motor Controllers and Disconnect Switches: Provide an identification nameplate for each new motor controller, and on each disconnect switch provided as part of the electrical work for equipment provided and installed by the Contractor.

2.2.2.5 Equipment Nameplates: Minimum 1/16" [1.59mm] thick 2-ply laminated coloured plastic plates, minimum 1/2" x 2" [12.7mm x 50.8mm] for smaller items such control valves, minimum 1" x 2-1/2" [25.4mm x 63.5mm] for equipment, and minimum 2" x 4" [50.8mm x 101.6mm] for control panels and similar items. Additional requirements are as follows:

- Each nameplate is to be white, complete with bevelled edges and black engraved capital letter wording to completely identify the equipment and its use with no abbreviations unless specified otherwise.
- Wording is to include equipment service but must be reviewed/approved prior to engraving.
- Supply stainless steel screws for securing nameplates in place.

2.2.2.6 Pipe Identification: Pipe identification is to be equal to Smillie McAdams Summerlin Ltd. or Brady vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:

- For pipe to and including 6" [152.4mm] diameter, coiled type snap-on markers of a length are to wrap completely around the pipe or pipe insulation.
- For pipe larger than 6" [152.4mm] diameter, saddle type strap-on markers with two opposite identification locations and completed with nylon cable ties.

2.2.2.7 Identification wording and colours are to match existing wording and colours at the site.

2.2.2.8 Where there is no existing identification onsite, the Contractor is to confirm identification, colour, and nomenclature with the Consultant.

2.2.2.9 Upon project completion, Contractor to supply Owner's Representative with both PDF and size Arch D drawing detailing all valve and equipment tags.

2.2.3 FINISH PAINTING OF MECHANICAL WORK

2.2.3.1 Paint type and colour shall match existing building and mechanical equipment.

2.2.3.2 Touch-up paint all damaged factory applied finishes on mechanical work products.

2.2.3.3 All surfaces must be prepared, and paint applied per manufacturer's recommendations.

2.2.3.4 The Contractor is responsible to ensure the surface preparation and paint application are completed by someone with at least three (3) years of experience.

2.2.3.5 Manufacturer's minimum and maximum recommended application temperatures shall be adhered to.

2.2.3.6 Examine surfaces one week prior to the commencement of work. Report any condition that may affect proper application to the Owner and the Consultant.

2.2.3.7 Mask all required surfaces prior to commencing work.

2.2.3.8 Clean all surfaces per manufacturer's recommendations.

2.2.3.9 Uncoated steel and iron surfaces: Remove grease, weld splatter, dirt, and rust. Where scale/rust is present, remove by wire brush or sand blasting, clean by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime all repairs after cleaning.

2.2.3.10 Prime and paint prepared surface per manufacture's recommendations.

2.2.4 PIPE LEAKAGE TESTING

2.2.4.1 Before new piping has been insulated, and before equipment has been connected, test all new piping for leakage as outlined in specific subsections. Submit signed and dated test report sheets to confirm proper test results.

2.2.4.2 Include temporary piping connections required to complete pipe leakage tests.

2.2.5 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

2.2.5.1 Motor starters for mechanical equipment, except for starters integral with packaged equipment and starters factory installed in equipment power and control panels, will be provided as part of the electrical work.

2.2.6 WASTE MANAGEMENT AND DISPOSAL

2.2.6.1 Separate and recycle waste materials in accordance with requirements of Canadian Construction Association Standard Document CCA 81, A Best Practices Guide to Solid Waste Reduction.

END OF SECTION

PART 3 DEMOLITION AND REVISION WORK

3.1 GENERAL

3.1.1 APPLICATION

3.1.1.1 This section specifies requirements, criteria, methods, and execution for mechanical demolition work that is common to one or more mechanical work sections, and it is intended as a supplement to each section and is to be read accordingly.

3.1.2 REFERENCE STANDARD

3.1.2.1 Perform demolition work in accordance with requirements of CAN/CSA-S350, Code of Practice for Safety in Demolition of Structures.

3.2 EXECUTION

3.2.1.1 The Contractor is responsible for all demolition and revision work.

3.2.1.2 Estimate the scope, extent, and cost of the demolition work at the site during the bidding period and include for all such costs in the bid price.

3.2.1.3 Demolitions shall be coordinated with the Owner's Representative to ensure minimal downtime.

3.2.1.4 Decommission and remove all existing equipment and materials which have been marked for removal.

3.2.1.5 All removed material and equipment is the property of the Owner and shall be disposed of in conjunction with the with Owner's wishes.

3.2.1.6 All materials and equipment approved for removal by the Owner shall be disposed of in an environmentally sustainable fashion.

3.2.1.7 Ensure that products and materials required for re-use are properly retained and protected.

3.2.1.8 Where existing valves with tags are removed, the tags shall be reused where possible.

3.2.1.9 Remove from the site and dispose of all existing equipment and materials which have been removed.

3.2.1.10 Demolitions shall be completed using a method which will ensure minimal building damage, and any damage which occurs during equipment removal must be restored to the original condition prior to the project completion.

3.2.1.11 If the Contractor, during renovations / demolition, should discover asbestos (or material suspected to be asbestos) on piping, he shall immediately cease all work in that area and advise the General Contractor and Owner. The Owner shall take appropriate action to verify presence of friable asbestos and be responsible for the removal of all friable asbestos. The Contractor will not be entitled to a claim for any delays resulting from the investigation of or removal of asbestos.

3.2.1.12 Where required, wetting agents approved by the Owner, or the Consultant shall be used for dust control.

3.2.1.13 All demolished material shall be quickly removed from site. All demolished material which must be stored onsite will be stored in a location approved by the Owner.

3.2.1.14 Appropriate bodies of water, including storm water, must be appropriately protected.

END OF SECTION

PART 4 PUMPS

4.1 GENERAL

4.1.1.1 All pumps must be constructed from appropriate materials or have appropriate coatings suited for their intended operation.

4.1.1.2 Pump construction shall permit complete servicing without breaking piping or motor connections.

4.1.1.3 Pumps shall operate at 1,800 rpm unless specified otherwise.

4.1.1.4 At a minimum upon commissioning, the following values shall be recorded and provided to the Owner and the Consultant.

- Pump suction pressure
- Pump discharge pressure
- Pump voltage and current
- Pump flow rate, design, and as measured at an appropriate location.

4.1.1.5 Approved pump manufacturers:

- Armstrong
- Grundfos
- Taco
- Xylem (B&G)

4.2 PRODUCTS

4.2.1 IN-LINE CIRCULATOR PUMPS

4.2.1.1 Suitable for a maximum working pressure of 860 kPa [125 psig] and maximum temperature of 107°C [225°F].

4.2.1.2 Casing: Cast iron radially split, with flanged connections. Supplied with matching companion flanges.

4.2.1.3 Impellor: Corrosion resistant cadmium plated steel.

4.2.1.4 Shaft: Alloy steel with bronze sleeve bearing, integral thrust collar.

4.2.1.5 Seal Assembly: Mechanical.

4.2.1.6 Coupling: Flexible self-aligning.

4.2.1.7 Motor: Resilient mounted, drip proof, sleeve bearing.

4.2.1.8 Refer to equipment schedule on drawings.

4.2.2 VERTICAL IN-LINE CENTRIFUGAL PUMPS

4.2.2.1 Suitable for a maximum working pressure of 1210 kPa [175 psig] and maximum temperature of 107°C [225°F].

4.2.2.2 Casing: Cast iron radially split, single stage, flanged suction and discharge connections, separate tapped openings for venting, draining and gauge connections.

4.2.2.3 Impellor: Stainless steel

4.2.2.4 Shaft: Stainless steel on split coupled pumps and carbon steel with bronze sleeve on close coupled pumps.

4.2.2.5 Seal Assembly: Inside unbalanced mechanical seal with factory installed seal flushing line.

4.2.2.6 Coupling: Close coupled on motors less than 7-1/2 HP and split couplers for all motors 7-1/2 HP and larger to permit removal of seal without disturbing the motor.

4.2.2.7 Motor: EEMAC Class B, squirrel cage induction, continuous duty, drip proof, ball bearings.

4.2.2.8 Accessories: Strainer/suction guide, combination check/balance valve where scheduled.

4.2.2.9 Refer to equipment schedule on drawings.

4.3 EXECUTION

4.3.1.1 Ensure that pumps are installed such that no piping or equipment loads are imposed on the pump body. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

4.3.1.2 All pumps to be installed with isolation valves, drain valves, pressure gauges on the inlet and outlet, and pressure gauges across strainers where installed.

4.3.1.3 Install a minimum of 2 feet of carbon steel piping at the inlet and outlet of each pump before transitioning to PVC.

4.3.1.4 Should the Contractor identify onsite conditions or design issues that could lead to cavitation within a pump, the Consultant must be notified prior to onsite construction

4.3.1.5 All floor mounted pumps to be installed on 100mm [4”] concrete housekeeping pad.

END OF SECTION

PART 5 HEAT TRACING

5.1 GENERAL

5.1.1.1 Provide complete, CSA approved system of heat tracing on piping located outdoors where indicated on the drawings.

5.1.1.2 The entire design and installation of the system shall comply with the Canadian Electrical Code and the requirements of the local inspection authority.

5.1.1.3 Provide all necessary materials to provide a complete system.

5.1.1.4 Provide a megohmmeter test in commissioning report.

5.2 PRODUCTS

5.2.1.1 Use Raychem Chemelex Auto Trace self-regulating, shielded, jacketed cable type XL-TRACE (use XTV for hot water piping systems) or equal. System shall be thermostatically controlled using Chemelex Automatrix Thermostat #AMC-F5 with non-adjustable set point of 5°C [40°F] complete with 900 mm [36"] capillary.

5.3 EXECUTION

5.3.1.1 Install heater system in accordance with manufacturer's instructions and these specifications.

5.3.1.2 Prior to installing heating cables, ensure the pipe systems are complete and have passed all necessary tests.

5.3.1.3 Cables to be secured to pipes using Raychem Type G554 glass cloth tape at 300 mm [12"] intervals on pipe, or equivalent.

5.3.1.4 Wrap all valves with a minimum of 1320 mm [52”] of heater cable. Follow manufacturer's recommendations for installation of cable around valves and flanges.

5.3.1.5 Install sensing bulb on side of pipe at least 1000 mm [40”] away from valves, flanges, pumps, etc.

5.3.1.6 After pipes are traced test all lengths prior to application of pipe insulation.

5.3.1.7 Provide suitable identification for those pipe systems provided with heat tracing. At intervals of 6000 mm [20 ft], provide on outside surface adhesive backed nameplate "Caution - Heat Tracing".

5.3.1.8 Field Tests and Inspections:

5.3.1.8.1 The following test shall be performed after the heat cable has been installed but before the insulation and after insulating the piping.

5.3.1.8.2 The results of both sets of test shall be recorded as detailed in the manufacturer's installation and maintenance manual and included in the final closeout submittals:

- Continuity Test
- Insulation Resistance – 2500VDC
- Capacitance Check – Circuit Length Verification
- Power Check
- Ground Fault Test
- Non-Conforming Work:

5.3.1.9 Any heat tracing circuit which fails the any of the above test must be corrected prior to commissioning or startup of the system.

5.3.1.10 System Start-Up:

5.3.1.10.1 Provide a factory-certified technician or manufacturer's representative for startup & commissioning of the heat tracing system and controller.

5.3.1.10.2 Provide commissioning report in the final closeout submittals package to Consultant for review, and for copy to be placed in the operations and maintenance manual.

END OF SECTION

PART 6 NATATORIUM DEHUMIDIFIER

6.1 GENERAL

6.1.1.1 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Dehumidifier Schedule included on the drawings.

6.1.1.2 Unit shall be factory built, and carry all necessary approvals. Coils shall be water tested and ARI certified. Fans shall be run and tested to performance. Test results shall be submitted for vibration sound and airflow performance.

6.1.1.3 Air-handling units are to be shipped to the job in one piece, factory assembled. All equipment shall where specified and applicable, be pre-wired and factory certified by an approved testing agency such as ETL, UL, or CSA for the destination.

6.1.1.4 All electrical circuits shall undergo a dielectric strength test and shall be factory tested and checked as to proper function.

6.1.1.5 All association building automation controls hardware and wiring to be field mounted by the controls contractor. Provide factory installed empty 25mm [1″] conduit with j-boxes in each section for controls contractor's use.

6.1.1.6 Motors powered by variable speed drive controllers shall be EEMAC Class B with Type F insulation, shall have a 1.15 service factor and shall be suitable to be driven by PWM variable speed drive controllers. The motor manufacturer shall submit in writing confirmation that the motors are designed to withstand voltage peaks of 1400 volts and a voltage rate of rise of 2000 volts / microsecond at a frequency of 20 kHz.

6.1.1.7 Outside louvers and hoods with 25mm [1″] birdscreen.

6.2 PRODUCTS – AIR HANDLING UNIT (CUSTOM BUILT)

6.2.1 UNIT CONSTRUCTION:

6.2.1.1 Unit casing shall be 18 ga (1.3 mm) satin coat galvanized sheet metal. Surfaces on indoor and outdoor units shall be cleaned with a degreasing solvent to remove oil and metal oxides. Outdoor units shall be primed with a two-part acid based etching primer. All unprotected metal and welds shall be factory coated.

6.2.1.2 2" (51 mm) thick, 3 lb./ ft.^{3} (48 kg/m^3) density coated insulation.

6.2.1.3 Unit liner shall be 22 ga (.85 mm) solid 5052 aluminum.

6.2.1.4 Unit casing floors in walk in sections shall be fabricated with 12 ga (2.66 mm) painted checkerplate. Provide reinforcing channels under floor to minimize deflection.

6.2.1.5 Units shall be provided with access doors to the following components: fans, motors, filters, dampers and operators, access plenums, electrical control panels. Access doors shall be as large as practical for easy access. Screwed wall panel access will not be acceptable for the above listed components.

6.2.1.6 Provide 2 foot LED light bar in each section provided with an access door. Lights shall be wired in EMT conduit to a 120 volt outdoor light switch. 120 volt power supply shall be supplied from unit power supply.

6.2.1.7 Cooling coil drain pans shall be fabricated of 316 stainless steel and are an integral part of the floor paneling, a minimum of 2" (51 mm) deep with welded corners. Drain pans shall extend a minimum of 6" (152 mm) downstream of coil face and be provided with a 1 ½" (38 mm) S.S. M.P.T. drain connection. All cooling coil drain pans shall have a fast pan and be sloped and pitched such that there is no standing water. Intermediate drain pans shall be provided where required for effective moisture removal.

6.2.1.8 Low leak construction shall be tested in accordance with AHRI1350 (Mechanical Performance Rating of Central Station Air-Handling Unit Casing) for casing air leakage rate. Testing to be performed at 1.5 times the total static pressure of the supply air to a maximum of 10" w.c. (2.5 kPa). This testing shall be performed after all mechanical and electrical components have been installed and functional testing has been completed.

6.2.1.9 The unit air leakage rate is to be shown on the submittal documentation as leakage CFM per 100ft² at the pressure noted above. The allowable air leakage rate shall be a maximum of Class 6.

6.2.1.10 Outdoor units shall be weatherproofed and equipped for installation outdoors. Units shall be fabricated to prevent the infiltration of rain and snow: louvers or hoods shall be provided on air intakes and exhaust openings. Rain gutters or diverters shall be installed over all access doors. All joints shall be caulked with a water resistant sealant. The roof joints shall be turned up 2" (51 mm) with three break interlocking design and the outer wall panels shall extend a minimum of ¼" (6 mm) below the floor panel.

6.2.1.11 Provide full perimeter roof mounting curb of heavy gauge sheet metal at a minimum of 12" (305 mm) high complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25 mm) upturn on inner perimeter to provide a complete seal against the elements. External insulation and

flashing of the roof-mounting curb shall be provided by the roofing subcontractor.

6.2.2 FANS

6.2.2.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code - Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

6.2.2.2 Fan and motor sheaves shall be factory installed, fan balanced, and tested prior to shipment.

6.2.2.3 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor that is welded to the structural frame of the unit. Use of separate bumpers or snubbers are not acceptable. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric with a sealed double locking fabric to metal connection.

6.2.3 VARIABLE FREQUENCY DRIVES

6.2.3.1 A pulse width modulated (PWM) inverter designed for use with both asynchronous and permanent magnet motors shall be provided.

6.2.3.2 Drives shall be UL labeled as a complete assembly.

6.2.3.3 The base drive shall be SEMI-F47 certified. The drive must tolerate voltage sags to 50% for up to 0.2 seconds, sags to 70% for up to 0.5 seconds, and sags to 80% for up to one second.

6.2.3.4 The drive shall provide full rated output from a line of +10% to -15% of nominal voltage. The drive shall continue to operate without faulting from a line of +25% to -35% of nominal voltage.

6.2.4 COILS

6.2.4.1 Refer to Dehumidifier Schedule on the drawings.

6.2.4.2 Provide Heresite P-413 a pure phenolic with plasticizers thermosetting resinous coating to protect the coils against exposure to corrosive air streams. The process shall be accomplished by a multiple coat application resulting in complete coating coverage of the fins, tubes, headers, and casing. Salt spray tested to ASTM B-117 standards.

6.2.5 FILTERS

6.2.5.1 Filter media shall be ULC listed, Class I or Class II.

6.2.5.2 Filters: suitable for air at 100% RH and air temperatures between 30°C [37°F] and 50°C [122oF].

6.2.5.3 Provide two (2) sets of filter media (for each filter) - one for final installation and one for handover to the owner as a spare. Obtain signed receipt.

6.2.5.4 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side of the unit as noted on the drawings.

6.2.5.5 The filters shall be designed to slide out of the unit. Side removal filters shall slide into a formed metal track sealing against metal spacers at each end of the track.

6.2.5.6 Filters shall be inserted into a frame grid from the upstream side of the filter section. Air filter holding frames shall be 316 stainless steel with filter sealing flange, centering dimples, sealing gasket, and lances for appropriate air filter fasteners. Fasteners shall be capable of being installed without the use of tools, nuts, or bolts. A ¾" (19 mm) filter sealing flange shall be an integral component of the holding frame complete with a foam gasket to assure filter to frame sealing integrity. On pre and final filter arrangements, the pre-filters shall fit into the same frame structure and all shall be secured with clips. Filter frame structure shall be reinforced as required to withstand the differential pressure.

6.2.5.7 Provide filter bank with unit mounted Dwyer 3000 Photohelic air filter gauge complete with aluminum tubing and single pole double throw switch for remote alarm capabilities.

6.2.5.8 Where the filter gauges are provided on outdoor units, they shall be flush or exterior mounted inside of a weatherproof enclosure.

6.2.6 DAMPERS

6.2.6.1 Damper frames shall be U-shaped satin coat galvanized metal sections securely screwed or welded to the unit casing. Pivot rods of 1/2" (13mm) diameter steel shall turn in nylon or bronze bushings. Rods shall be secured to the blade by nuts and bolts.

6.2.6.2 Outside Air: Modulating spring return

6.2.6.3 Exhaust Air: Modulating spring return

6.2.6.4 Exhaust Air bypass: Tamco Series 1000, SW aluminum airfoil damper, uninsulated, 2-position, spring return.

6.2.6.5 Fan Array Inlet: Tamco Series 7600, SW aluminum airfoil damper, uninsulated, gravity.

6.2.7 EXECUTION

6.2.7.1 Install units as indicated on the drawings and to manufacturers' recommendations.

6.2.7.2 Maintain proper clearance around equipment to permit performance of service maintenance, coil removal and repair.

6.2.7.3 Make ductwork, piping, and wiring connections to the unit in accordance with the drawings.

6.2.7.4 Pipe from condensate drains to roof drain complete with trap. Install unit so that the curb height is sufficient to accommodate depth of 'P' trap.

6.2.7.5 Seismically secure roof mounted AHU’s to curbs/pads by either bolting or welding to embedded steel plates.

END OF SECTION

PART 7 HYDRONIC PIPING AND VALVES

7.1 GENERAL

7.1.1.1 Piping system work is to be in accordance with the following Codes and Standards:

7.1.1.1.1 ASTM A53, Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless

7.1.1.1.2 ASTM A105, Standard Specification for Carbon Steel Forgings for Piping Applications

7.1.1.1.3 ASTM A536, Standard Specification for Ductile Iron Castings

7.1.1.1.4 ANSI/ASME B16.4, Cast Iron Threaded Fittings

7.1.1.2 All field welding to be in accordance with the procedures of CSA-W117.2 and the current edition of ASME/ANSI B31.1 or B31.9 Code.

7.1.1.3 All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. (combining products of multiple manufacturers is not permitted.) Grooving tools shall be of the same manufacturer as the grooved components.

7.1.1.4 The manufacturer shall be ISO 9001 certified.

7.1.1.5 All coupling, fitting, and valve (body and component) castings shall be date stamped for quality assurance and traceability.

7.1.1.6 Gaskets shall be molded and produced by the coupling manufacturer.

7.1.1.7 EPDM elastomer materials shall be developed, manufactured, and tested in the coupling manufacturer's facility. The EPDM shall be a proprietary blend that exceeds industry standards for performance over the long term.

7.1.1.8 The coupling manufacturer's gasket development and production shall be periodically audited by quality and polymer industry professionals.

7.1.1.9 The Victaulic proprietary blend is the only EPDM that is considered acceptable for hot water heating systems to 110°C / 230°F.

7.1.1.10 Contractor responsible for confirming thermal fluid chemistry and operating temperatures with grooved fitting manufacturer to ensure proper specification of gasket.

7.1.1.11 All grooved joint products shall comply with CSA B242.

7.1.1.12 Contractor to provide thermal calculations from grooved fitting supplier including all details for anchoring and expansion compensation. Contractor to provide calculations in shop drawing review stage before installation.

7.1.2 WATER TREATMENT SERVICE

7.1.2.1 Provide for cleaning and degreasing of all systems that use glycol or water as a heat transfer medium.

7.1.2.2 Water treatment chemicals and treatment process shall be supplied and performed by the Contractor. This work shall be supervised by an approved professional chemical cleaning and treatment agency (the Water Treatment Specialist) who, upon completion shall certify that the process is satisfactory and submit a report outlining the cleaning operation and the treatment process.

7.1.2.2.1 For existing systems, confirm current Water Treatment Specialist and chemical supplier with the Owner.

7.1.2.3 The Water Treatment Specialist shall provide supervision of installations, set-up and adjustments and shall submit a written report on system operations.

7.1.2.4 All chemicals, feed systems and test equipment shall be provided by the Water Treatment Specialist.

7.1.2.5 Treatment chemicals shall not contain hydrazene.

7.1.2.6 Allow for replenishing of existing system levels where fluid is drained or system is expanded.

7.1.2.7 Treatment chemicals shall be non-foaming.

7.1.2.8 The Water Treatment Specialist shall instruct the facility maintenance personnel before substantial completion. Written instructions of the treatment, dosages control charts and test procedures shall be included in the maintenance manuals.

7.1.2.9 Provide a test kit suitable for all chemical treatments used. The test kit shall be made available for on-site tests and provide a Myron 3 range TDS meter to check conductivity. Hand over the kit to the Building Operator at project completion - obtain receipt.

7.1.2.10 Provide one mild steel and one copper corrosion coupon package to monitor corrosion rate for each open and closed systems.

7.1.2.11 Glycol System:

7.1.2.11.1 Charge the following new systems with minimum 20% solution (by volume) in water of inhibited propylene glycol.

- chilled water systems(s)

7.1.2.11.2 Existing systems: Confirm glycol solution and percentage with the Owner.

7.2 PRODUCTS

7.2.1 PIPE, FITTINGS AND JOINTS

7.2.1.1 Black Steel - Screwed Joint: Mild black carbon steel, Grade B, ERW, ASTM A53, complete with Class 125 cast iron threaded fittings to ANSI/ASME B16.4, and screwed joints.

7.2.1.2 Black Steel - Grooved End Mechanical Joint: Mild black carbon steel, Grade B, ERW, ASTM A53, factory or site roll grooved, complete with Victaulic Co. (or equal) cast ductile iron grooved end fittings, including full flow elbows, conforming to ASTM A536.

7.2.1.3 PVC – Pipe shall be made from unplasticized PVC compounds having a minimum cell classification of 12454 as defined in ASTM D 1784. The compound shall qualify for Hydrostatic Design Basis (HDB) of 4000 psi for water at 73.4°F, in accordance with the requirements of ASTM D 2837.

7.2.1.3.1 New PVC piping, fitting, coupling, and valve system to match existing (IPEX Xirtec SCH 80).

7.2.1.4 Mechanical Couplings for Joining Carbon Steel Pipe:

- Victaulic Standard Mechanical Couplings, 2 inch (DN50) through 12 inch (DN300): Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard Victaulic.

7.2.1.4.1 Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.

- 2" (DN50) through 12" (DN300): Victaulic Style 107N (Quick-Vic™). Installation ready rigid coupling for direct stab installation without field disassembly. Center-leg gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).

7.2.1.4.2 Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.

- 2" (DN50) through 8" (DN200): Victaulic Style 177 (Quick-Vic™). Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).

7.2.1.5 Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges. Victaulic Style 741. For direct connection to ANSI Class 300 flanges use Victaulic Style 743.

7.2.1.6 Grooved couplings shall meet the requirements of ASTM F-1476.

7.2.1.7 Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

7.2.1.8 Reference shall always be made to the latest published Selection Guide for Victaulic Gaskets for proper gasket selection for the intended service.

7.2.2 VALVES GENERAL

7.2.2.1 Wherever possible all valves shall be of one manufacturer.

7.2.2.2 Grooved valves shall be of the same manufacturer as the adjoining couplings.

7.2.2.3 All valves shall have a Provincial CRN number which is current.

7.2.2.4 Valves in insulated piping are to be complete with stem extensions.

7.2.2.5 Acceptable manufacturers are:

- Toyo Valve Co.
- Milwaukee Valve Co.
- Kitz Corporation
- Conbraco Industries Inc. Apollo
- Watts Water Technologies Inc.

7.2.3 SHUT-OFF VALVES

7.2.3.1 Butterfly Type: Cast ductile iron, lug body style, 1200 kPa (175 psi) rated butterfly valves, each suitable for bubble-tight dead-end service with the valve closed and either side of the connecting piping removed, and each complete with:

- a neck to permit 2½" of insulation above the flange
- a field replaceable EPDM seat

- a bronze disc (316 stainless steel for brine)
- a stainless-steel shaft with EPDM seal

7.2.3.2 Ball Valve: Class 600, 4140 kPa (600 psi) non-shock WOG rated, 2-piece, full port ball type valves, each complete with:

- a forged brass or bronze body
- blowout-proof stem
- solid forged brass or bronze chrome plated ball
- "Teflon" or PTFE seat
- a removable coated steel lever handle marked with valve identification
- ends to suit the piping being connected

7.2.4 SWING CHECK VALVES

- In compliance with MSS-SP-71
- NPS 2-1/2" and over, flanged:
- ANSI Class 125 (860 kPa)
- Cast iron body, renewable or re-grindable seat, bronze swing disc, bolted cap

7.2.5 SILENT CHECK VALVES (SPRING TYPE)

- NPS 2-1/2" through 12", grooved ends
- 2065 kPa (300 PSI) non-shock W.O.G. rated
- Ductile iron body, electroless nickel plated seat, EPDM coated disk and seals, stainless steel spring and shaft.

7.2.6 PIPELINE STRAINER

7.2.6.1 NPS 2 and smaller:

- Bronze body to ASTM B62.
- Screwed connections.
- Y pattern.

7.2.6.2 NPS 2-1/2 and larger:

- Cast ductile iron body to ASTM A536, Grade 65-45-12, grooved ends.
- Cast steel body to ASTM A278M, Class 30, flanged connections.
- Blowdown connection: NPS 1.
- Screen: stainless steel with 1.19 mm through 3.2 mm perforations.
- Maximum working pressure: 2,065 kPa (300 PSI).

7.2.7 CIRCUIT BALANCING VALVES NPS 2 AND UNDER:

7.2.7.1.1 Maximum operating pressure 2,065 kPa (300 PSI).

7.2.7.1.2 Lead free brass or copper alloy body, double regulating valve, "Y" pattern globe, threaded ends with test points, memory stop and hand wheel providing flow measurement, flow balancing and drip-tight shut-off. 90° 'circuit-setter' style ball valves are not acceptable.

7.2.8 CIRCUIT BALANCING VALVES NPS 2-1/2 AND OVER:

7.2.8.1.1 Maximum operating pressure 2,065 kPa (300 PSI).

7.2.8.1.2 Cast iron body with flanged connections or ductile iron with grooved ends, double regulating valve "Y" pattern globe, with test points, memory stop and hand wheel providing flow measurement, flow balancing and drip-tight shut-off. 90° 'circuit-setter' style ball valves are not acceptable.

7.2.8.2 Include calibration charts and adjustment tools.

7.2.9 WATER TREATMENT

7.2.9.1 GENERAL

7.2.9.1.1 System Cleaner: Use a Sodium Metasilicate, Sodium Nitrite and a wetting agent compound which in solution removes grease and petroleum products. Concentration level to be determined by Water Treatment Specialist. (PACE Chemicals Ltd. - PURGEX L-24 or approved equal).

7.2.9.1.2 Closed System Treatment (Hot Water, Chilled Water, etc.): Use an all-organic based corrosion inhibitor. Maintain levels at 60 to 100 ppm. (PACE Chemicals Ltd. - BAR COR CWS-105 or approved equal.) Note: The use of Nitrite only, Molybdate only or Sulphite only will not be accepted.

7.2.9.1.3 For new installations, provide sufficient chemicals to treat the system from the time of commissioning to acceptance of the system. In addition, provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months normal operation.

7.2.9.1.4 Materials which may contact finished areas must be colourless

7.3 EXECUTION

7.3.1.1 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of dirt.

7.3.1.2 All high temperature piping, greater or equal to 95 °F, is to be Schedule 40 black steel with MPT ends and FPT fittings and couplings.

7.3.1.3 Screw, or weld, fittings (unless otherwise specified) for all piping systems up to NPS 2.

7.3.1.4 Weld or Victaulic groove (unless otherwise specified) all piping systems NPS 2-1/2 and over.

7.3.1.5 Use long radius elbows. Victaulic #10 or W10 standard radius elbows may be used in lieu of long radius elbows in grooved piping systems in equipment rooms and where space considerations must be made.

7.3.1.6 Use eccentric reducers at pipe size changes, flush on top side, to permit positive venting and drainage.

7.3.1.7 Provide screwed unions or removable mechanical joint couplings in piping at all connections to valves, and at all equipment connections.

7.3.1.8 Provide shut-off valves in piping connections to all pieces of major equipment, including but not limited to injection loops, heat exchangers, and pumps.

7.3.1.9 All piping shall be provided with clearance around systems, equipment, and components for observation of operation, inspection, and servicing. Clearance must meet manufacturers requirements and the National Fire Code of Canada.

7.3.1.10 All piping must be installed with enough space to allow for disassembly, removal of equipment and components per manufacturer recommendations.

7.3.1.11 All piping greater than two inches shall be installed with butterfly isolation valves.

7.3.1.12 All piping smaller or equal to two inches shall be installed with ball isolation valves.

7.3.1.13 All branch lines shall be installed with isolation and bypass lines with valves to allow maintenance.

7.3.1.14 All drains shall be sloped towards drain.

7.3.1.15 Saddle type fittings may be used on branch tees where branch is less than half the size of the main. All saddles must be installed to maintain full inside diameter of branch like prior to welding saddle.

7.3.1.16 All dissimilar metals shall be connected with dielectric couplings appropriate for the application.

7.3.1.17 Install dielectric type unions or flanges or Victaulic Style 47 Clearflow Dielectric Waterways on "OPEN" type systems, where copper piping connects to steel. eg. domestic hot water tanks.

7.3.1.17.1 All bolt threads shall be lubricated with anti-seize compound.

7.3.1.18 All flanges mating to cast iron valve or equipment shall have flat faces.

7.3.1.19 Threaded joints in ferrous piping shall have NPT taper screw threads and shall be reamed and deburred before being used.

7.3.1.20 All piping which has potential for freezing, water condensation, and heat loss shall be protected by the appropriate insulation, vapor barrier, cladding, and heat trace where required.

7.3.1.21 Piping shall be installed to prevent air traps. Where required, install air vents at high points and elsewhere, and drains in all low points, drain points, heat transfer outlets and elsewhere to ensure reliable operation and maintenance.

7.3.1.22 The Contractor will be responsible for the identification of all piping, valves and equipment installed under this contract. A list of existing valve tag numbers is to be used and added to as required.

7.3.2 GROOVED JOINT PIPING

7.3.2.1 Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions.

7.3.2.2 Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.

7.3.2.3 Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer.

7.3.2.4 The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products.

7.3.2.5 The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

7.3.3 PIPING SUPPORTS

7.3.3.1 All hangers, supports, and sway braces are to be in accordance with MSS SP58.

7.3.3.2 All piping is to be installed and supported per piping manufacturer recommendations.

7.3.3.3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in the affected specification section.

7.3.3.4 All hangers and associated hardware located in corrosive or high-humidity environments (eg. pool environments, outdoors) must be stainless steel. All hangers inside the mechanical room (non-corrosive environment) may be painted or hot dipped galvanized.

7.3.3.4.1 Ensure steel hangers are in tensile load only.

7.3.3.5 Cold piping NPS 2 or smaller can be supported by I-beam C clamp with steel cup set screw, locknut and carbon steel retaining clip. Must be UL listed or FM approved.

7.3.3.6 Ensure that hanger rod is vertical in operating conditions.

7.3.3.7 All outside rooftop riser clamps to be stainless steel, aluminum, or at a minimum hot dipped galvanized.

7.3.3.8 Piping supports shall be supported by bolts and only welded upon approval from a structural engineer.

7.3.3.9 All clevis plates must be secured with a minimum of 4 concrete inserts, one at each corner.

7.3.3.10 All flexible joint roll grooved piping shall also be supported by at least one hanger at the piping joints.

7.3.3.11 Per good piping practice, the following recommended piping support spacing table shall be adhered to. It should be noted that piping transitions, pump inlets and outlets, flanges, valves, and other high piping load concentrations require more support than shown in the table below. In this case, the component or piping manufacturer shall be consulted for recommended piping supports.

MAXIMUM SPACING				
NOMINAL PIPE SIZE	ROD DIAMETER	STEEL	COPPER	PVC (SCH 80)
≤ 1-¼″	⅜″	7′	7′	4′
1 ½″	⅜″	9′	9′	5′
2″	⅜″	10′	10′	6′
2 ½″	½″	11′	11′	6′
3″	½″	12′	12′	7′
3 ½″	½″	13′	13′	7′
4″	⅝″	14′	14′	7′
5″	⅝″	16′	16′	7′
6″	¾″	17′	17′	9′

7.3.3.12 Piping and tubing smaller than 1-in may require more supports to reducing piping vibrations. The Contractor must install sufficient supports to avoid excessive vibration.

7.3.3.13 All piping must be supported.

7.3.3.14 Constant support hangers will be used when the vertical moment of the pipework is 13 mm or more and variable support will be used where the variation in support effect does not exceed 25% of the total load.

7.3.3.15 Piping clamps and supports used on pipe transporting fluid above ambient air temperatures may penetrate through insulation.

7.3.3.16 Piping clamps and supports used on piping operating below ambient air temperatures shall not penetrate through insulation.

7.3.3.17 All piping shall be installed with appropriate seismic restraints per the geographic location of the project.

7.3.4 EXPANSION OF PIPING

7.3.4.1 Install all piping systems with due regard and provision for expansion avoiding strain or damage to equipment and building. Pay particular attention to piping running horizontal across building expansion joints and provide adequate expansion and contraction for all such piping.

7.3.4.2 Only major expansion configuration and fittings have been shown on the drawings. Provide all required additional compensators, loops and swing connections.

7.3.4.3 Provide anchors, as required. Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.

7.3.4.4 Expansion loops shall be of all welded construction with long radius elbows.

7.3.4.5 Install expansion loops, cold sprung 50% of the calculated expansion.

7.3.4.6 Install at least three [3] elbows in all branch connections. Where space does not permit 3 elbows, install braided flexible pipe connectors in accordance with manufacturers recommendations. Three [3] elbow branch connections shall have sufficient developed length to ensure that excessive stresses are not generated in the piping and in no case less than 900 mm [36"].

7.3.4.7 For water systems, use adequate numbers of Victaulic Style 77 flexible couplings in header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops. (In accordance with Victaulic instructions and as approved by the Consultant.) Where expansion loops are required, use Victaulic Style 77 couplings on the loops.

7.3.4.8 Provide engineering sealed drawings in the shop drawing phase from grooved piping supplier for expansion calculations and details including anchors and envelope, structural and seismic details for anchors.

7.3.5 VALVES

7.3.5.1 Install valves with stems upright or angled 45° above horizontal unless approved otherwise.

7.3.5.2 Install control valves with their stems upright unless approved otherwise and with adequate clearance for removal of actuators.

7.3.5.3 Use ball valves (NPS 2 and under) to shut off branch takeoffs and to isolate equipment.

7.3.5.4 Butterfly valves may be used for isolation as an alternative on chilled water, condenser water, hot water heating, heat pump and glycol heat recovery systems.

7.3.5.5 Use plug type globe valves in control valve bypass connections.

7.3.5.6 Provide valves upstream of all meters, gauges, automatic air vents, etc. for isolation purposes.

7.3.5.7 Use swing or spring loaded check valves, in horizontal and vertical upflow pipes and on the discharge of pumps. Spring loaded water check valves shall be located 8 pipe diameters downstream of pumps or elbows.

7.3.5.8 Use silent check valves where specifically shown in vertical pipes with downward flow.

7.3.6 PRESSURE & LEAK TESTS

7.3.6.1 Notify the Consultant and the Inspection Authority Having Jurisdiction, a minimum of 48 hours in advance of intended test dates.

7.3.6.2 Before testing piping, isolate all equipment which cannot withstand the test pressure.

7.3.6.3 Do not insulate, backfill or conceal until tests have been completed and approved by the Inspection Authorities.

7.3.6.4 Examine all systems under test for leaks.

7.3.6.5 Joints shall remain dry during the test. Any moisture around a weld shall be reason for rejection.

7.3.6.6 Remake all leaking connections and joints.

7.3.6.7 Tests shall be limited to new piping only.

7.3.6.8 New connections to existing piping shall be warranted.

7.3.6.9 Initial Hydrostatic test: 150% of working pressure, but not less than 860 kPa [125 psig] for minimum 2 hours.

7.3.6.10 Final Hydrostatic test: 150% of working pressure, after piping connections to all equipment are complete, maintain until all parts of piping systems have been inspected.

7.3.7 WELDING TESTS

7.3.7.1 Replace welds of poor or doubtful quality at Contractor's expense.

7.3.7.2 In the event of weld rejection, the Owner has the right to insist on further testing at the Contractor's cost. Repairs will also be at the Contractor's cost.

7.3.7.3 Leave welds uncovered until inspected and approved by the Consultant or Boiler Inspection Branch.

7.3.8 PIPE FLUSHING AND CLEANING

7.3.8.1 Flushing and cleaning shall commence once all piping tests have been completed.

7.3.8.2 Install temporary bypass connections around all heat pumps, heat exchangers, etc. before commencing chemical cleaning.

7.3.8.3 Chemically clean the following piping systems as recommended by the Water Treatment Specialist:

7.3.8.3.1 New heat recovery system piping

7.3.8.4 Flush out all traces of chemicals with clean water after chemical cleaning is complete.

7.3.8.5 Remove, clean and reinstall all strainer baskets.

7.3.9 CHEMICAL TREATMENT

7.3.9.1 Ferrous piping systems must be chemically cleaned and flushed before water treatment is added. This includes partial or complete filling for pressure testing.

7.3.9.2 Notify Consultant minimum 48 hours prior to chemical cleaning so that work may be verified and inspected.

7.3.9.3 Provide drain connections to drain system in one hour.

7.3.9.4 All drains for chemical treatment shall be piped to the sanitary sewer.

7.3.9.5 After all components of the piping system have been pressure tested and proven to be in full operational condition and leak free, flush entire system with fresh, clean make-up water to remove loose mill scale, sediment and construction debris.

7.3.9.6 After initial flushing has been completed, clean all strainer screens.

7.3.9.7 System pumps may be used for cleaning, provided that pumps are dismantled and inspected, worn parts repaired with new gaskets and seals installed. Submit used seals.

7.3.9.8 Add cleaner to closed systems at concentration levels recommended by the Water Treatment Specialist.

7.3.9.9 For hot water heating systems, apply heat while circulating, raise temperature slowly to 70°C and maintain at 70°C for minimum of 12 hours. Remove heat and circulate at 40°C or less. After cleaning, drain system as rapidly as possible. Flush system by opening drain valves and opening bypass valve on water make-up to system. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Install corrosion coupons, refill system and immediately add water treatment to proper level.

7.3.9.10 For chilled water systems, circulate for 48 hours. After cleaning, drain system as rapidly as possible. Flush system by opening drain valves and opening bypass valve on water make-up to system. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Install corrosion coupons, refill system and immediately add water treatment to proper level.

7.3.9.11 Use neutralizing agents upon recommendation of the Water Treatment Specialist and as approved by Consultant.

7.3.9.12 Inspect, remove sludge and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

7.3.10 GLYCOL ANTIFREEZE SYSTEM

7.3.10.1 Label drain valves with “GLYCOL – DO NOT DRAIN”.

7.3.10.2 Pre-mix solution in mixing tank, demonstrate specific gravity of solution to Consultant at sample points and charge system(s) using feed pump. After system filled, check specific gravity of solution in each system. Leave mixing tank filled with specified glycol solution.

END OF SECTION

PART 8 STANDARD DUCTWORK

8.1 GENERAL

8.1.1.1 Ductwork is to be in accordance with requirements of the following Standards:

8.1.1.1.1 ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Coated (Galvannealed) by the Hot-Dip Process

8.1.1.1.2 ANSI/SMACNA HVAC Duct Construction Standards- Metal and Flexible

8.1.1.1.3 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilation Systems

8.1.1.1.4 CAN/ULC-S110, Standard Methods of Test for Air Ducts

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

8.2 PRODUCTS

8.2.1 GALVANIZED STEEL DUCTWORK

8.2.1.1 **General:** Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. Galvanizing for bare uncovered duct to be finish painted is to be G60. All other galvanizing is to be G90.

8.2.1.2 **Rectangular:** Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.

8.2.1.3 **Round:** Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings, and couplings. Use full throat spiral elbows. Short throat spiral elbows can be substituted if approved by the Consultant.

8.2.1.4 Provide ductwork and plenums fabricated from galvanized steel for the static pressure categories listed below.

8.2.1.4.1 1000 Pa [4" W.G.] static pressure.

- SMACNA Seal Class A
- All supply air ductwork downstream from supply air handling units discharge, to the upstream side of mixing boxes/air valves.
- All exhaust and return air ductwork downstream from return/exhaust air valves to the return/exhaust fans and downstream from the return/exhaust fans to the air handling units and/or outdoor relief.
- All outdoor intake plenums in mechanical room(s).

8.2.1.4.2 500 Pa [2" W.G.] static pressure

- SMACNA Seal Class A
- All supply ductwork downstream from mixing boxes/air valves to terminal air outlets.
- All supply ductwork and plenums on systems without mixing boxes/air valves.
- All return air ductwork and plenums, except where otherwise specified.
- All exhaust and relief air ductwork and plenums, except where otherwise specified.
- All outdoor air ductwork and plenums, except as otherwise specified.

8.2.2 METAL DUCT SYSTEM JOINT SEALANT

8.2.2.1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 maximum flame spread rating of 5 and smoke developed rating of 0.

8.2.3 ACOUSTIC LINING

8.2.3.1 Minimum 25 mm (1-in) thick acoustic lining material meeting NFPA 90A requirements and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on the inside (airside) face with a black fire-resistant coating.

8.2.3.2 Use minimum 25 mm (1-in) thick fiber-free, closed-cell thermal and acoustical duct liner meeting requirements and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102, in high humidity [natatorium] return or exhaust ductwork where indicated on the drawings.

8.2.3.3 Acceptable Manufacturers: Armacell, CertainTeed, Manson Insulation, Knauf, Johns Mansville.

8.3 EXECUTION

8.3.1 FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK

8.3.1.1 Provide all required standard galvanized steel ductwork, rectangular and/or round and/or flat oval as shown. Note that where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.

8.3.1.2 Duct Routing and Dimensions: Confirm the routing of all ductwork at the site and site measure ductwork prior to fabrication. Note that duct dimensions may be revised to suit site routing and building element requirements if dimension revisions are reviewed with and approved by the Consultant. Duct

routing and/or dimension revisions to suit conditions at the site are not grounds for a claim for an extra cost.

8.3.1.3 **Ductwork Located at Sprayed Fireproofing:** Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install the ductwork only after the fireproofing work is complete and do not compromise the fire rating of the sprayed fireproofing.

8.3.1.4 **Automatic Control Components:** Install (but do not connect) all duct system mounted automatic control components supplied as part of the automatic control work.

8.3.1.5 **Flanged Duct Joints:** Where flanged duct joints are used, do not locate the joints in wall or slab openings, or immediately at wall or slab openings.

8.3.1.6 **Leakage Testing:** Leakage testing is to be performed in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. Submit reports of successful testing to the Consultant. Leakage test rectangular supply and return ducts. Spiral duct and elbows with properly sealed joints can be excluded from leakage testing.

8.3.1.7 **Application of Sealants:** Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of the sealant.

8.3.1.8 **SMACNA Seal Class A:** All transverse joints and longitudinal seams and duct wall penetrations shall be sealed. Pressure sensitive tape shall not be used as primary sealant. Max. 2 to 5 percent total system leakage.

8.3.1.9 **Connection of Dissimilar Metal Ducts:** Where dissimilar metal ducts are to be connected, isolate the ducts by means of flexible duct connection material as specified in the Section entitled Duct System Dampers and Accessories.

8.3.1.10 **Seismic Requirements:** In addition to ANSI/SMACNA duct construction standards specified above, ductwork is to be constructed and installed to meet seismic requirements of the Building Code and ANSI/SMACNA The Seismic Restraint Manual: Guidelines for Mechanical Systems.

8.3.2 INSTALLATION OF ACOUSTIC LINING

8.3.2.1 Provide acoustic lining in ductwork in locations as follows:

8.3.2.1.1 wherever shown and/or specified on the drawings

8.3.2.1.2 supply ductwork downstream of air terminal boxes for 2.4 m (8-ft) measured along the duct and outward from the box in all directions

8.3.2.1.3 for all transfer air ducts

8.3.2.2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel as per the detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

8.3.3 DUCT SYSTEM PROTECTION, CLEANING AND START-UP

8.3.3.1 Temporarily cover all open ends of new ducts during transportation, storage, and construction.

8.3.3.2 Vacuum all dirt and foreign matter from new ductwork and clean the interior of air handling units prior to operating fans.

8.3.3.3 Prior to starting any supply air handling system provide 50 mm (2-in) thick glass fibre construction filters at fan equipment in place of permanent filters.

8.3.4 TESTING, ADJUSTING AND BALANCING

8.3.4.1 When work is complete and equipment is operating as intended, test, adjust and balance air flows and temperatures in accordance with requirements specified in the drawings.

END OF SECTION

PART 9 MECHANICAL INSULATION

9.1 GENERAL

9.1.1.1 This Section specifies thermal insulation requirements that are common to mechanical work Sections of the Specification. It is a supplement to each Section and is to be read accordingly.

9.1.2 SUBMITTALS

9.1.2.1 **Product Data Sheets & WHMIS Sheets:** Product data sheets must confirm that the product conforms to requirements of referenced Codes, Standards, and material properties.

9.1.3 QUALITY ASSURANCE

9.1.3.1 The company with the sub-contract for mechanical insulation work is to be a member in good standing of the Thermal Insulation Association of Canada.

9.1.3.2 Mechanical insulation requirements specified in this Section are based on the Thermal Insulation Association of Canada Best Practices Guide.

9.1.3.3 Mechanical insulation is to be applied by journeyman tradespersons in the Heat and Frost Insulation Trade. Registered apprentice tradespersons must be under direct, daily, on-site supervision of a journeyman.

9.1.4 DEFINITIONS

9.1.4.1 For the work of this Section:

9.1.4.1.1 **Concealed** means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.

9.1.4.1.2 **Exposed** means exposed to normal view during normal conditions and operations.

9.1.4.1.3 **WHMIS Sheets** means Workplace Hazardous Materials Information System sheets.

9.1.4.1.4 **Mineral Fibre** means a type of insulation manufactured from molten rock, slag, or glass in accordance with requirements of ASTM C547.

9.1.4.1.5 **Insulation System** means insulation material, fasteners, jacket, and any other accessory.

9.1.4.1.6 **TIAC** means Thermal Insulation Association of Canada.

9.1.5 HEAT TRACED PIPING

9.1.5.1 Piping subject to freezing is specified to be heat traced. Insulation shall cover heat tracing. Allow for oversized insulation as required for heat trace element thickness.

9.2 PRODUCTS

9.2.1 FIRE HAZARD RATINGS

9.2.1.1 Unless otherwise specified, all insulation system materials inside the building and above ground must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

9.2.2 THERMAL PERFORMANCE

9.2.2.1 Unless otherwise specified, thermal performance, i.e. conductivity, of insulation is to meet or exceed the values given in the National Energy Code of Canada for Buildings, and ASHRAE/IES Standard 90.1.

9.2.3 PIPE INSULATION MATERIALS

9.2.3.1 **Horizontal Pipe Insulation at Hangers & Supports:** Insulated pipe support inserts consisting of minimum 150 mm (6-in) long, pre-molded, rigid, sectional phenolic foam or fiberglass insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a 180° captive galvanized steel saddle. Acceptable products are:

- Belform Insulation Ltd. "Koolphen K-Block"
- Shur-Fit Products Ltd. “Pro-Pipe Supports”

9.2.3.2 Specialty Insulation for Piping: Factory fabricated foamed glass or closed cell foamed plastic insulation fittings specifically made for pipe mechanical joint fittings and couplings, and pipe risers at riser clamps. Acceptable manufacturers are:

- Shur-Fit Products Ltd.
- Armacell Canada Inc.
- Owens Corning “FOAMGLASS”

9.2.3.3 **Hot Piping Insulation (50 °C inside and 25 °C outside):** TIAC Standard 1501, Code A2, Preformed Mineral Fibre: Rigid, sectional, sleeve type insulation to ASTM Standard C 547, Standard Specification for Mineral Fibre Pipe Insulation, supplied in 915 mm (3’) lengths with a factory applied vapour barrier jacket and adhesive jacket closure to ASTM C1136, Standard Specification for Flexible,

Low Permeance Vapor Retarders for Thermal Insulation, with a maximum thermal conductivity of 0.033 W/mK @ 24 °C.

9.2.3.4 **Cold Piping (Operating below the ambient dew point and above 0 °C) TIAC Standard 1501, Code A6, Flexible Foam Elastomeric:** Closed cell, sleeve type, longitudinally split self-seal, foamed plastic pipe insulation in accordance with requirements of ASTM C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, maximum thermal conductivity of 0.039 W/mK @ 24 °C, minimum density of 96 kg/m³, and supplied with all required installation accessories.

9.2.4 DUCTWORK SYSTEM INSULATION MATERIALS

9.2.4.1 **TIAC Standard 1502, Code A2, Rigid Mineral Fibre Board:** Preformed board type insulation to ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation, with a factory applied reinforced aluminum foil and Kraft paper facing to ASTM C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation, a minimum thermal conductivity of 0.033 W @ 24 °C, and a minimum density of 48 kg/m³.

9.2.4.2 **TIAC Standard 1502, Code B2, Flexible Mineral Fibre:** Roll form insulation to ASTM C1290, Standard Specification for Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts, with a factory applied vapour barrier facing to ASTM C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation, a minimum thermal conductivity of 0.042 W @ 24 °C, and a minimum density of 12 kg/m³.

9.2.5 PIPE PROTECTION

9.2.5.1 Prior to insulating, all ferrous piping operating with fluids below the ambient dew point must be coated with either epoxy primer and epoxy painted or Polyguard Rg-2400 LT.

9.2.5.2 Factory painted equipment or piping does not require paint unless the type of paint is not approved for use in the specified area, or the factory coating is damaged, scuffed, or chipped.

9.2.5.3 The Contractor is responsible for ensuring that all insulated equipment and piping that has not received the treatment listed in section 9.2.55 is stripped of insulation, treated as listed in section 9.2.55, and re-insulated.

9.2.6 INSULATION FASTENINGS

9.2.6.1 **Aluminium Jacketing Stainless Steel Banding:** Equal to Childers Products Co. "FABSTRAPS" 0.6 mm (1/16-in) thick, minimum 12 mm (½-in) wide type 304 stainless steel strapping.

9.2.6.2 **Tape Sealant:** Equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match the surface being sealed.

9.2.6.3 **Adhesive - Mineral Fibre Insulation:** Clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20 °C to 82 °C (-4 °F to 180 °F), compatible with the type of material to be secured, and WHMIS classified as non-hazardous.

9.2.6.4 **Adhesive – Closed Cell Foamed Glass Insulation:** Equal to Pittsburgh Corning PC88 multi-purpose two-component adhesive.

9.2.6.5 **Lagging Adhesive:** White, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.

9.2.6.6 **Sheet Metal Screws:** No. 10 stainless steel sheet metal screws.

9.2.7 INSULATION VAPOUR BARRIER

9.2.7.1 All vapour barrier to have a permeance rating less than or equal to .02 Perm.

9.2.7.2 All Hot Piping Insulation shall be supplied with manufacturers vapour barrier.

9.2.7.3 All Styrofoam XPS Extruded Styrofoam insulation shall have a factory applied vapour barrier. Alternatively, the insulation may be covered with a field applied, Henry Blueskin SA, winter grade.

9.2.7.4 ITW Saran 520 tape to be used to seal piping vapour barrier.

9.2.7.5 All butt seams in Saran vapour barrier to be taped with 3” wide Saran 520 tape or Venture Clad Cryogenic Tape.

9.2.7.6 All valves, fittings, and other equipment to have vapour barrier of ITW Insulation Saran 560 or Venture Clad Cryogenic tape. Vapour barrier and tape must be applied per manufacturer’s specifications.

9.2.8 INSULATION JACKETS AND FINISHES

9.2.8.1 **PVC Jacketing to be Used on Interior Piping, Valves, and Equipment:** TIAC Code C1, PVC: Roll form sheet and fitting covers in accordance with ASTM D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds, minimum 15 mil thick, white, PVC, 25/50 rated, complete with installation and sealing accessories.

9.2.8.2 **Aluminum Jacketing Exterior Piping Insulation, Valves, and Equipment:** TIAC Code C2, Rigid Aluminum: Equal to Childers Metals "Lock-on" 0.020" thick stucco embossed aluminum jacket material to ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate, factory cut to size and complete with PolyFilm Moisture Barrier (PFMB) and continuous modified Pittsburgh Z-Lock, and "Fabstraps" and butt straps to cover end to end joints. Fittings are to be 2-piece epoxy coated pressed aluminum with weather locking edges.

9.2.8.3 All insulation exposed to the outdoors, inside the mechanical room, and outside shall be jacketed with 16 mil, stucco embossed, anodized aluminum.

9.2.9 REMOVABLE/REUSABLE INSULATION COVERS

9.2.9.1 **Valve, Etc. Covers:** Custom manufactured covers conforming to the shape of the item to be insulated, designed to be easily removable and replaceable to suit the use and maintenance procedures of the particular item, and to provide adequate personnel protection.

9.3 EXECUTION

9.3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

9.3.1.1 Unless otherwise specified, do not insulate the following:

- Factory insulated equipment and piping
- Domestic water and heating system expansion tanks

9.3.1.2 Do not apply insulation unless piping leakage tests have been satisfactorily completed.

9.3.1.3 Ensure that all surfaces to be insulated are clean and dry.

9.3.1.4 Ensure that the ambient temperature is minimum 13 °C (55 °F) for at least one day prior to the application of insulation, and for the duration of insulation work, and that relative humidity is and will be at a level such that mildew will not form on insulation materials.

9.3.1.5 All insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from the site and replaced. Any costs incurred due to storing, removing, and/or replacing insulation materials are the responsibility of the Contractor.

9.3.1.6 Install hot piping insulation directly over pipes and not over hangers and supports.

9.3.1.7 Install high density jacketing insulation inserts at hangers and supports.

9.3.1.8 Install piping insulation and jacket continuous through pipe openings and sleeves.

9.3.1.9 All insulation shall be installed with appropriate vapor barriers with a permeance rating less than or equal to 0.02 Perms. Mineral insulation may be installed with factory applied vapour-retardant jacket.

9.3.1.10 All joints shall be taped to prevent a break in the vapour barrier.

9.3.1.11 Caulk all joints and fittings in jacketing with a colour matching sealant.

9.3.1.12 Ensure water shedding on all installed jacketing.

9.3.1.13 Stainless banding must be installed wherever aluminum jacketing or cold piping insulation (< 0°C) is used. Banding must be provided at all circumferential edges and not more than 12" between centers.

9.3.1.14 All damage and dents shall be removed.

9.3.1.15 Exterior surfaces shall be cleaned of any dirt, oil, or other contaminants.

9.3.1.16 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect the insulation jacketing from the action of condensation at its junction with the metal.

9.3.1.17 When insulating vertical piping risers 75 mm (3-in) diameter and larger, use insulation support rings welded directly above the lowest pipe fitting, and thereafter at 4.5 m (15-ft) centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.

9.3.1.18 Where insulation is terminated at valves, equipment, unions, etc., neatly cover the exposed end of the insulation with a purpose made PVC or aluminum cover.

9.3.1.19 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.

9.3.1.20 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in the insulation and provide a suitable grommet in the opening.

9.3.1.21 Insulate, vapour seal, and finish all seismic restraints, braces, anchors, hanger rods, and similar hardware directly connected to "cold" piping and/or

equipment, for a distance of 300mm (12") clear of the adjacent pipe or equipment finish, to match the piping and/or equipment insulation.

9.3.1.22 Where existing insulation work is damaged because of new mechanical work, repair the damaged insulation work to new work standards.

9.3.1.23 Fire stop penetrations shall be insulated with Closed Cell Foamed Glass insulation. Closed Cell Foamed Glass segments must match adjacent insulation (diameter and joint type).

9.3.1.24 Combustible pipes penetrating fire rated partitions must use intumescent fire stop collars, Hilti Firestop Collar, or approved equal installed in accordance with the manufacturer's instructions.

9.3.2 COLD PIPING INSULATION USING XPS EXTRUDED STYROFOAM

9.3.2.1 All shut-off valves and elbows to be factory fabricated.

9.3.2.2 All elbow joints to be tongue and groove.

9.3.2.3 All Styrofoam PIB pipe insulation 2" and less thickness shall have longitudinal joint of the tongue and groove or ship-lap style joint.

9.3.2.4 All Styrofoam PIB insulation over 2" thick shall be double layer.

9.3.2.5 All piping and vessel sidewall insulation to be supplied in 36" long segments.

9.3.2.6 All insulation 20" finished diameter and smaller to be taped with filament tape every 9".

9.3.2.7 All insulation over 20" finished diameter to be secured with ½" stainless steel banding every 9". Prior to application of vapor barrier, sharp edges must be flattened to prevent damage to vapor barrier.

9.3.2.8 Apply a non-setting, low temperature joint sealant on all longitudinal and butt joints. On double and triple layer applications, apply joint sealant on second and third layers only.

9.3.2.9 Provide vapor stops on valves, end caps and termination points.

9.3.3 INSULATION FOR PIPE MECHANICAL JOINT FITTINGS & COUPLINGS, ETC.

9.3.3.1 Provide manufactured insulation fittings, the same thickness as the adjoining pipe insulation, for mechanical joint fittings and couplings, and for piping at riser clamps through the floor. Cover with purpose made PVC or aluminium covers or jacketing sealed with tape.

9.3.4 INSULATION FOR HORIZONTAL PIPE AT HANGERS AND SUPPORTS

9.3.4.1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply the insulation sections to the piping installers for installation as the pipe is erected.

9.3.4.2 For 100 mm (4") diameter and larger heating system piping where roller type hangers and supports are provided, a steel saddle will be tack welded to the pipe at each roller hanger or support location. Pack saddle voids with loose mineral fibre insulation.

9.3.5 PIPE INSULATION REQUIREMENTS

9.3.5.1 INSIDE BUILDING & ABOVE GROUND (Hot Applications)

9.3.5.1.1 Insulate pipe inside the building and above ground, as scheduled below, in accordance with TIAC Quality Standard 1501, Piping, as follows:

- **Material:** Type A3 mineral fibre, factor applied vapour barrier and PVC cladding.
- **Insulation application:** 1501-H for hot piping.
- **Insulation finish:** CPF/4 PVC jacket for exposed piping
- TIAC Standard 1501 Code A6 foamed elastomeric insulation may be used in lieu of Type A2, with 1501-CA application and specified finish.

9.3.5.1.2 Insulation thickness in accordance with the following table:

PIPE SERVICE	DIAMETER	INSULATION THICKNESS
HEAT RECOVERY SUPPLY & RETURN	TO 50 MM	25 MM
	LARGER THAN 50 MM	40 MM

9.3.5.2 INSIDE BUILDING & ABOVE GROUND (Cold Applications)

9.3.5.2.1 Insulate pipe inside the building and above ground, as scheduled below, in accordance with TIAC Quality Standard 1501, Piping, as follows:

- **Material:** Flexible Foam Elastomeric, with vapour barrier, and PVC jacketing
- **Insulation application:** 1501-C for cold piping
- **Insulation finish:** CPF/4 PVC jacket for exposed piping.

9.3.5.2.2 Insulation thickness in accordance with the following table:

PIPE SERVICE	DIAMETER	INSULATION THICKNESS
CHILLED GLYCOL SOLUTION SUPPLY & RETURN	TO 100 MM	25 MM
	LARGER THAN 100 MM	40 MM

9.3.5.3 OUTSIDE BUILDING & ABOVE GROUND

9.3.5.3.1 Insulate pipe outside the building and above ground, as scheduled below, in accordance with TIAC Quality Standard 1501, Piping, as follows:

- **Material:** Type A2 mineral fibre, factor applied vapour barrier and aluminum cladding.
- **Insulation application:** 1501-H for hot piping, 1501-C for cold piping
- **Insulation finish:** CPF/3

9.3.5.3.2 Insulation thickness in accordance with the following table:

PIPE SERVICE	DIAMETER	INSULATION THICKNESS
HEAT RECOVERY, SUPPLY & RETURN	TO 50 MM	50 MM
	LARGER THAN 50 MM	50 MM
CHILLED GLYCOL SOLUTION, SUPPLY & RETURN	TO 50 MM	25 MM
	LARGER THAN 50 MM	40 MM

9.3.6 APPLICATION OF INSULATING AND PROTECTIVE COATINGS

9.3.6.1 Apply insulating and protective coatings in accordance with the manufacturer's instructions. Remove any splatter from adjacent surfaces. Apply insulating/protective coating to the following surfaces:

9.3.6.1.1 Paint all bare metal surfaces clear of "cold" piping and/or equipment insulation for between 300 mm (12") and 600 mm (24") clear of the pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating.

9.3.6.1.2 Paint all bare metal surfaces associated with mechanical systems with an operating temperature above 60 °C (140 °F) with "ThermaLite" insulating coating.

9.3.6.1.3 Paint all seismic restraint hardware such as hanger rods, braces, anchors, etc., as specified on the first two points above.

9.3.7 DUCTWORK SYSTEM INSULATION REQUIREMENTS

9.3.7.1 Insulate duct systems as scheduled below, in accordance with TIAC Quality Standard 1502, Ductwork and Plenums, as follows:

9.3.7.2 Material:

- Type A2 rigid mineral fibre for exposed rectangular ducts, and all plenums
- Type B2 flexible mineral fibre for concealed rectangular ducts, and concealed and exposed round or oval ducts

9.3.7.3 Insulation Application:

- CER/1 for heating and ventilating system rigid insulation
- CER/2 for heating and air conditioning system rigid insulation
- CEF/1 for heating and ventilation system flexible insulation
- CEF/2 for heating and air conditioning system flexible insulation

9.3.7.4 Insulation Finish:

- CRF/1 for exposed rectangular duct systems
- CRD//1 for exposed round/oval duct systems

DUCT SYSTEM SERVICE	INSULATION THICKNESS	
	RIGID INSULATION	FLEXIBLE INSULATION
EXTERIOR DUCTWORK	-	50MM

9.3.7.5 Provide commercial quality corner bead only on exposed rigid duct, plenum and casing insulation in all equipment rooms, corridors, and similar areas where the insulation is subject to damage.

9.3.8 OUTDOOR DUCTWORK

9.3.8.1 Exposed ductwork shall be recovered all around with insulation aluminum jacketing. Exterior application shall be a vapour sealed installation. Over the insulation, apply aluminum jacketing system. The moisture barrier shall be continuous across the full width of the jacketing. The longitudinal seams shall be located to shed water. Attach with holding strap at 150 mm [6"] on centres. Provide a complete aluminum jacket system using all of the parts, accessories and installation procedures of the manufacturer. Seal all outdoor jacketing watertight.

9.3.9 COMMON DUCT SYSTEM INSULATION APPLICATION REQUIREMENTS

9.3.9.1 At duct connection flanges insulate the flanges with neatly cut strips of the rigid insulation material secured with adhesive to side surfaces of the flange with a top strip to cover the exposed edges of the side strips, then butt the flat surface duct insulation up tight to the flange insulation, or alternatively, increase the insulation thickness to the depth of the flange and cover the top of the flanges with tape sealant.

9.3.9.2 The installation of fastener pins and washers is to be concurrent with the duct insulation application.

9.3.9.3 Cut insulation fastener pins almost flush to the washer and cover with neatly cut pieces of tape sealant.

9.3.9.4 Accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers.

9.3.9.5 Prior to concealment of insulation by either construction finishes or jacket material, patch all vapour barrier damage by means of tape sealant.

9.3.9.6 At trapeze hanger locations for rectangular duct install insulation between the duct and the hanger.

9.3.9.7 At each duct hanger for round and provide a 100 mm (4") wide full-length piece of rigid mineral fibre board insulation between the duct and the hanger.

END OF SECTION

PART 10 CONTROLS & AUTOMATION

10.1 GENERAL

10.1.1 QUALITY ASSURANCE

10.1.1.1 Control system must be thoroughly tested for functionality following the integration of all new equipment to ensure proper operation in all scenarios.

10.1.1.2 Proof of proper operation is to be provided to the Owner and to the Consultant.

10.1.1.3 Contractor is responsible for providing the Consultant with control system remote access for the first year of operation.

10.1.2 SUBMITTALS

10.1.2.1 Submit complete controls system shop drawings in accordance with Section 1.2 – Shop Drawings.

10.1.2.2 Provide data for all control valve sizing including pressure drops with control valve shop drawing submission.

10.1.2.3 Include complete operating data, component setpoints, system drawings, wiring diagrams, installed program flow charts and program listing, written detailed sequences of operation and engineering data on each control system component. Include sizing as requested. Components are to be labelled and identified as to use. Submit to Mechanical Contractor for inclusion in Operating and Maintenance Manuals.

10.2 PRODUCTS

10.2.1 CONTROLS SYSTEM

10.2.1.1 New controls upgrades shall be an extension of the existing Delta Controls Building Management System (BMS).

10.2.1.2 Contractor shall modify and integrate with the existing controls system unless noted otherwise.

10.2.1.3 The Contractor must deliver a copy of the program, graphics, and remote access information to the Owner.

10.2.2 ELECTRICAL COMPONENTS, WIRING AND CONDUIT

10.2.2.1 Wiring and Conduit:

10.2.2.1.1 By Electrical Trade:

- All power supply wiring to mechanical equipment.
- All power supply wiring and conduit to main control panels.

10.2.2.1.2 By Mechanical Trade:

- All control system low voltage wiring.
- Conduits for control wiring and components associated with the mechanical work. All low and line voltage control wiring shall be in EMT conduit in accordance with Electrical specifications.
- All low and line voltage control wiring and conduit for specified motor interlocks.
- Power wiring from electrical panel to control transformers distributed round the building.

10.2.2.2 Components:

10.2.2.2.1 By Electrical Trade:

- All disconnect switches except as specified in Mechanical Equipment Schedules.
- All motor protection switches, magnetic starters and contactors.
- All line voltage relays to power and control mechanical equipment.

10.2.2.2.2 By Mechanical Trade:

- All temperature control systems components and packaged equipment controls, relays and transformers.
- All disconnect switches, relays, transformers as specified in Mechanical Equipment Schedules.
- All thermostats, dampers, damper motors, timer clocks and control panels.
- All low voltage transformers to power mechanical equipment controls.
- All power wiring (120 V/1 Ph) to controls transformers, control panels and control devices requiring 120 V/1 Ph power wiring (infrared flush meters etc.).

10.2.2.3 Minimum Wiring Requirements:

10.2.2.3.1 All exposed wiring and wiring located above removable, acoustic ceiling tiles shall be run in plenum rated, 18 gauge, two wire, twisted, shielded pair. Two wire twisted pair shall be acceptable for sensor wiring or output; coaxial cable shall be acceptable for transmission wiring. Plenum rated wiring not in EMT conduit shall be run neatly bunched in J-hooks in a rectilinear fashion, running parallel to building. Cable lines must be run at least 12" (300 mm) above ceiling. Where controls cables and wiring is run through, or in "exposed ceilings" such as corridors, all wiring and cables shall be run in conduit. Where permission has been gained to run in a cable tray, only then can conduit be deleted, except for branches from the cable and individual run-outs.

10.2.2.3.2 Alternating current wiring over 24 V, both line and low voltage, shall not be run in the same conduit or cable with direct current signals. Direct current signals include communications wiring, analog input wiring, digital input wiring and analog output wiring. 24 V AC and 0-10 V DC may be run together.

10.2.2.3.3 Line voltage power or switched power wiring - #12 gauge copper wire minimum.

10.2.2.3.4 Line voltage control wiring - #14 gauge copper wire, length not to exceed 50 meters; #12 gauge copper wire, lengths exceeding 50 meters.

10.2.2.3.5 Low voltage – wire as directed by applicable electrical codes and requirements but minimum #20 gauge.

10.2.2.3.6 Under no circumstances shall the Mechanical Controls Trade run controls cabling or wiring in the Electrical cable tray system without prior written permission from the Electrical Consultant and the Electrical Contractor. Unless otherwise agreed or directed, all control cabling and wiring shall be run independently in conduits and/or separate raceways to be provided by the Controls Trade for their own use.

10.2.3 FIELD CONTROL DEVICES

10.2.3.1 General:

10.2.3.1.1 Occupancy sensors, temperature transmitters (sensors), CO2 detectors must be verified, an initial calibration should not be required if factory calibrated. Refer to manufactures recommendation as a minimum. If the device is not within specification, it should be noted on the commissioning documents and corrected. If a reoccurrence or drift error occurs within the warranty period, it shall be replaced.

10.2.3.1.2 All Sensors Gauges and Transmitters shall be installed to be operated within 75% of their capacity.

10.2.3.2 Temperature Sensors:

10.2.3.2.1 Shall be resistance type and shall be either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD or 10K thermister type. Sensor shall have service tool communicating jack for interface with laptop computer service tool for adjustment and troubleshooting.

10.2.3.2.2 Shall be available for room, duct, outside or well mounting with proper ranges to suit application.

10.2.3.2.3 Shall give an end-to-end accuracy of not less than ±0.45°F [±0.25°C].

10.2.3.2.4 Duct sensors shall be in insertion type complete with locking nut and mounting plate. Mounting box shall be weatherproof for all outdoor applications. Where duct dimension is greater than 48" [1,200 mm] averaging sensors complete with capillary support shall be used.

10.2.3.2.5 Immersion wells shall be of stainless steel materials for domestic water systems and brass for other applications. Heat transfer compound will be used and shall be compatible with sensor. Sensor to be spring loaded construction with compression fitting for 3/4"[20 mm] stainless steel sheathed construction.

10.2.3.3 Humidity Sensors:

10.2.3.3.1 Shall be equipped with non-interactive span and zero adjustment complete with 2-wire isolated loop powered 4-20 mA 0-100% linear proportional output. Sensing probe shall be constructed of Type 304 stainless steel.

10.2.3.3.2 Have a control range of 20% to 80%.

10.2.3.3.3 Have an accuracy of plus or minus 3% RH over an ambient temperature range of 70°F [21°C] to 80.6°F [27°C].

10.2.3.3.4 All wall mounted humidity sensors are to be sealed so that cavity air temperature does not affect the sensor readings.

10.2.3.4 CO_2 Detectors:

10.2.3.4.1 Duct Mounted:

- Without display screen.
- 0 - 2000 ppm range, 8 bit accuracy, +/- 2%
- Non-dispersive infrared detector, 0° C to 40° C and 0 to 95% relative humidity operating range
- +/- 2% drift, +/- 20 ppm repeatability.
- ISO 9002 certified.
- 0 - 10 VDC or 4 - 20mA output, jumper selectable
- Basis of Design: Greystone CD2DT

10.2.3.5 Motor Current Sensors:

10.2.3.5.1 Provide current sensors for all motor-driven equipment as indicated on the drawings.

10.2.3.5.2 Shall have linear output proportional to the motor current draw.

10.2.3.5.3 Sensor shall connect to the controller by means of a 2-wire cable.

10.2.3.5.4 Sensor shall have dual HI/LO range selector.

10.2.3.5.5 Sensor shall have an accuracy of 1% of full scale, maximum response time of 100 milliseconds and a loading error not greater than .25% with a 1 megaohm load.

10.2.3.6 Differential Pressure Sensors:

10.2.3.6.1 All differential pressure sensors/transmitters are to be installed as indicated on the drawings in an accessible location to allow for easy maintenance and calibration. Transmitters to be mounted 90 degrees to the top of pipe to prevent scale and other debris from being deposited in the system.

10.2.3.6.2 Shall vary the output voltage with changes in differential pressure.

10.2.3.6.3 Shall connect to the controller by means of a 2-wire cable.

10.2.3.6.4 Shall have an end-to-end accuracy of not less than ±1% of span including non-linearity and hysteresis.

10.2.3.6.5 Will be located 2/3 down the run of the controlled equipment i.e. duct or piping system.

10.2.3.7 Low Limit Temperature Switches (Freeze Protection)

10.2.3.7.1 Provide high/low temperature switches where indicated on the drawings.

10.2.3.7.2 Temperature sensing element shall be liquid, vapour or bimetallic type.

10.2.3.7.3 Adjustable setpoint and differential.

10.2.3.7.4 Snap action type rated at 120 volts, or 24 V DC as required.

10.2.3.7.5 Sensors shall operate automatically and reset automatically. Sensors used for freeze detection or fire detection shall be manually reset type.

10.2.3.7.6 Temperature accuracy shall be +/-1°C.

10.2.4 CONTROL VALVES

10.2.4.1 Provide valves in accordance with general valve specification with maximum 3 psi [20.7 kPa] pressure drop, or maximum 5 psi [34.5 kPa] pressure drop for 6-way hydronic control valves only.

10.2.4.2 Valves shall “fail-safe”, spring return to normal position. 2-way and 3-way valves for liquids shall have either equal percentage or linear characteristics. Size 2-way valve operators to close against maximum pump shutoff head. Control valve coefficient shall be determined with the valve in the 100% open position. Control valves using a limited stroke to create the required flow coefficient shall not be acceptable.

10.2.4.3 All control valves shall be threaded type. All valve bodies shall have a replaceable packing gland.

10.2.4.4 Control valves shall be globe type with modulating electronic actuator. Actuators for valves on larger coils in air handlers shall have spring return to normal position. 2-way and 3-way valves for liquids shall have equal percentage characteristic. Maximum shut off head leakage shall not exceed 1% of full design flow.

10.2.4.5 Refer to Control Valve Schedule on the drawings.

10.2.5 VARIABLE FREQUENCY DRIVES (VFD)

10.2.5.1 Controls Contractor to provide all VFDs not supplied with equipment. Confirm preferred VFD make and mode with the Owner to ensure facility wide compatibility.

10.2.5.2 Acceptable VFD manufacturers include Danfoss, and ABB. Substitutions are to be approved by the Consultant and must be equivalent with respect to options, functionality, quality, and control system integration.

10.2.5.3 VFD filters to limit the total harmonic distortion from the VFD to 5%.

10.2.5.4 Passive harmonic filters shall consist of an inductive-capacitive network in parallel with the load.

10.2.5.5 Passive harmonic filters shall be complete with capacitor disconnects that shall automatically disengage the capacitors if the motor is not running or lightly loaded (less than 30% loading).

10.3 EXECUTION

10.3.1 CONTROL SYSTEM

10.3.1.1 It is the responsibility of the Contractor to integrate all new equipment, VFDs, sensors, and electronic valves.

10.3.2 GRAPHICS PACKAGE

10.3.2.1 The Contractor must update all existing graphics to accommodate the new equipment which has been installed.

10.3.2.2 The Contractor shall make changes to the operating code and graphics package, per the direction of the Owner's Representative and the Consultant, for 6 months after the agreed upon start-up date at no charge to the Owner or the Consultant.

10.3.2.3 The graphics package and code required to operate the controls must be provided on a USB drive to the Owner at the end of the project.

10.3.3 INSTALLATION

10.3.3.1 All sensors, wiring, and mounting locations shall be installed per the controls section of the detailed design drawings.

10.3.3.2 Low limit and freeze protection thermostats shall be hardwired to the fan motor starter. The vapour tension element shall be installed in a serpentine pattern across the complete coil face. For larger coil areas use two thermostats wired in series.

10.3.3.3 As-built controls drawings, both in hardcopy size Arch D format and as a PDF, must be provided to the Owner upon completion of the project.

10.3.3.4 Contractor is responsible for furnishing and installation of all electrical components required to integrate the new system and associated hardware with onsite electrical and control equipment.

10.3.4 WIRING

10.3.4.1 All wires must be neat and orderly.

10.3.4.2 All exposed wires are to be routed in conduit.

10.3.4.3 All outdoor wiring and sensors are to be installed in the appropriate NEMA enclosures, conduit, and terminal boxes.

10.3.5 LOW LIMIT TEMPERATURE SWITCHES (FREEZE PROTECTION)

10.3.6 All supply air systems containing coils shall have a non-recycling, manual reset, electric line voltage freeze protection controller (also referred to as low temperature controller) that will stop the system upon sensing 40ºF [4ºC].

10.3.7 The freeze protection controllers shall contain an additional set of dry contacts that will close on freeze detection for remote alarm indication at the Operator Work Station.

10.3.8 The freeze protection contacts shall be connected on the common line after the H.O.A. selector switch.

10.3.9 VFDS

10.3.9.1 All VFD shall be controlled by a digital start command and a 0 to 10V or 4-20mA signal from the main controls system.

10.3.9.2 All VFD will be installed with BACnet and connected to the existing control system to monitor the output speed, operation frequency, amperage, and start command.

10.3.9.3 DV/DT filters are to be used any time a VFD is over 50ft away from the load it is controlling.

10.3.9.4 Install VFD in a clean and dry location per the manufacturer's specifications.

10.3.9.5 VFDs that can be subjected to splashes or leaks from nearby mechanical equipment must be provided with a suitable NEMA enclosure.

10.3.9.6 Integrate VFD with the main controls system.

10.3.9.7 Install VFD with load reactors if the wire between the VFD and the load is longer than 50 feet.

10.3.10 POST INSTALLATION

10.3.10.1 After the system has been started, all controls must be adjusted to accommodate observed operating conditions.

10.3.10.2 The Contractor must provide a training course detailing the operation, data logging, and recommended maintenance of the controls system. Course time and length are to be appropriate for the complexity of system operation.

10.3.11 TRAINING AND MANUAL

10.3.11.1 After the system has been installed and started, the Contractor shall work with the Consultant to provide a training manual and put on a training session regarding the new equipment controls. This training session shall cover the following:

- Operating methodology
- Graphic interface
- Expected operating conditions
- System trouble shooting
- Control inputs
- Physical location of systems
- System safeties

10.3.12 PROGRAMMING

10.3.12.1 All control strategies found in the associated drawing package are meant to be used as a guideline for the expected operation of the new equipment. These strategies can be used, however, The consultant recommends modifying these strategies based on site conditions and commissioning data to ensure optimal performance, as the contractor sees fit. The contractor will be responsible for all final control strategies. All final control strategies are to be approved by The consultant.

10.3.12.2 All final control strategies are to be approved by the Consultant.

10.3.12.3 Contractor to provide final control strategies and sequence of operations to Owner following commissioning of DDC system.

END OF SECTION