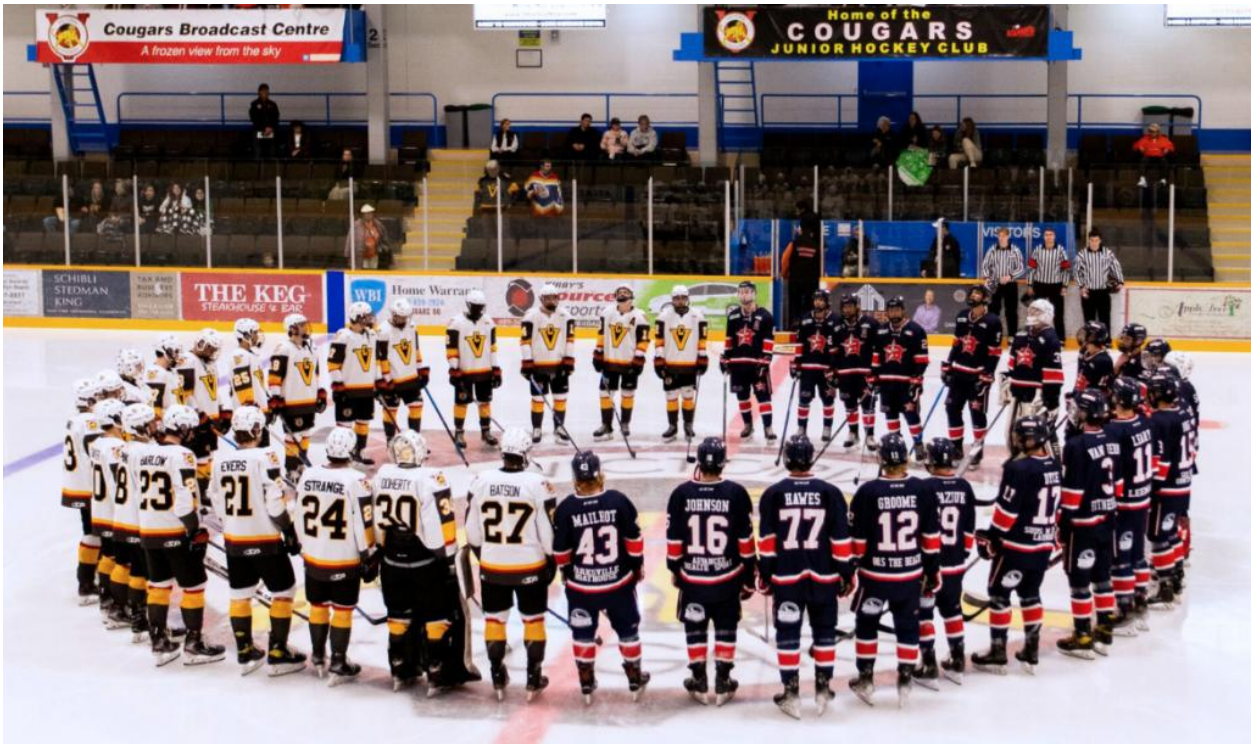
Archie Browning Sports Centre

Refrigerated Floor Replacement



POLAR ENGINEERING

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EGBC Permit to Practice
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Revision Log

VERSION	DATE	AFFECTED SECTIONS	CHANGE REQUEST	COMMENTS	CHANGE AUTHOR
R1	2025-11-28	-	-	ISSUED FOR TENDER	TP
R2	2025-12-03	2-PROJECT COSTING	-	RE-ISSUED FOR TENDER	TP

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Project Overview

1 Project Introduction

The Archie Browning Sports Centre is a single-sheet ice arena located at 1151 Esquimalt Road in Victoria, British Columbia. The facility also features a six-sheet curling rink, lounge areas, and offices. The Archie Browning Ice Arena operates year-round, serving as an ice arena in the winter and hosting dry-floor events during the summer. The existing refrigerated floor of the arena is currently at end of life, and as a result, it will be replaced as part of this project.

The successful contractor will be responsible for the demolition of the existing refrigerated slab, cooling piping, electrical underfloor heating system, and dasher boards. In addition, the contractor will be responsible for demolition of the existing snow melt system and arena cold brine pump.

The existing refrigerated slab will be replaced with a new concrete cooling floor of equal size. The concrete slab will contain 1" HDPE cooling piping at 4" O.C. and buried 8" HDPE centre headers/mains, transitioning to the existing steel piping at the entrance to the ammonia mechanical room. Additionally, a new cold brine pump will be installed in place of the existing pump. A new underfloor heating system will also be installed, utilizing 1" HDPE heating pipes at 12" O.C. and 4" HDPE buried center headers/mains.

A new ammonia condenser will be installed on the rooftop of the facility, nearby to the facility's existing evaporative condenser. This heat exchanger will provide heat to the new hydronic underfloor heating system, as well as a new snow melt coil that is to be provided by the contractor and installed within the facility's existing snow melt pit.

The successful contractor will be responsible for the supply and installation of a new dasher board system, per the dasher board design specification. Prior to purchasing these dasher boards, the contractor will be responsible completing a detailed site survey to confirm all relevant site measurements to ensure the successful installation of this new equipment.

Lastly, the contractor will be responsible for completing upgrades to the existing arena dehumidifier supply and return ductwork to reduce noise and improve occupant comfort.

2 Project Costing

Please see Township of Esquimalt tendering documentation for detailed project costing requirements.

As part of the bidding process, contractors are to provide breakout pricing for the following items:

1. Demolition and replacement of the existing snow melt system (See Mech. Drawings – Sheets M1, M3, M5)
2. Arena Dehumidifier Ducting Upgrades – Metal (See Mech. Drawings – Sheet M10)
3. Arena Dehumidifier Ducting Upgrades – Fabric (See Mech. Drawings – Sheet M10.1)
4. Dasher Board System – Impact Absorbing Safety Sill (See Section 12.4)
5. Dasher Board System – Spectator-Side Paneling (See Section 12.4)
6. Dasher Board System – Rubber Flooring in Boxes (See Section 12.4)
7. Dasher Board System – Access gates at End of Players Boxes (See Section 12.4)
8. Dasher Board System – Drainage Scupper (See Section 12.4)

3 Design Methodology

Polar Engineering works with industry leaders across the world to ensure that our clients receive state-of-the-art engineering solutions. We pride ourselves on working with our clients through in-depth interviews to balance initial costs, operating costs, and energy reductions. This design methodology has allowed our team of engineers to win awards from ASHRAE, RFABC, and the University of Victoria.

4 Contractor Experience

The refrigerated floor contractor must provide sufficient proof to the Consultants that all the conditions below can be met, prior to issuing a contract for the work.

1. Concrete slab work shall be performed by an established concrete floor finishing contractor with a proven track record of satisfactory, consistent-quality workmanship for a minimum period of five years related to refrigerated floor slab and other stringent floor tolerance concrete slabs.

2. Work shall be performed by a company regularly engaged in the installation of refrigerated concrete floors and the application of concrete materials. Provide proof to the Consultants that the contractor has successfully completed at least five projects of similar size and complexity in the past five years.

   As part of the bidding package, the Contractor is to supply a list of relevant past projects complete with the following information:

   - Project description
   - Project value
   - Name, email address, and phone number of a reference contact.

3. All bidding refrigeration contractors must demonstrate proven experience with ice arena ammonia refrigeration systems, including the installation, commissioning, and servicing of similar facilities. Contractors shall also hold valid and current certification for all HDPE fusion welding methods required for the construction of the refrigerated floor. Documentation of relevant experience and current certifications must be provided with the bid submission.

5 Project Schedule

Please see Township of Esquimalt tendering documentation for detailed project schedule requirements.

Specifications

1 CONTRACTOR DELIVERABLES

1.1 DEFINITIONS

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. 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.
2. Allow enough time for submittal review, including resubmittals. Time for review shall commence on receipt of submittal by 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.
    - Initial Review: Allow 10 working days for initial review of each submittal. Additional time may be required for coordination with subsequent submittals or Subconsultants.
    - Resubmittal Review: Allow 5 working days for review of each resubmittal.
3. Shop drawings shall include equipment performance data, piping, power, and control wiring schematics, included accessories, rated capacities, weights, and all other relevant data.
4. The Contractor must obtain shop drawings approved by the Consultant prior to ordering equipment.

5. All pressure vessels must be certified and registered with the appropriate governing body.
6. 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.
7. Submittals shall include the following information where applicable:
    - Manufacturer
    - Surface area and heat transfer arena
    - Refrigerant inlet/outlet temperatures
    - Fluid inlet/outlet temperatures
    - Operating pressures
    - Pressure drops
    - Manufacturing material
    - Pressure ratings
    - CRN numbers
    - Voltage and phase
    - RPM
    - Seals and gaskets
    - Construction materials

1.3 STARTUP / COMMISSIONING / BALANCING REPORTS

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 engineer for review of all air and water systems.
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:
    - Pumps (pressure, speed, rpm, flow)
    - Heat Exchangers (pressure and temperature at all ports)
    - Balancing Valves (pressures, conditions)
    - Air Fans (pressure, speed, rpm, flow)
    - Boilers (hydronic pressures and temperatures, stack pressure, stack O2, safety operation checklist)

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:
    - Inspection Date
    - Inspection or test personnel.
    - Description of testing procedure
    - VFD speed and current of all pumps
    - Pump pressure differentials
    - VFD speed and current of all fans
    - Heat exchanger supply and return temperatures
    - Heat Pump compressor speed and current
    - Supply and return temperatures of all heat pump heat exchangers, including evaporators, condensers, and sub-coolers
    - Heat pump suction gas temperature
    - EEV valve average position
    - Ammonia high cut out testing
    - Ammonia liquid level normal operating percentages
    - Control system testing and verification
    - All other relevant information that may impact the performance of the system.
4. Furthermore, the following operating conditions shall be simulated, and the operation of the controls system checked to ensure a fully functional system.
    - Operation of ammonia solenoids and energy recovery heat exchanger
    - Heat pump energy recovery system starting and operating at desired setpoint.
    - Unless otherwise noted, heat pump compressors shall be operated across entire capacity range to ensure proper oil return.
    - 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.
    - Condenser floating head pressure control algorithm
    - If applicable, industrial compressors to be unloaded and tested in each capacity control range.

- All other operating conditions required to confirm the intended operation and performance of the system.
- Please refer to control strategies contained within the attached drawing package for more information.

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:
    - Speed and pressure differential of all pumps
    - Speed and amperages of the compressor motors operating in the conditions outlined above
    - Temperatures on the inlet and outlet of heat pump supply and return lines, including evaporator, condenser, and subcooler lines.
    - Temperature and pressure at the inlet and outlet of the ammonia energy recovery heat exchanger.
    - All other relevant information required to evaluate the performance of the system.
6. Final balancing and commissioning reports to be included in the O&M manual.

1.4 AS-BUILT OR RECORD DRAWINGS

1. One printed copy of the latest tender or construction drawings shall be kept onsite during construction to allow for red-line markup of detail changes.
2. Contractor must deliver in hardcopy (size Arch D) and PDF a digitally created *As-Built drawing* set to the Owner at project closeout, pending Consultant review and approval.
3. Alternatively, the Contractor may deliver a red-line markup version of construction documents for the Engineer (Polar) to create *Record Drawings* from.
4. Polar charges $500 per drawing set for this work.

1.5 OPERATION & MAINTENANCE MANUALS

1. Prior to application for Substantial Completion, submit all required items and documentation specified, including the following:
    - Operating and Maintenance Manuals
    - Final commissioning report

2. Operation and Maintenance Manuals must be provided in the following formats:
    - Submit 2 hard copies consolidated in hardcover D-ring binders
    - Submit 1 digital copy on a USB flash drive to facility staff
    - Submit 1 digital copy to the Owner's Representative
3. Maintenance manuals shall include:
    - The Consultant's name, street address, telephone number, and email address
    - The Contractor's name, street address, telephone number, and email address
    - All subcontractor's names, street address, telephone number, and email address
    - A copy of each "Reviewed" shop drawing or product data sheet

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

    Each shop drawing shall include the email address for local source of parts and service.
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. Provide training to the Owner's designated personnel in all aspects of operation and maintenance of the equipment after start-up.
2. All demonstrations and training shall be performed by qualified technicians employed by the equipment/system manufacturer/supplier.
3. The Contractor shall provide a onetime onsite training course which will include the following:
    - Coordinate with all subcontractors to ensure that training encompasses all relevant systems.
    - Record date of training and name and signature of all attendees
4. The Contractor shall provide a syllabus of the training session to the Owner and Consultant for approval before scheduling the training session.
5. Training for Facility Operations Staff shall cover the following subjects:
    - Regular and seasonal preventative maintenance procedures

- Sequence of operations
- Desired operating temperature/pressure ranges of equipment
- Safety controls
- Emergency isolation valves
- Alarms
- Proper use of computer control system
- Trouble-shooting procedures
- Primary & secondary pressure relief systems and overflows
- All other relevant system information required for safe and efficient operation of the system.

6. Training for facility electricians shall cover the following subjects:
    - All electrical systems
    - Sequence of operations
    - Safety controls

END OF SECTION

2 GENERAL WORK INSTRUCTIONS

2.1 GENERAL

2.1.1 REFERENCES

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

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

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. All work is to be in accordance with requirements with Codes, Regulations, and Standards applied by governing authorities, including:
    - The BC Building Code
    - Technical Safety BC (TSBC)
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.
4. All work must be completed in a manner that allows the Owner to maintain a TSBC Risk Assessed status.

2.1.4 QUALITY ASSURANCE

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. 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.

3. All quality control services must be provided by qualified personnel or testing agency.
4. All quality control services must be recorded, and documentation submitted to the Owner and the Consultant for verification and approval.
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.
6. All welders must be Class B or A and have up to date documentation.

2.1.5 SEISMIC RESTRAINT SYSTEMS

1. Supply and install seismic restraints for all piping and ductwork systems and all equipment specified in the refrigeration, HVAC, and plumbing sections of this specification in accordance with the British Columbia Building Code.
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 refrigeration, HVAC, and plumbing 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.
3. Supply and install restraint on all piping, ductwork, equipment and machinery, which is part of the refrigeration, HVAC, and plumbing systems to prevent injury or hazard to persons and equipment and to retain equipment in its normal position in the event of an earthquake.
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.
5. When equipment is mounted on concrete housekeeping pads, and/or concrete curbs the anchor bolts shall extend through the pad into the structure.
6. Structural integrity of packaged equipment and its internal components is the responsibility of the equipment manufacturer.
7. Seismic restraints may only be omitted where not required by SMACNA Guidelines.

2.1.6 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

1. All professional engineers retained by you to perform consulting services with regard to your 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. Your engineer's professional liability insurance is to protect your Consultants and Sub-Consultants, and their respective servants, agents, and employees against any loss or damage resulting from the professional services rendered by your Consultants, Sub-Consultants, and their respective servants, agents, and employees regarding the work of this Contract.
3. The Contractor is to meet or exceed all liability insurance requirements laid out in the Owner's contract documentation.
4. If the Owner's contract documentation does not contain specific liability insurance requirements, the following requirements are to be met at a minimum:
    - Coverage is to be a minimum of $2,000,000.00 inclusive of any one occurrence
    - 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
    - Liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the location of the work
5. Evidence of the required liability insurance in such form as may be required is to be issued to the Owner, the Owner's consultant, and Municipal Authorities as required prior to commencement of your consultant's services.

2.1.7 EXAMINATION OF SITE AND DOCUMENTS

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

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.
4. Contractors are responsible for checking all the relevant dimensions and line routing before bidding.
5. Contractors are responsible for confirming available supply voltage onsite, prior to ordering of equipment.

2.1.8 DRAWINGS AND SPECIFICATION

1. The mechanical drawings show approximate locations of equipment and connecting services. Any information regarding accurate measurements of the building are to be taken at the site by the Contractor.
2. As-built drawings shall be kept onsite during construction to allow for identification of design changes as part of the construction process.
3. A marked-up set of the drawings shall either be submitted to the Consultant for update, paid for by the Contractor, or a complete set of updated drawings will be submitted for approval by the Consultant and the Owner.
4. Both hardcopy in size Arch D and PDF versions of the as-built drawings must be supplied to the Owner upon project completion.
5. Submit a digital copy of all as-built drawings to the Owner's Representative.

2.1.9 PERMITS AND FEES

1. Contractor is responsible for applying for, obtaining, and paying for all permits and inspection fees required to complete the work
2. A copy of each permit and inspection report shall be provided to the Owner's Representative.
3. Design registration shall be completed and submitted by the Contractor as required by Technical Safety BC.

2.1.10 PAYMENT

1. Unless otherwise specified by the Owner's documents, the following payment section shall apply.
    - Progress payments are to be discussed and approved prior to project award and outlined in the contract with the Contractor and Owner.

- 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.
- 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.
- Upon completion of the deficiencies and approval by the Consultant, the Contractor may bill for the remaining project amount.
- 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 SCAFFOLDING, RIGGING, AND HOISTING

1. Supply, erect and operate all scaffolding, rigging, hoisting equipment and associated hardware required for your work.
2. Do not place major loads on any portion of the structure without approval from the Consultant.
3. Submit for review, rigging and hoisting plans, contemplated dates, permits, equipment, safety measures, and personnel prior to hoisting operations.

2.1.12 PHASING, HOURS OF WORK, AND NOISE CONTROL

1. 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. 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.
3. The Contractor shall instate appropriate controls to reduce nuisance noise level from affecting the areas adjacent to the work site.

2.1.13 EQUIPMENT AND SYSTEM START-UP

1. 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.

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

1. Contractor to employ the services of an independent TAB firm to test and balance new dehumidifier air systems and commission associated air handling unit.
2. Provide draft TAB report to engineer for review of all air systems.
3. Final TAB report to be included in the O&M manual.

2.1.15 EQUIPMENT INSPECTIONS

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 inside British Columbia and two weeks' notice outside of British Columbia.
2. Upon substantial project completion, the Contractor shall contact the Consultant for a final inspection and deficiency list.
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.
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.

2.1.16 SAFETY AND TRAFFIC

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

2.1.17 PROJECT SCHEDULE

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. The schedule shall be reviewed and approved by the Owner and the Consultant prior to work commencing at the site.

2.1.18 PROJECT MEETINGS

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. Upon commencement of work, the Contractor shall attend and chair an online bi-weekly meeting to update the Owner and Consultant on the project status.
3. Contractor to prepare meeting minutes and distribute to all attendees.
4. Polar Engineering can be contracted to take and distribute meeting minutes at a cost of $150 per meeting paid by the Contractor.
5. 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:
    - Expected equipment delivery dates
    - Construction schedule
    - Required facility shutdowns and expected startup dates
    - Expected inspection dates
    - Expected project completion date
    - Other information deemed important by the Owner's Representative or Consultant

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

2.1.19 REQUESTS FOR INFORMATION

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:
    - The Project name, the date, and Contractor's name and the name of the person making the query
    - An RFI number, a drawing reference if applicable, and a detailed description of the problem for which the RFI is issued.
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 PRODUCTS

2.2.1 MECHANICAL WORK IDENTIFICATION MATERIALS

1. **Equipment Nameplates:** Minimum 1/16" thick 2-ply laminated coloured plastic plates, minimum ½" x 2" for smaller items such control valves, minimum 1" x 2½" for equipment, and minimum 2" x 4" 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. **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" diameter, coiled type snap-on markers of a length are to wrap completely around the pipe or pipe insulation.
    - For pipe larger than 6" diameter, saddle type strap-on markers with two opposite identification locations and completed with nylon cable ties.
3. Identification wording and colours are to match existing wording and colours at the site.

4. Ammonia piping, valves, and other components shall be labelled per IIAR (International Institute of Ammonia Refrigeration) recommendations.
5. Where there is no existing identification onsite, the Contractor is to confirm identification, colour, and nomenclature with the Consultant.
6. Upon project completion, Contractor to supply Owner's Representative with both PDF and size Arch D drawing detailing all valve and equipment tags.

2.3 EXECUTION

2.3.1 INSTALLATION OF EQUIPMENT

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. The Contractor is responsible for transportation, off-loading, and rigging of all mechanical equipment and materials, including all costs associated with these activities.
3. The Contractor is responsible for all premium or special freight costs required to deliver materials and equipment to site to meet construction schedules.
4. Contractor to provide piping and equipment supports, anchors, sleeves, anchor bolts, restraints, and accessories as required.
5. Contractor to provide equipment supports, structural steel frames, housekeeping pads, and mounting accessories as required.
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.
7. The Contractor is responsible for ensuring that equipment supports adequately elevate the equipment to ensure that snow accumulation does not affect equipment performance.
8. Contractor to provide snow guards and/or snow breaks to ensure falling snow does not damage or negatively affect the performance of installed equipment.
9. All systems and pieces of equipment are to be provided with all necessary piping, valves, equalization lines, filters, purge points, drains, vents, and disconnects required to ensure reliable operation.
10. All systems and pieces of equipment to be provided with all electrical components and accessories required to integrate with onsite electrical infrastructure.

11. All systems and pieces of equipment are to be provided with all necessary mechanical, electrical, and controls equipment required to ensure reliable operation.
12. Contractor responsible for providing, charging, and installing new primary/secondary fluids and inhibitors required to operate the system for the first 6 months.
13. Primary/secondary fluids shall only be reused with express written permission from the Owner and Consultant.
14. Contractor responsible for updating all required pressure relief and safety systems to ensure compliance with governing codes and standards.
15. Contractor responsible for providing controls wiring, conduit, sensing equipment, coding, graphics, and licenses for all new/modified systems and pieces of equipment.
16. Contractor responsible for commissioning all new equipment and making any necessary adjustments to existing equipment to ensure safe and reliable operation.
17. Contractor must provide a one-year labor and material warranty (on-site) commencing from when substantial completion is granted.
18. Contractor is responsible for labeling all the equipment, piping, valves, and electrical per the specification document and accompanied drawings.
19. Contractor is responsible for updating mechanical room ventilation systems to ensure compliance with CSA B52 clause 6.2.5.5.

2.3.2 MECHANICAL WORK IDENTIFICATION

1. Identify all new mechanical work in accordance with existing identification standards at the site.
2. Identify new piping adjacent to each valve and at each piece of connecting equipment.
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.
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.

2.3.3 FINISH PAINTING OF MECHANICAL WORK

1. The Contractor shall prepare all surfaces, prime, and paint all piping support steels, conduit and boxes, and heat pump.
2. Contractor is to paint all the new equipment on site to match existing building and mechanical equipment.
3. Paint type and colour shall match existing building and mechanical equipment.
4. Touch-up paint all damaged factory applied finishes on mechanical work products.
5. All surfaces must be prepared, and paint applied per manufacturer's recommendations.
6. The Contractor is responsible to ensure the surface preparation and paint application are completed by someone with at least three (3) years of experience.
7. To ensure a long life, paint and all other exterior coatings must not be applied during rain, snow, or when the relative humidity is outside the recommended manufacturers procedures.
8. Manufacturer's minimum and maximum recommended application temperatures shall be adhered to.
9. Examine surfaces one week prior to the commencement of work. Report any condition that may affect proper application to the Owner and the Consultant.
10. Mask all required surfaces prior to commencing work.
11. Clean all surfaces per manufacturer's recommendations.
12. **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.
13. Prime and paint prepared surface per manufacture's recommendations.

2.3.4 PIPE LEAKAGE TESTING

1. Before new piping has been insulated, and before equipment has been connected, test all new piping for leakage. Submit signed and dated test report sheets to confirm proper test results.
2. Include temporary piping connections required to complete pipe leakage tests.
3. Piping under test pressure is to have a maximum of a 2-psi pressure drop for the length of the test period unless specified otherwise.

2.3.5 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

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. Motors greater than 10hp shall be supplied with a soft starter unless supplied with a VFD.

2.3.6 WASTE MANAGEMENT AND DISPOSAL

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

3 DEMOLITION AND REVISION WORK

3.1 GENERAL

3.1.1 APPLICATION

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

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

3.2 EXECUTION

1. The Contractor is responsible for all demolition and revision work.
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 your bid.
3. Demolitions shall be coordinated with the Owner's Representative to ensure minimal downtime.
4. Decommission and remove all existing equipment and materials which have been marked for removal.
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.
6. All materials and equipment approved for removal by the Owner shall be disposed of in an environmentally sustainable fashion.
7. Ensure that products and materials required for re-use are properly retained and protected.
8. Where existing valves with tags are removed, the tags shall be reused where possible.
9. Remove from the site and dispose of all existing equipment and materials which have been removed.
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.

11. The Contractor is responsible for site inspections to determine if there are any hazardous materials, such as asbestos, onsite, and to perform remediation per the codes and standards in BC required to complete the work outlined in this specification.
12. Where required, wetting agents approved by the Owner, or the Consultant shall be used for dust control.
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.
14. Appropriate bodies of water, including storm water, must be appropriately protected.

END OF SECTION

4 EQUIPMENT

4.1 GENERAL

4.1.1 APPLICATION

1. This section specifies requirements and instructions that are common to the remainder of this section. It is a supplement and is to be read accordingly.

4.1.2 SUBMITTALS

1. Contractor shall provide the following submittals to the Consultant and Owner's Representative.
    - 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.
    - Factory inspections and test reports with O & M Manual project close-out data.
    - Site inspection and start-up report detailing all the important equipment functions required to ensure equipment performance over the entire range of operation.
    - A one-year written warranty for all workmanship dated and signed by the Contractor.

4.1.3 QUALITY ASSURANCE

1. Piping system work is to be in accordance with the following Codes and Standards:
    - CAN/CSA B-52 Mechanical Refrigeration Code
    - CAN/CSA B-51 Boiler Pressure Vessel and Piping Code
    - ASME/ANSI B31.1 Power Piping
    - ASME/ANSI B31.5 Refrigeration and Heat Transfer Components
    - ASHRAE 15 Safety Standard for Refrigeration System
    - ASHRAE Standard 34 Designation and Safety Classification of Refrigerants
    - IIAR2 Ammonia Refrigeration Piping Handbook

4.2 PRODUCTS

1. The Contractor shall confirm the supply voltage available on site before ordering equipment.

4.3 EXECUTION

4.3.1 EQUIPMENT ACCESSORIES

1. All equipment shall be installed and integrated with the existing systems with all the necessary piping, valves, purge points, strainers, sight glasses, sensors, drain ports, conduit, disconnects, control equipment, electrical, base, and piping supports as required to ensure a complete functioning system.
2. Install ¼-in purge valves on major pieces of equipment to allow for proper depressurization of equipment.

4.3.2 SEISMIC RESTRAINTS

1. The Contractor is responsible for ensuring that all equipment is appropriately seismically restrained, and that all installed seismic restraints conform to all seismic codes and regulations.

4.4 PUMPS

4.4.1 GENERAL

1. 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

4.4.2 PRODUCTS

1. Approved pump manufacturers are Grundfos, Taco, and Armstrong.
2. Alternate pump manufacturers can be installed at the discretion of the Consultant and the Owner.
3. All pumps must be constructed from appropriate materials or have appropriate coatings suited for their intended operation. For example, all pumps used to pump pool water must have at a minimum an epoxy coating.

4. All pumps to be used in potable water applications must be constructed of appropriate materials and be approved for use with potable water by the pump manufacturer.

4.4.3 EXECUTION

1. All pumps to be installed, supported, and commissioned per manufacturer's recommendations.
2. All pumps to be installed with isolation valves, drain valves, and pressure gauges on the inlet and outlet.
3. All pumps to be supplied with appropriate suction guide and/or triple-duty valves to ensure a complete and functioning system.
4. Install a minimum of 2 feet of carbon steel piping at the inlet and outlet of each pump before transitioning to PVC, CPVC, or HDPE. Note, steel pups are not required for transition to copper piping.
5. All pumps must be installed with tags identifying pump to as-built mechanical and controls drawings.
6. 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.

4.5 HEAT EXCHANGERS

4.5.1 GENERAL

1. The Contractor shall record and provide the following values to the Consultant and the Owner when commissioning a heat exchanger:
    - Heat exchanger type
    - Heat exchanger application
    - Inlet temperatures
    - Outlet temperatures
    - Pressure drop through heat exchanger

4.5.2 PRODUCTS

1. Approved heat exchanger manufacturers are Alfa Laval, Danfoss, and Kelvion. Alternate heat exchanger manufacturers can be installed at the discretion of the Consultant and the Owner.

2. All heat exchangers must meet or exceed the specified capacity at the design conditions outlined in the associated drawing package.
3. Heat exchangers operating with brine ($CaCl_2$) must be constructed from Titanium.
4. Heat exchangers being used in potable water applications must be double wall vented to avoid water contamination.

4.5.3 EXECUTION

1. Install heat exchangers with adequate space to allow for disassembly, and removal of equipment and components as per manufacturer recommendations.
2. Support heat exchangers per the manufacturer's recommendations.
3. Install a minimum of 2 feet of carbon steel piping on the inlet and outlet of heat exchangers. Please note, this does not apply to heat exchangers connected to copper piping.
4. Install isolation, purge, and drain valves on the inlet and outlet of all heat exchangers.
5. Install appropriate filtration on the inlet of all heat exchangers.
6. Install purge and drain valves on the vessels of heat exchangers such as U-turns.
7. Install pressure relief valves and lines on the refrigerant side of heat exchangers. Pressure relief valves to be installed between the heat exchanger and the isolation valve of the heat exchanger.
8. Install secondary pressure relief valves on the liquid side of ammonia heat exchangers. Secondary pressure relief valves shall be installed between the heat exchanger and the isolation valves of the heat exchanger.
9. Insulate heat exchangers operating above 50 °C or below the ambient dew point.
10. Insulate heat exchangers operating as condensers or subcoolers when fluid temperatures are greater than 40 °C.
11. Insulate heat exchangers with the manufacturer's approved insulation.
12. Install drip pans with drain lines below heat exchangers that are susceptible to condensation or frost buildup.
13. Install heat exchangers that are operating as evaporators on a raised steel or concrete platform.

14. Install evaporators with a minimum of 2" of clearance to allow a 5-gallon bucket to be placed under the oil drain valve.
15. Install a 24-in drop leg with sight glass on the condensate outlet of all single circuit condensers, unless otherwise noted.
16. All condensers that contain multiple refrigerant circuits must be installed with a minimum 6-foot drop leg on each refrigerant circuit, unless otherwise noted.
17. Heat exchangers operating as evaporators and condensers shall be supplied with DDC and visual temperature sensors on the fluid inlet and outlet.
18. Heat exchangers operating as evaporators and condensers shall be supplied with DDC and visual pressure and temperature sensors on the refrigeration inlet and outlet.
19. Heat exchangers operating as evaporators shall have a level column with a minimum of four sight glasses installed on the refrigerant side. The liquid level sensor shall be located in the sight column.
20. Liquid-to-liquid heat exchangers shall be supplied with visual temperature sensors on the inlets and outlets of the heat exchangers.
21. Liquid-to-liquid heat exchangers with a capacity greater than 50kW shall be supplied with DDC temperature sensors on the inlets and outlets.
22. Liquid-to-air heat exchangers with a capacity greater than 50kW shall be supplied with visual and DDC temperature sensors on the liquid inlet and outlet
23. Heat exchangers that are susceptible to frost buildup shall be supplied with aluminum clad insulation. Aluminum clad insulation must allow for disassembly and heat exchanger inspection as required by the manufacturer

4.6 EXPANSION TANKS

4.6.1 GENERAL

1. The Contractor shall record and provide the following values to the Consultant and the Owner when commissioning an expansion tank:
    - Tank nameplate data
    - Air-side charge pressure

4.6.2 PRODUCTS

1. Approved manufacturers are: Amtrol, Armstrong, Bell & Gossett, State, Taco, Watts, Wessels, and Wheatley.

2. Tank: Welded steel, rated for specified working pressure and 115°C (240°F) maximum operating temperature. Factory test after taps are fabricated and supports installed and labeled in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, CSA B51, and provincial regulations.
    - Submit certificate of registration as required by provincial authorities.
3. Finish: Red oxide primer or baked enamel finish.
4. Bladder: Partial or Full Acceptance as scheduled on drawings; heavy duty butyl or EPDM suitable for system fluid; replaceable; rated for 115°C (240°F) operating temperature; securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
5. Air-Charge Fitting: Schrader valve, stainless steel with EPDM seats.
6. Factory Pre-Charge: 83 kPa (12 psig); adjust to match initial fill pressure of system.
7. Maximum Operating Temperature: 115°C (240°F).
8. Maximum Working Pressure: as scheduled on drawings.
9. Capacity: as scheduled on drawings.
10. Provide saddles for horizontal installation and base mount for vertical installation unless approved for pipe mounting by manufacturer.
11. Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.

4.6.3 EXECUTION

1. Adjust expansion tank pressure to suit design criteria.
2. Install locksheild type valve at inlet to tank.
3. Bolt floor mounted units to concrete housekeeping pads. Install seismic slack cables to suspended tanks.
4. With tank empty of water, adjust air pre-charge to match system fill pressure.

4.7 INDUSTRIAL COMPRESSORS

4.7.1 GENERAL

1. Compressor refers to an industrial refrigeration compressor for the remainder of section 1.1.

4.7.2 PRODUCTS

1. The approved compressor manufacturer is Mycom. Alternate compressor manufacturers can be installed at the discretion of the Consultant and the Owner.

4.7.3 EXECUTION

1. Compressors must be installed per the manufacturer's recommendations.
2. Compressors shall have appropriate suction and discharge isolation valves.
3. If not integral to the compressor, compressors shall have purge valves on the discharge side of the compressor before the isolation valve.
4. Appropriate protection via a guard must be provided for the direct drive coupling or belts. An extra set of belts shall be provided as part of the install.
5. Compressors must be charged with the manufacturer's approved oil and enough extra oil provided for the first oil change.
6. Compressors must be installed with a crank case heater. The heater is to be energized per the compressor manufacturer's instructions.
7. Compressors must be installed with oil separation as per the manufacturer's recommendations.
8. Compressors must be installed with high pressure, low pressure, oil pressure, high cooling water temperature, and discharge temperature safeties. All safeties must have a manual reset.
9. Compressors must be installed with visual gauges for discharge pressure, oil pressure, and suction pressure visual with one gauge set per compressor. Gauges are to be 4-in and display both the saturated refrigerant condition and the pressure of refrigerant.

4.8 AIR COOLED CONDENSERS

4.8.1 GENERAL

1. The Contractor is responsible for performing all electrical and controls upgrades required by condensers.

4.8.2 SUBMITTALS

1. Submit with delivery of the condenser a copy of the factory inspection and test report. A copy of this report shall also be included with the O&M Manual project closeout data.

2. Submit a site inspection and start-up report from the manufacturer's representative.
3. Submit a signed copy of the condenser manufacturer's extended warranty, in the name of the Owner, for all condenser rotating mechanical equipment (fan, fan shaft, bearings, sheaves, motor, drive system, and mechanical equipment support) for 4 years following the date of expiration of the 1-year Contract warranty.
4. The extended warranty is to be a written, full on-site parts and labour warranty with the same terms and conditions as the Contract warranty.

4.8.3 QUALITY ASSURANCE

1. Condensers and all aspects of their installation are to be in accordance with all requirements of the following:
    - All applicable Provincial Codes and Standards
    - Cooling Technology Institute CTI STD-105, Acceptance Test Code
    - ASHRAE Standard 90.1, Energy Standard for Buildings

4.8.4 PRODUCTS

1. The approved condenser is the specified model. Alternate models can be proposed by the Contractor and will be approved at the discretion of the Consultant.
2. Unless otherwise noted, condensers are to be supplied with the following:
    - Corrosion Resistant Coating: All steel panels and structural members, unless otherwise specified, are to be factory protected by a thermosetting hybrid polymer corrosion protection coating consisting of an electrostatically sprayed thermosetting hybrid polymer fuse bonded to the metal surfaces.
    - Passivation: Contractor responsible for performing passivation of all evaporative cooling equipment utilizing galvanized construction.
    - Contractor to contact water treatment vendor a minimum of 4 weeks prior to adding water to the system to provide equipment passivation plan. Contractor responsible for all costs associated with passivation of equipment.

- **Motors & Drives:** TEFC motors, variable torque, specially insulated for exterior condenser duty, and adjustable V-belt drives with taper lock sheaves, adjustable motor base, and guard. The fan is to be equipped with a standard motor and drive capable of being controlled with a VFD.
- **Access Ladder and Handrail:** Handrail, knee rail and toe board around the perimeter of the top of the condenser, designed and constructed in accordance with OSHA Standards and capable of withstanding a 890 N concentrated live load in any direction, and a vertical 450 mm (18-in) wide aluminum ladder with 75 mm (3-in) I-beam side rails and 32 mm (1-¼-in) diameter rungs permanently attached to the condenser casing and extended up from the base of the condenser to the top of the handrail.
- **Ladder Safety Cage:** Galvanized steel cage in accordance with OSHA Standards extending from a point 2.134 m (7-ft) above the foot of the access ladder to the top of the fan deck handrail.

4.8.5 EXECUTION

1. During demolition, protect all existing vibration isolated and seismically restrained piping support for re-use with the new condenser.

   Install condensers on a structural steel base or concrete housekeeping pad level and plumb. The Contractor is responsible for structural and/or seismic engineering as specified.
2. The Contractor is responsible for ensuring that all reused, existing structural supports will last the life expectancy of the new condenser, with responsibilities including but not limited to inspection and refinishing.
3. Ensure adequate vibration isolation is installed.
4. Install components shipped loose with condensers.
5. Install fan motors, VFD, and all supporting equipment required for condenser operation.
6. Install piping, valves, purges, overflow, and valved drain piping as required for the operation of condensers.
7. Contractor responsible for ensuring that all outdoor condenser spray water piping can completely drain back to the remote sump tank when not in use to avoid freezing.
8. Connect condensers to the control systems and install control wiring in conduit in accordance with electrical work wiring standards.

9. Implement floating head pressure condenser control algorithm. Contact the Consultant for guidance on the required control sequence.

4.9 HEAT PUMPS

4.9.1 GENERAL

1. Heat pump is defined as the heat pump and supporting energy recovery equipment within the contract scope of work.
2. The Contractor is responsible for performing all work to ensure the successful and safe operation of heat pumps. This work includes mechanical, electrical, structural, controls, and safety upgrades.
3. The Contractor is responsible for changes to heat pumps for 6 months after installation without cost to the Consultant or the Owner.
4. Compressor refers to a heat pump compressor for the remainder of section 4.9.
5. Major components for heat pumps include:
    - Refrigerant piping
    - Liquid and suction line filter driers
    - Suction accumulators
    - Compressors
    - Oil separators
    - Heat exchangers
    - High pressure receivers
    - Pumps
    - Valves
    - Sight glasses
    - Liquid levels
    - Electrical and control panels
    - Structural elements

4.9.2 QUALITY ASSURANCE

1. Heat pumps and all aspects of their installation are to be in accordance with requirements of the following codes and standards:
    - All applicable Provincial Codes and Standards, including BC SSA
    - CSA B51 Boiler and Pressure Vessel Code
    - CSA B52 Mechanical Refrigeration Code

- ASME/ANSI B31.5 Refrigeration Piping and Heat Transfer Components

4.9.3 SUBMITTALS

1. All submittals including but not limited to product data sheets, shop drawings, calculations, and drawings must be submitted to the Consultant for review at least two weeks prior to ordering components.
2. The Contractor shall submit to the Consultant data sheets and shop drawings for all major components.
3. The Contractor shall create a 3D model of the heat pump which includes all major components.
4. The 3D model shall be dimensionally accurate, annotated, and meet LOD 300.
5. Acceptable 3D modelling software are Autodesk Inventor or Dassault Systemes Solidworks.
6. The Contractor shall submit the 3D model of the heat pump for review at least two (2) weeks prior to commencing fabrication of the heat pump.
7. The Contractor shall submit the 3D model as an annotated PDF drawing package and a 3D interchange file (STP, OBJ, DXF).
8. The Contractor must provide the Consultant with a detailed part load oil return control plan which must be tested during heat pump commissioning.
9. Heat pump pressure testing documentation must be supplied to the Owner and the Consultant for approval as per CSA B52.
10. The Contractor shall provide the Consultant with a detailed commissioning report of heat pumps.
11. Contractor is responsible for completing all heat pump pressure relief requirement calculations defined by CSA B52. Pressure relief calculations shall be submitted for review to the Consultant prior to the commencement of construction.
12. Contractor is responsible for completing all heat pump ventilation requirement calculations defined by CSA B52. Pressure relief calculations shall be submitted for review to the Consultant prior to the commencement of construction.

4.9.4 PRODUCTS

GENERAL

1. The heat pump must fit within the space specified by the Consultant in the associated drawing package. The Consultant must approve any alternate locations or footprints.

2. All equipment layouts must be approved by the Consultant prior to procurement of equipment or heat pump construction.
3. The design working pressure (DWP) of all equipment must meet the requirements of the CSA B52.
4. Refrigerant shall be R513A, unless specified otherwise. Alternative refrigerants must be approved by the Consultant with preference given to Low-GWP synthetic and natural refrigerants.
5. Heat pump components must conform to the standards defined in this specification.
6. Heat pump components must be the make and model specified. Alternative heat pump components must be approved by the Consultant and shall meet all the specified design requirements.

COMPRESSORS

1. The approved compressor manufacturer for heat pumps is Bitzer. Alternate compressor manufacturers can be installed at the discretion of the Consultant and the Owner.
2. Compressors shall be installed per the manufacturer's recommendations.
3. Bitzer reciprocating compressors are to be supplied with the following unless specified otherwise:
    - Bitzer IQ module (CM-RC-01)
    - Varistep mechanical capacity control
    - Kriwan INT280B oil level regulator
    - Pressure transducer add-on
    - Crank case heater, energized as per manufacturer's instructions
4. Bitzer screw compressors are to be supplied with the following unless specified otherwise:
    - Discharge shut-off valve
    - Suction shut-off valve
    - Oil level switch
    - Vibration dampers
    - Motor Protection SE-i1
5. Compressors to be provided with additional cooling equipment as required by the manufacturer's compressor operating envelope.

6. Compressor suction and discharge piping must be provided with vibration absorbers to prevent pipe failure from cyclical loading.
7. Compressors shall be installed with appropriate suction and discharge isolation valves. These isolation valves can be integral to the compressor.
8. Compressors shall have purge valves on the discharge side of the compressor before the isolation valve. This purge valve can be integral to the compressor.
9. Compressors to be supplied with all equipment necessary to ensure the minimum required suction gas superheat as required by the compressor manufacturer.
10. Compressors must be charged with oil approved by the manufacturer and suitable for the operating conditions of the compressor.
11. Contractor will supply adequate oil to complete the first oil change of the compressors.
12. Compressors must be installed with high pressure, low pressure, oil pressure, oil level and discharge temperature safeties. All safeties must have a manual reset.
13. Compressors must be installed with oil separation as per the manufacturer's recommendations.
14. Compressors shall be installed with at least 12-inches of straight pipe on their discharge port before a change in direction.

OIL SEPARATORS

1. Oil separator inlet and outlet connections shall not be smaller in diameter than the compressor discharge line.
2. Oil separators must be sized to match or exceed the heat pump capacity and to accommodate the maximum compressor discharge volumetric.
3. Oil separators shall be coalescing type with removable filter.
4. A solenoid valve shall be installed on the oil return line between the oil separator and the compressor and shall be located close to the oil separator.
5. Solenoid valve must remain closed long enough to evaporate refrigerant in the oil separator when the heat pump starts.
6. Solenoid valve must only be opened when the compressors are running. The run state of the compressor must be validated by a current sensor.

SUCTION ACCULATORS

1. Suction accumulators must be sized to accommodate 80% of the refrigeration charge of the heat pump.

2. Suction accumulators must be sized to at least match the maximum mass flowrate of heat pumps.
3. Suction accumulators shall have a refrigerant boil out coil unless specified otherwise.

RECEIVERS

4. Receivers must be sized to accommodate 100% of the refrigeration charge of the heat pump without exceeding 80% of the receiver volume.
5. The receiver inlet must have a diameter at least equal to the condenser drain line diameter.

FILTER DRIERS

1. Filter driers must be sized to match or exceed the capacity and refrigerant charge of the heat pump.
2. Filter driers shall be cartridge style with replaceable core.
3. Contractor shall supply an extra filter cartridge to be installed by the Contractor after two (2) weeks of heat pump operation.
4. Filter driers on liquid lines must have an integral sight glass with moisture indicator. A discrete sight glass with a moisture indicator may be installed between the liquid line filter drier and expansion device, subject to approval by the Consultant.

EXPANSION VALVES

1. Expansion valves must be Electronic Expansion Valves (EEV). Thermostatic Expansion Valves (TEV) will not be accepted.
2. The expansion valve must have an operating envelope that includes all heat pump operating conditions including variations in condensing and evaporating temperatures, and compressor turndown under low-load conditions.
3. Expansion valves shall be provided with compatible superheat controllers and all required controls equipment to ensure a complete and functioning system.

PIPING

1. Heat pump piping shall be ASTM B280 registered type K copper unless specified otherwise.
2. Refrigeration fittings and connections shall be brazed unless specified otherwise.

ELECTRICAL

1. All transformers and other electrical equipment required for effective operation shall be supplied as part of the heat pump.

2. The heat pump shall have a single point electrical integration panel that shall match the facility's available electrical supply. Remotely located controls may be powered from alternate supplies.

CONTROLS

1. The Contractor is responsible for providing all sensors, wiring, control panels, and other controls equipment required for performance monitoring, system troubleshooting, energy tracking, and integration with existing controls systems.
2. DDC systems must conform to the standards defined in this specification.

4.9.5 EXECUTION

1. The Contractor is responsible for ensuring that the heat pump can be delivered and installed in the specified location. This includes identifying any obstructions, limits, or choke points that may impede transport of the heat pump to the specified location.
2. All heat pump equipment must be placed in locations that allow all new and existing equipment and valves to be serviced and maintained.
3. Good piping design practices must be followed to ensure oil return and to stop refrigerant migration during normal heat pump operation and on/off cycles.
4. A check valve is to be installed on the discharge line between the oil separator and condenser unless specified otherwise.
5. All piping must be purged with N2 during brazing.
6. Major components must be installed with purge valves, drain valves, and appropriate isolation valves for maintenance.
7. Filter drier cartridges must be replaceable without requiring brazing.
8. Oil separator filters must be replaceable without requiring brazing.
9. All components and equipment must be installed as per the standards defined in this specification and manufacturers instructions.
10. The fully installed refrigeration system shall be tested for leaks, evacuated, and pressure tested.
11. The entire pressure piping assembly must be rated, and pressure tested to ensure the heat pump can supply 180F fluid from its condenser.
12. Insulation shall not be applied until pressure testing has been successfully completed.
13. All hot and cold surfaces shall be insulated to the standards defined in this specification.

14. Temperature transducers and analog temperature indicators to be installed on the secondary inlets and outlets of all heat exchangers unless specified otherwise.
15. Contractor to provide equipment bypasses where applicable, allowing existing building infrastructure to operate as originally designed during maintenance of heat pump equipment.
16. Contractor is responsible for integrating heat pumps with the facility's electrical and controls systems as specified.
17. Sensors shall be installed to allow the tracking and display on the building automation system (BAS) of heat supplied by the heat pump (condenser and subcooler).
18. Heat pump DDC systems must be integrated with the controls of existing refrigeration systems and BAS as specified.
19. Heat pump control strategies and setpoints must update dynamically with changes to the facility's existing DDC/BAS system.
20. Heat pump control strategies shall ensure that the minimum suction gas superheat required by the heat pump compressor, as defined by the compressor manufacturer, is maintained under all operating conditions.
21. Strap-on temperature sensors to be installed at the outlet of the evaporator, liquid-suction heat exchanger and suction accumulator to ensure adequate suction gas superheat is being maintained.
22. Contractor is responsible for installing and upgrading onsite safety systems to ensure heat pumps meet all regulating codes and standards. This includes, but is not limited to:
    - Pressure relief system upgrades
    - Installation or modification of refrigerant detection systems
    - Relocation or modification of nearby combustion equipment, as required.
    - Installation or modification of HVAC systems

4.9.6 PRESSURE RELIEF

1. Contractor is responsible for completing all work to meet the pressure relief requirements of CSA B52.
2. All pressure relief components shall conform to the standards defined in this specification.
3. Contractor to provide all pressure relief valves, piping, and related equipment required to meet the requirements of the CSA B52.

4. All pressure relief calculations to be verified by the Consultant prior to system construction.

4.9.7 VENTILATION

GENERAL

1. Contractor to complete all works required to meet the ventilation requirements of the CSA B52.

PRODUCTS

1. Contractor to provide all ventilation equipment including but not limited to fans, VFDs, ducting, and controls equipment.
2. Contractor to provide refrigerant vapour detection equipment.

EXECUTION

1. Exhaust ducting inlet to be installed in locations that refrigerant is most likely to accumulate in the case of a leak.
2. Provide acoustically lined ducting in all noise-sensitive areas.
3. Provide refrigerant vapour detectors in locations that refrigerant is most likely to concentrate.
4. Vapour detectors must produce a sufficiently audible alarm and initiate mechanical ventilation system in the case of a leak.
5. Ventilation system to be modulated beyond the minimum ventilation requirements to ensure a consistent temperature within the heat pump enclosure.
6. Where required by the CSA B52, the Contractor is responsible for ensuring that all nearby combustion equipment is shut down in the case of a refrigerant leak.

4.9.8 SOUND ATTENUATION

GENERAL

1. The Contractor is responsible for all work necessary to minimize noise and vibration generated by the heat pump.

PRODUCTS

1. The Contractor shall provide vibration isolation equipment including but not limited to:
    - Vibration isolation mounts for compressors
    - Vibration isolation mounts for heat pump frames
    - Vibration isolation couplings for all piping penetrating heat pump enclosures and noise sensitive areas.

- Flex connections on ducting penetrating heat pump enclosures and noise sensitive areas.
- 1-inch acoustically lining for ducting penetrating heat pump enclosures and noise sensitive areas.

2. The Contractor is responsible for providing specified industrial acoustic enclosures. Enclosures shall include:
    - Removable acoustic panels on all sides, including the roof, to allow for servicing and maintenance of the heat pump.
    - Acoustic enclosure to include openings required for proper heat pump ventilation.
    - Acoustic enclosure must meet all governing fire codes and regulations.

EXECUTION

1. Acoustically lined duct shall extend 10-feet past the exterior of acoustic enclosures or 3-feet past the throat of 90-degree elbow, which ever is shorter.

END OF SECTION

5 AMMONIA REFRIGERATION PIPING AND VALVES

5.1 GENERAL

5.1.1 QUALITY ASSURANCE

1. Piping system work is to be in accordance with the following Codes and Standards:
    - CAN/CSA B-52 Mechanical Refrigeration Code
    - CAN/CSA B-51 Boiler Pressure Vessel and Piping Code
    - ASME/ANSI B31.1 Power Piping
    - ASME/ANSI B31.5 Refrigeration and Heat Transfer Components
    - ASHRAE 15 Safety Standard for Refrigeration System
    - ASHRAE Standard 34 Designation and Safety Classification of Refrigerants
    - IIAR2 Ammonia Refrigeration Piping Handbook

5.2 PIPES, FITTINGS, AND JOINTS

5.2.1 GENERAL

1. All applicable refrigeration piping to be pressure tested per CSA B52.
2. A pressure test of 1.1 times the design pressure shall be applied to all piping before being put into service. Pressure testing shall be held for 24 hrs. A picture detailing the gauge with a time stamp at the beginning and end of the pressure test shall be supplied to the Consultant.
3. The Contractor is responsible for the piping design registration and design submission of all ammonia piping to TSBC. For project continuity, it is recommended that the Consultant is hired to complete this work, however it is an option for the Contractor to complete it internally, if required.

5.2.2 PRODUCTS

1. All piping must be supplied capped and free of any internal debris or rust.
2. Piping 2-in or smaller must be schedule 80, ASTM SA106, grade B, seamless pipe.
3. Piping over 2-in must be schedule 40, ASTM SA106, grade B, seamless or ASTM SA53 grade B, welded (ERW).
4. Threaded pipe and fittings under 2.5-in to be schedule 80.

5. Welded fittings over 2-in to be SA-234-WPB fittings of the same size as the pipe being welded to.
6. Schedule 80 piping on all relief valve inlets and three-way valves.
7. Steel tubing 3/8-in and smaller shall be stainless steel.
8. Flanges, if used, must be approved for use with ammonia.

For simplicity, the following chart has been created:

PRIMARY REFRIGERATION PIPING SPECIFICATION		
PIPING SHALL BEAR THE MILL TEST #		
NOTE: COPY OF THE MILL TEST CERTIFICATES TO BE INCLUDED IN MANUAL		
NOTE: CONTRACTOR RESPONSIBLE FOR PROVIDING IMPACT TESTING, IN ACCORDANCE WITH ASME/ANSI B31.5, FOR ANY PIPING OPERATING BELOW ITS RATED TEMPERATURE RANGE.		
UP TO 2" IPS		
	> SCH.80.A106 GR. B SEAMLESS	
	> IPS: SCHE 80 A 106 GR. B SEAMLESS WITH SOCKET WELD OR BUTT WELD CONNECTIONS	
2 ½" IPS & OVER		
	> SCH.40A53GR.BERW	
	> A106GR.B SEAMLESS	
	> A333 GRADE 1 OR 6 TYPE E OR S (BELOW-20°F/-29°C).	
FITTINGS-SHALL BEAR THE MANUFACTURER'S IDENTIFICATION		
UP TO 1 ½" IPS:		
	> FORGED STEEL SOCKET WELD ASTM A105 GR. 2.CLASS 3000.	
	> THREADED CONNECTION WITH SAME SPECIFICATIONS, ONLY IF LOCATION APPROVED BY REFRIGIRATION CONSULTANT	
2" IPS & UP:		
	> CARBON STEEL BUTT WELD ASTM A234B, OR A105 OR A420 (BELOW -20°F/-29°C)	
		> COMPATIBLE WITH THE WALL THICKNESS OF THE PIPE
TUBING – STAINLESS STEEL, 0.035" THK. WALL IN ¼" O.D. & ⅜" O.D SIZES.		
FITTINGS: PARKER-HANNIFIN CB CARBON STEEL COMPRESSION TYPE.		
FLANGES: ANSI RAISED FACE, ASTEM A105 GR. 1 OR A181. GR 1 A105, A707 (BELOW -20°F/-29°C) RATING TO MATCH PIPE		
UNION: FORGED STEEL ASTM 105 GR. 2 300# WOG, STEEL TO STEEL GROUND JOINT, SOCKET WELD CONNECTIONS		

5.2.3 EXECUTION

1. Contractor to do all required piping system demolition work, as outlined in the attached drawing package.
2. Contractor to provide all required system piping, fittings, and joints.
3. Pipe and fittings 2.5-in and larger to be welded.
4. Welded fittings 2-in and smaller to be socket weld 3000 psi.
5. Provide shut-off valves and piping connections to refrigeration equipment.
6. Re-use existing restrained supports, including vibration isolation seismically restrained supports. Provide new supports to match existing supports where required.
7. All piping shall be provided with clearance around systems, equipment, and components for observation of operation, inspection, and servicing. Clearance must meet manufacturers requirements, CSA B52, and the National Fire Code of Canada.
8. Piping must be installed with enough space to allow for disassembly and removal of equipment and components, per manufacturer recommendations.
9. Branch lines shall be installed with isolation and bypass lines with valves to allow for maintenance.
10. Bolt threads shall be lubricated with anti-seize compound.
11. Threaded joints in ferrous piping shall have NPT taper screw threads and shall be reamed and deburred before being used.
12. Piping which has potential for freezing, water condensation, and heat loss shall be protected by the appropriate insulation, vapor barrier, cladding. Refer to Mechanical Piping and Equipment Insulation for more information.
13. Ammonia discharge piping must, at a minimum, be painted with corrosion resistant paint.
14. Indoor piping insulation shall be protected by PVC cladding, per insulation specification.
15. Provide supply and return computer temperature sensors to all appliances and coils.
16. Piping shall be installed to prevent liquid traps.
17. Where required, install drains in all low points, drain points, heat transfer outlets, and elsewhere to ensure reliable operation and maintenance, and drainage of liquid refrigerant back to receiver or chiller.

18. 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. The Contractor will provide marked up P&IDs listing valve tag numbers at the end of the project.
19. Sloped piping is to be sloped at ¼" per foot unless otherwise specified.

5.2.4 PIPING SUPPORTS

1. All hangers, supports, and sway braces are to be in accordance with MSS SP58.
2. All piping is to be installed and supported per piping manufacturer recommendations.
3. All hangers located in corrosive environments or outdoors must be stainless steel, aluminum, or at a minimum hot dipped galvanized. All hangers inside the mechanical room may be painted or hot dipped galvanized.
4. Ensure steel hangers are in tensile loading only.
5. Cold piping NPS 2 or smaller can be supported by I-beam C clamps with a steel cup set screw, or a locknut and carbon steel retaining clip. Must be UL listed or FM approved.
6. Ensure that hanger rod is vertical in operating conditions.
7. All outside rooftop riser clamps are to be stainless steel, aluminum, or at a minimum hot dipped galvanized.
8. Piping supports shall be supported by bolts and only welded upon approval from a structural engineer.
9. All clevis plates must be secured with a minimum of 4 concrete inserts, one at each corner.
10. Per good piping practice, the following steel recommended piping support spacing table shall be adhered to. It should be noted that piping transitions, component 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.

Recommended Sch 40 and 80 Carbon Steel, PVC, and Copper Piping Support.

NOMINAL PIPE SIZE	ROD DIAMETER	MAXIMUM SPACING			
			PVC*		
		STEEL	SCHEDULE 40	SCHEDULE 80	COPPER
⅜″ – 1 ¼″	⅜″	7′	4′	4′	5′
1 ½″	⅜″	9′	5′	5′	8′
2″	⅜″	10′	5′	6′	8′
2 ½″	½″	11′	6′	6′	9′
3″	½″	12′	6′	7′	10′
3 ½″	½″	13′	6′	7′	11′
4″	⅝″	14′	6′	7′	12′
5″	⅝″	16′	6′	7′	13′
6″	¾″	17′	7′	9′	14′
8″	¾″	19′	8′	9′	16′
10″	⅞″	22′	8′	10′	
12″	⅞″	23′	9′	10′	
14″	1″	25′	10′	11′	
16″	1″	27′	10′	11′	

11. Piping and tubing smaller than 1″ may require more support to reducing piping vibration. The Contractor must install sufficient support to avoid excessive vibration.
12. All piping must be supported accordingly.
13. 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.
14. Piping clamps and supports used on pipe transporting fluid above ambient air temperatures may penetrate through insulation.
15. Piping clamps and supports used on piping operating below ambient air temperatures shall not penetrate through insulation.
16. All piping shall be installed with appropriate seismic restraints per the geographic location of the project.

5.3 REFRIGERATION VALVES

5.3.1 GENERAL

1. Refrigeration valves shall be registered in the jurisdiction that they are to be installed and conform with local codes and regulations.
2. Refrigeration valves to be installed in *British Columbia* must be registered with *Technical Safety BC* and have a *CRN number*.

5.3.2 GENERAL EXECUTION

1. Valves with a diameter less than 1-in shall be seal capped and socket welded where possible.
2. Valves with a diameter less than 1-in may be threaded when interfacing with components.
3. Valves with a diameter from 1-in to 2-in shall be seal capped and socket welded.
4. Valves with a diameter greater than 2-in shall be seal capped and butt welded.

5.3.3 SHUT OFF VALVES

PRODUCTS

1. Approved Manufacturers: Danfoss, Hansen, and Parker are accepted manufactures of shut off valves.
2. All shut off valves must be globe style.

EXECUTION

3. All major pieces of equipment must be installed with isolation valves to allow for maintenance and system shutdown.
4. All major pieces of equipment must be installed with a ¼-in purge valve used to allow to proper depressurization of equipment.

5.3.4 ACTUATED VALVES

PRODUCTS

1. Approved Manufactures: Danfoss, Hansen, and Parker are accepted manufacturers of actuated valves.
2. Danfoss ICF valve stations are preferred but not required.
3. Solenoid valves and electric regulators are to have strainers and pilot lights on coils.
4. All electronic expansion valves (EEV) must be controlled by the appropriate manufacturer controller to ensure system reliability.

EXECUTION

1. Actuated valves must be installed with appropriate stop valves to allow for isolation and maintenance.
2. Sensors used to control electronic expansion valves must be installed within 4 ft of the outlet of the evaporator, must be installed on the evaporator side of the isolation valve, and must not be isolated from the system by a valve.

5.3.5 PRESSURE RELIEF VALVE

PRODUCTS

1. The accepted manufacturers of refrigerant pressure relief valves are Danfoss, Hansen, Cyrus Shank, and Parker.
2. The accepted secondary pressure relief valve is Mercer's 91-12E51T07LC.

EXECUTION

1. Pressure relief valves must be installed on all major pieces of equipment per CSA B52.
2. Contractor to install exact pressure relief valve models specified by the Consultant. Any substitutions must be approved by the Consultant prior to procurement.
3. Compressor pressure relief valves may be sized based on compressor unloading per CSA B52. If installed using this method, the Owner's representative must be notified to ensure proper documentation is maintained.
4. Where required by CSA B52 code, all pressure vessels large enough must be installed with a three-way valve to allow for proper maintenance of pressure relief valves.
5. Schedule 80 piping to be installed on all relief valve inlets and three-way valves.
6. Secondary relief valves shall have a set pressure of 75psig.
7. Secondary relief valves shall be piped to an elevated transparent tank to ensure lifted relief valves can be identified. Tank shall be supplied with an overflow piped to the header trench, or to the floor if no header trench exists.

END OF SECTION

6 HYDRONIC PIPING AND VALVES

6.1 GENERAL

6.1.1 QUALITY ASSURANCE

1. Piping system work is to be in accordance with the following Codes and Standards:
    - ASTM D 1784 Standard Specification for Rigid PVC Compounds and Chlorinated PVC Compounds
    - ASTM D3035 Standard Spec for PE Pipe (DR-PR) Based on Controlled Outside Diameter
    - ASTM A53, Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless
    - ASTM A105, Standard Specification for Carbon Steel Forgings for Piping Applications
    - ASTM A536, Standard Specification for Ductile Iron Castings
    - ANSI/ASME B16.4, Cast Iron Threaded Fittings

6.1.2 WATER TREATMENT SERVICE

1. 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.
    - For existing systems, confirm current Water Treatment Specialist and chemical supplier with the Owner.
2. The Water Treatment Specialist shall provide supervision of installations, set-up and adjustments and shall submit a written report on system operations.
3. All chemicals, feed systems and test equipment shall be provided by the Water Treatment Specialist.
4. Treatment chemicals shall not contain hydrazene.
5. Allow for replenishing of existing system levels where fluid is drained or system is expanded. At minimum, confirm initial water chemistry prior to starting new work and return system to these values prior to placing system back into service. Chemicals shall match existing.

6. Treatment chemicals shall be non-foaming.
7. 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.
8. On new systems, the Water Treatment Specialist shall provide monthly visits to check chemical treatment, take water samples and recommend any necessary changes to treatment, and provide a written report for a period of one year after substantial completion. Provide sufficient chemicals to treat the system from the time of commissioning to acceptance of the building. In addition, provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months normal operation. The minimum amount of chemicals provided shall include the following:
    - One spare drum (200L) of chemicals for each open system requiring treatment.
    - One spare pail (20L) of biocide for each open system requiring treatment.
    - One spare pail (20L) of chemicals for each closed system requiring treatment.
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.
10. Provide one mild steel and one copper corrosion coupon package to monitor corrosion rate for each open and closed systems.

6.2 PRODUCTS

6.2.1 PIPE, FITTINGS AND JOINTS

1. 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.
2. HDPE - shall be made from a PE 4710 high density polyethylene resin compound meeting cell classification 445474C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34 per ASTM D1238.

3. 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.
4. 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, and Victaulic Style 77 standard flexible couplings.

6.2.2 SHUT-OFF VALVES

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
2. Ball Valve: Lead free, 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 (316 stainless steel for brine)
    - blowout-proof stem
    - solid forged brass or bronze chrome plated ball (316 stainless steel for brine)
    - "Teflon" or PTFE seat
    - a removable coated steel lever handle marked with valve identification
    - ends to suit the piping being connected
3. Valves in insulated piping are to be complete with stem extensions.
4. Acceptable manufacturers are:
    - Toyo Valve Co.
    - Milwaukee Valve Co.
    - Kitz Corporation
    - Conbraco Industries Inc. Apollo
    - Watts Water Technologies Inc.
5. 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

6. 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.

6.2.3 PIPELINE STRAINER

1. NPS 2 and smaller:
    - Bronze body to ASTM B62.
    - Screwed connections.
    - Y pattern.
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.
3. Blowdown connection: NPS 1.
4. Screen: stainless steel with 1.19 mm through 3.2 mm perforations.
5. Maximum working pressure: 2,065 kPa (300 PSI).

6.2.4 BASKET STRAINER

1. Manufacturers: Keckley Company, Metraflex Company, Titan Flow Control, Watts
2. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: 40-mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
5. Maximum working pressure: 1,207 kPa (175 PSI).

6.2.5 CIRCUIT BALANCING VALVES

1. NPS 2 and under:

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

2. NPS 2-1/2 and over:
   - Maximum operating pressure 2,065 kPa (300 PSI).
   - 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.
3. Include calibration charts and adjustment tools.
4. Provide one (1) differential pressure meter kit suitable for direct readout c/w connection hoses suitable for system pressure.

6.2.6 WATER TREATMENT

1. MATERIALS:
   - 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).
   - 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.
   - 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.
   - Materials which may contact finished areas must be colourless
2. EQUIPMENT:
   - CLOSED SYSTEM (Heating or Cooling)

- Bypass Pot Feeder: All closed hot water and chilled water systems shall have a by-pass chemical pot feeder with a 7.6 litre capacity. It shall be constructed of heavy duty cast iron or welded steel (suitable for 1380 kPa [200 psig] working pressure), with quick opening cap and complete with 20 mm NPT connections. Isolating valves shall be installed on the inlet, outlet and drain.
- Sidestream Filter: All closed hot water and chilled water systems shall have a sidestream filter housing of steel construction using a 250 mm x 30 micron filter cartridge, with a minimum flow rate of 35 litres/minute. A flow indicator shall be installed in conjunction with the sidestream filter. Connections shall be 20 mm MxFNPT and all isolating valves shall be installed as per manufacturer's instructions. Include 6 filter cartridges.
- Totalizing Make-up Water Meter: Cast Bronze body, 20 mm NPT connections, thermoplastic rotor and gear train, rated at 1034 kPa [150 psig] maximum operating pressure.
    - ♦ Chemical Feed Piping:
        - ◊ Schedule 40 black steel.
- Corrosion Coupon and Holder Assembly:
    - ◊ Mild steel corrosion coupon.
    - ◊ Holder, 20 mm or 25 mm NPT male connection.
    - ◊ Provide malleable or cast iron cross, 20 mm or 25 mm NPT female connection.
- TEST KITS:
- Provide test kits to determine proper systems treatment, including but not limited to the following:
    - ◊ Closed System Test Kit: To determine proper level of inhibitor in closed system treatment. (PACE Chemicals Test Kit #105 or approved equal.)

6.3 EXECUTION

6.3.1 DEMOLITION

1. Do all required hydronic piping system demolition/revision work laid out in attached drawing package. Refer to demolition requirements specified in the Mechanical Work section entitled Demolition and Revision Work.

6.3.2 PIPING INSTALLATION REQUIREMENTS

1. All low-temperature piping (below 95 °F) shall be PVC or HDPE. Unless otherwise noted, PVC shall be Schedule 80 and HDPE shall be DR 11. HDPE piping is permitted only in locations allowed by the Building Code, Fire Code, and all other applicable regulatory requirements.
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.
3. Provide screwed unions or removable mechanical joint couplings in piping at all connections to valves, and at all equipment connections.
4. Provide shut-off valves in piping connections to all pieces of major equipment, including but not limited to injection loops, heat exchangers, and pumps.
5. Re-use existing retained supports, including vibration isolated seismically restrained supports. Provide new seismic supports where required to properly restrain pipe.
6. 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. All piping must be installed with enough space to allow for disassembly, removal of equipment and components per manufacturer recommendations.
8. All piping transportation water lines greater than two inches shall be installed with butterfly isolation valves.
9. All piping transportation water lines smaller or equal to two inches shall be installed with ball isolation valves.
10. All branch lines shall be installed with isolation and bypass lines with valves to allow maintenance.
11. All drains shall be sloped towards drain.
12. 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.
13. All dissimilar metals shall be connected with dielectric couplings appropriate for the application.
14. All bolt threads shall be lubricated with anti-seize compound.
15. All flanges mating to cast iron valve or equipment shall have flat faces.
16. Threaded joints in ferrous piping shall have NPT taper screw threads and shall be reamed and deburred before being used.

17. 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.
18. Provide supply and return computer temperature sensors to all appliances and coils.
19. 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.
20. A pressure test of 50 psig shall be applied to all piping before being put into service. Pressure testing shall be held for 24 hrs. A picture detailing the gauge with a time stamp at the beginning and end of pressure test shall be supplied to the Consultant.
21. 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. The Contractor will provide marked up P&IDs listing valve tag numbers at the end of the project.

6.3.3 PIPING SUPPORTS

1. All hangers, supports, and sway braces are to be in accordance with MSS SP58.
2. All piping is to be installed and supported per piping manufacturer recommendations.
3. All hangers located in corrosive environments or outdoors must be stainless steel aluminum, or at a minimum hot dipped galvanized. All hangers inside the mechanical room may be painted or hot dipped galvanized.
4. Ensure steel hangers are in tensile load only.
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.
6. Ensure that hanger rod is vertical in operating conditions.
7. All outside rooftop riser clamps to be stainless steel, aluminum, or at a minimum hot dipped galvanized.
8. Piping supports shall be supported by bolts and only welded upon approval from a structural engineer.
9. All clevis plates must be secured with a minimum of 4 concrete inserts, one at each corner.

10. 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.
11. All flexible joint roll grooved piping shall also be supported by at least one hanger at the piping joints.

NOMINAL PIPE SIZE	ROD DIAMETER	MAXIMUM SPACING			
			PVC*		
		STEEL	SCHEDULE 40	SCHEDULE 80	COPPER
≤ 1-¼"	⅜"	7'	4'	4'	5'
1 ½"	⅜"	9'	5'	5'	8'
2"	⅜"	10'	5'	6'	8'
2 ½"	½"	11'	6'	6'	9'
3"	½"	12'	6'	7'	10'
3 ½"	½"	13'	6'	7'	11'
4"	⅝"	14'	6'	7'	12'
5"	⅝"	16'	6'	7'	13'
6"	¾"	17'	7'	9'	14'
8"	¾"	19'	8'	9'	16'
10"	⅞"	22'	8'	10'	
12"	⅞"	23'	9'	10'	
14"	1"	25'	10'	11'	
16"	1"	27'	10'	11'	

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.
13. All piping must be supported.
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.
15. Piping clamps and supports used on pipe transporting fluid above ambient air temperatures may penetrate through insulation.
16. Piping clamps and supports used on piping operating below ambient air temperatures shall not penetrate through insulation.

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

6.3.4 PIPE FLUSHING AND CLEANING

1. Flushing and cleaning shall commence once all piping tests have been completed.
2. Install temporary bypass connections around all heat pumps, heat exchangers, etc. before commencing chemical cleaning.
3. Chemically clean the following piping systems as recommended by the Water Treatment Specialist:
    - Chilled water system(s)
    - Condenser water system(s)
    - Heat recovery system(s)
    - Heating water system(s)
4. Flush out all traces of chemicals with clean water after chemical cleaning is complete.
5. Remove, clean and reinstall all strainer baskets.

6.3.5 CHEMICAL TREATMENT

1. All systems must be chemically cleaned and flushed before water treatment is added. This includes partial or complete filling for pressure testing.
2. Notify Consultant minimum 48 hours prior to chemical cleaning so that work may be verified and inspected.
3. Provide drain connections to drain system in one hour.
4. All drains for chemical treatment shall be piped to the sanitary sewer.
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.
6. After initial flushing has been completed, clean all strainer screens.
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.
8. Add cleaner to closed systems at concentration levels recommended by the Water Treatment Specialist.

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.
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.
11. Use neutralizing agents upon recommendation of the Water Treatment Specialist and as approved by Consultant.
12. Inspect, remove sludge and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

END OF SECTION

7 DOMESTIC WATER PIPING AND VALVES

7.1 GENERAL

7.1.1 NSF/ANSI 61, DRINKING WATER SYSTEM COMPONENTS-HEALTH EFFECTS

1. All products specified in this Section that are in contact with domestic water are to be NSF/ANSI 61 certified.

7.2 PRODUCTS

7.2.1 PIPE, FITTINGS AND JOINTS

1. Hard Copper - Solder Joint: Type "L" hard drawn seamless copper to ASTM B88, complete with wrought copper solder type fittings to ASME/ANSI B16.22 and soldered joints using NSF/ANSI 61 certified silver alloy lead-free solder for cold water pipe, with flux to ASTM B813.

7.2.2 SHUT-OFF VALVES

1. Lead free, 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 and ends to suit the piping being connected. Valves in insulated piping are to be complete with stem extensions. Acceptable manufacturers are:
    - Toyo Valve Co.
    - Milwaukee Valve Co.
    - Kitz Corporation
    - Conbraco Industries Inc. Apollo
    - Watts Water Technologies Inc.

7.3 EXECUTION

7.3.1 DEMOLITION

1. Do all required domestic water system demolition work outlined in attached drawing package. Refer to demolition requirements specified in the mechanical work Section entitled Demolition and Revision Work.

7.3.2 PIPING INSTALLATION REQUIREMENTS

1. Provide all required domestic water piping.
2. Piping is to be Type "L" hard copper with solder joints.
3. 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.
4. All plate heat exchangers shall be protected by inline filtration systems.
5. All piping must be installed with enough space to allow for disassembly and removal of equipment and components per manufacturer recommendations.
6. All branch lines shall be installed with isolation and bypass lines with valves to allow for maintenance.
7. All drains shall be sloped towards drain.
8. 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.
9. All dissimilar metals shall be connected with dielectric couplings appropriate for the application.
10. All bolt threads shall be lubricated with anti-seize compound.
11. All piping which has potential for freezing, water condensation, and heat loss shall be protected by the appropriate insulation, vapor barrier, cladding, and heat tracing where required.
12. All piping exposed to the outdoor environment shall be weather-proofed, protected from UV, and insulation protected with aluminium cladding.
13. All indoor piping insulation shall be protected by a minimum of PVC cladding.
14. Piping shall be installed to prevent air traps. Where required, install air vents at high points, heat transfer coils, and elsewhere and drains in all low points, drain points, heat transfer outlets, and elsewhere to ensure reliable operation and maintenance.
15. A pressure test of 50 psig shall be applied to all piping before being put into service. Pressure testing shall be held for 24 hrs. A picture detailing the gauge with a time stamp at the beginning and end of pressure test shall be supplied to The Consultant.

16. 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. The Contractor will provide marked up P&IDs listing valve tag numbers at the end of the project.

7.3.3 PIPING SUPPORTS

1. All hangers, supports, and sway braces are to be in accordance with MSS SP58.
2. All piping to be installed and supported per piping manufacturer recommendations.
3. All hangers located in corrosive environments or outdoors must be stainless steel aluminium, or at a minimum hot dipped galvanized. All hangers inside the mechanical room may be painted or hot dipped galvanized.
4. Ensure steel hangers in contact with copper piping are at a minimum epoxy coated.
5. All copper piping must be not come into direct contact with steel. Support to be copper plated with black steel at a minimum.
6. Ensure steel hangers are in tensile load only.
7. 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.
8. Ensure that hanger rod is vertical in operating conditions.
9. All outside rooftop riser clamps to be stainless steel, aluminium, or at a minimum hot dipped galvanized.
10. Piping supports shall be supported by bolts and only welded upon approval from a structural engineer.
11. All clevis plates must be secured with a minimum of 4 concrete inserts, one at each corner.
12. Per good piping practice, the following copper 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.

NOMINAL PIPE SIZE	ROD DIAMETER	MAXIMUM SPACING			
		PVC*			
		STEEL	SCHEDUAL 40	SCHEDUAL 80	COPPER
⅜″ – 1 ¼″	⅜″	7′	4′	4′	5′
1 ½″	⅜″	9′	5′	5′	8′
2″	⅜″	10′	5′	6′	8′
2 ½″	½″	11′	6′	6′	9′
3″	½″	12′	6′	7′	10′
3 ½″	½″	13′	6′	7′	11′
4″	⅝″	14′	6′	7′	12′
5″	⅝″	16′	6′	7′	13′
6″	¾″	17′	7′	9′	14′
8″	¾″	19′	8′	9′	16′
10″	⅞″	22′	8′	10′	
12″	⅞″	23′	9′	10′	
14″	1″	25′	10′	11′	
16″	1″	27′	10′	11′	

13. Piping and tubing smaller than 1-in may require more supports to reduce piping vibrations. The Contractor must install sufficient supports to avoid excessive vibration.
14. All piping must be supported.
15. 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.
16. Piping clamps and supports used on pipe transporting fluid above ambient air temperatures may penetrate through insulation.
17. Piping clamps and supports used on piping operating below ambient air temperatures shall not penetrate through insulation.

7.3.4 FLUSHING AND CHLORINATION OF WATER LINES

1. All new domestic water piping shall be thoroughly flushed so that it is free from scale, sediment, construction debris etc.
2. On completion of installation and testing of the potable water systems, pre-flush, chlorinate with Sodium Hypochlorite to AWWA C651-05 specifications and let stand for 24 hours. Thoroughly flush again until flush water meets AWWA standards.

3. Retain an independent inspection firm to supervise and inspect the chlorination and flushing procedures and perform chemical tests as required.
4. Submit to the Consultant, a certificate from the testing firm, stating that the chlorination and flushing have been successfully carried out.

7.3.5 COMMISSIONING OF PLUMBING SYSTEMS

1. Commissioning is the process of advancing the installation from the stage of static completion to full working order in accordance with the contract documents and design intent. It is the activation of the completed installation.
2. Provide commissioning of all plumbing piping, equipment and systems including the following:
    - Domestic cold water
    - Domestic hot water and recirculation
    - Tempered water and recirculation
    - Sanitary waste and venting
    - Storm drainage
    - Natural gas
    - Tanks, pumps, and all other equipment
3. Commissioning related to plumbing systems shall include the start-up, set up, adjustment and recording of the operational data of at least all of the following systems and components as related to the project:
    - Incoming municipal water pressure
    - Pressure reducing valve set points and downstream pressures
    - Domestic water heater temperature set points
    - Balancing of the domestic hot water recirculation systems
    - Setting of temperature limit stops on all shower valves with maximum temperatures recorded for each fixture
    - Operation of all plumbing fixtures and adjustments of all flush valves
    - Verification of pump operation
    - Set points for all control devices
    - Testing and certification of all backflow preventers
    - Sump pump operation and high water alarms

END OF SECTION

8 STANDARD DUCTWORK

8.1 GENERAL

8.1.1 SUBMITTALS

1. **Product Data:** Submit product data sheets for all products specified in this Section except shop fabricated ductwork and fittings.

8.1.2 QUALITY ASSURANCE

1. Ductwork is to be in accordance with requirements of the following Standards:
    - ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Coated (Galvannealed) by the Hot-Dip Process
    - ANSI/SMACNA HVAC Duct Construction Standards- Metal and Flexible
    - NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilation Systems
    - CAN/ULC-S110, Standard Methods of Test for Air Ducts
    - 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

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.
2. **Rectangular:** Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.
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.
4. **Flat Oval:** Factory machine fabricated, single wall, 4-ply spiral lock seam duct, fittings, and couplings.

8.2.2 METAL DUCT SYSTEM JOINT SEALANT

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

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

8.3 EXECUTION

8.3.1 DEMOLITION

1. Do all required standard ductwork system demolition/revision work. Refer to demolition requirements specified in the mechanical work Section entitled Demolition and Revision Work.

8.3.2 FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK

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.
2. Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct pressure class designation of minimum 500 Pa (2 in-wg) positive or negative as applicable, a maximum velocity of 10 m/s (2000 fpm), and so that the ductwork does not "drum". All flat surfaces of rectangular ductwork are to be cross-broken. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.

3. 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.
4. Ducts Run Within or Through OWSJ: Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, note that ductwork shown on the mechanical drawings is schematic only and is to be altered as required to suit the steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.
5. 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.
6. Rectangular Duct Support Inside Building: Support horizontal rectangular ducts inside the building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for all ducts that are exposed, and all concealed ducts wider than 500 mm (20-in).
7. Round and Flat Oval Duct Support Inside Building: Support round and flat oval ducts inside the building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at the top of the duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If the duct is insulated, size the strap to suit the diameter of the insulated duct.
8. 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.
9. Watertight Ductwork: Where watertight horizontal ductwork is required, construct the ducts without bottom longitudinal seams. Solder or weld the joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for all galvanized steel ductwork outside the building or otherwise exposed to the elements including fresh air intakes and wherever else shown or specified.

10. **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.
11. **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.
12. **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.
13. **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.

8.3.3 INSTALLATION OF ACOUSTIC LINING

1. Provide acoustic lining in ductwork in locations as follows:
   - wherever shown and/or specified on the drawings
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.

8.3.4 DUCT SYSTEM PROTECTION, CLEANING AND START-UP

1. Temporarily cover all open ends of new ducts during transportation, storage, and construction.
2. Vacuum all dirt and foreign matter from the entire new duct system.
3. Include all labour for a complete site walk-through with testing and balancing personnel following the route of all duct systems to be tested, adjusted, and balanced for the purpose of confirming the proper position and attitude of dampers, the location of pitot tube openings, and any other work affecting the testing and balancing procedures. Perform all corrective work required as a result of this walk-through.

8.3.5 TESTING, ADJUSTING AND BALANCING

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

9 MECHANICAL INSULATION

9.1 GENERAL

9.1.1 APPLICATION

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

1. **Product Data Sheets & WHMIS Sheets:** Product data sheets must confirm that the product conforms to requirements of referenced Codes, Standards, and material properties.
2. **Fire Rated Duct Wrap Certification Letter:** As per Part 3 of this Section, submit a letter from the fire rated duct wrap supplier to certify that the duct wrap has been properly installed.

9.1.3 QUALITY ASSURANCE

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

For the work of this Section:

1. **Concealed** means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.
2. **Exposed** means exposed to normal view during normal conditions and operations.
3. **Domestic Water** means all piping (cold, hot, tempered) extended from the building Municipal supply main.

4. **WHMIS Sheets** means Workplace Hazardous Materials Information System sheets.
5. **Mineral Fibre** means a type of insulation manufactured from molten rock, slag, or glass in accordance with requirements of ASTM C547.
6. **PEX** means cross-linked polyethylene.
7. **Insulation System** means insulation material, fasteners, jacket, and any other accessory.
8. **TIAC** means Thermal Insulation Association of Canada.

9.2 PRODUCTS

9.2.1 INSTALLATION

1. It is the responsibility of the Contractor to ensure that all the proper piping, valves, vessels, and equipment are insulated, per the drawing package and specification documents.

9.2.2 ACCEPTABLE INSULATION PRODUCT MANUFACTURERS

1. Acceptable insulation product manufacturers are listed in Section 4, Products, of the TICA Best Practices Guide.

9.2.3 FIRE HAZARD RATINGS

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.

9.2.4 THERMAL PERFORMANCE

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.

9.2.5 PIPE INSULATION MATERIALS

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:

2. Belform Insulation Ltd. "Koolphen K-Block"
3. Shur-Fit Products Ltd. “Pro-Pipe Supports”
4. 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:
5. Shur-Fit Products Ltd.
6. Armacell Canada Inc.
7. Owens Corning “FOAMGLASS”
8. **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. **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.
10. **Cold Piping Insulation: XPS Extruded Styrofoam (Below 0 °C):** Rigid, sectional, insulation used for cold piping. With a service temperature range of -297 °F to 165 °F (-183 °C to 74 °C).

9.2.6 EQUIPMENT INSULATION MATERIALS

1. **Hot Equipment (Operating above 50 °C) TIAC Standard 1501, Code A6, Flexible Foam Elastomeric:** Closed cell. 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.

2. **Cold Equipment (Operating below the ambient dew point and above 0 °C) TIAC Standard 1501, Code A6, Flexible Foam Elastomeric:** Closed cell. 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.
3. **Cold Equipment Insulation: XPS Extruded Styrofoam (Below 0 °C):** Rigid, sectional, insulation used for cold piping. With a service temperature range of -297 °F to 165 °F (-183 °C to 74 °C).

9.2.7 DUCTWORK SYSTEM INSULATION MATERIALS

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.
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.

9.2.8 PIPE PROTECTION

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.
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.
3. The Contractor is responsible for ensuring that all insulated equipment and piping that has not received the treatment listed in section 9.2.8 is stripped of insulation, treated as listed in section 9.2.8, and re-insulated.

9.2.9 INSULATION FASTENINGS

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.
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.
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.
4. **Adhesive – Closed Cell Foamed Glass Insulation:** Equal to Pittsburgh Corning PC88 multi-purpose two-component adhesive.
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.
6. **Sheet Metal Screws:** No. 10 stainless steel sheet metal screws.

9.2.10 INSULATION VAPOUR BARRIER

1. All vapour barrier to have a permeance rating less than or equal to .02 Perm.
2. All Hot Piping Insulation shall be supplied with manufacturers vapour barrier.
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.
4. ITW Saran 520 tape to be used to seal piping vapour barrier.
5. All butt seams in Saran vapour barrier to be taped with 3” wide Saran 520 tape or Venture Clad Cryogenic Tape.
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.

9.2.11 INSULATION JACKETS AND FINISHES

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.

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.
3. All insulation inside the building 7 feet above grade shall be finished with 0.020" thick, white PVC with a self-seal lap.
4. All insulation inside of the building below 7 feet from grade shall be finished with 0.030" thick, white PVC with a self-seal lap.
5. All insulation exposed to the outdoors, inside the mechanical room, and outside shall be jacketed with 16 mil, stucco embossed, anodized aluminum.

9.2.12 REMOVABLE/REUSABLE INSULATION COVERS

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. All equipment cover insulation and access locations must be approved by the Consultant.
2. **Equipment 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. All equipment cover insulation and access locations must be approved by the Consultant.

9.3 EXECUTION

9.3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

1. Unless otherwise specified, do not insulate the following:
    - Factory insulated equipment and piping
    - Brine Pumps used below the ambient dew point.
    - Domestic water and heating system expansion tanks
2. Do not apply insulation unless piping leakage tests have been satisfactorily completed.
3. Ensure that all surfaces to be insulated are clean and dry.

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.
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.
6. Install hot piping insulation directly over pipes and not over hangers and supports.
7. Install high density jacketing insulation inserts at hangers and supports.
8. Install piping insulation and jacket continuous through pipe openings and sleeves.
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.
10. All joints shall be taped to prevent a break in the vapour barrier.
11. Caulk all joints and fittings in jacketing with a colour matching sealant.
12. Ensure water shedding on all installed jacketing.
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.
14. All damage and dents shall be removed.
15. Exterior surfaces shall be cleaned of any dirt, oil, or other contaminants.
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.
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.
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.

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

1. All shut-off valves and elbows to be factory fabricated.
2. All elbow joints to be tongue and groove.
3. All vessel head insulation to be factory fabricated to match the geometry and contour of the vessel head. All vessel head insulation of 2" or more thickness must be double layer.
4. All Styrofoam PIB pipe insulation 2" and less thickness shall have longitudinal joint of the tongue and groove or ship-lap style joint.
5. All Styrofoam PIB insulation over 2" thick shall be double layer.
6. All piping and vessel sidewall insulation to be supplied in 36" long segments.
7. All insulation 20" finished diameter and smaller to be taped with filament tape every 9".
8. 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. 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.
10. Provide vapor stops on valves, end caps and termination points.

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

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

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.
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 – INSIDE BUILDING & ABOVE GROUND (TEMPERATURE RANGE ABOVE 50 °C)

1. Insulate pipe inside the building and above ground, as scheduled below, in accordance with TIAC Quality Standard 1501, Piping, as follows:
2. **Material:** Type A3 mineral fibre, factor applied vapour barrier and PVC cladding.
3. **Insulation application:** 1501-H for hot piping.
4. **Insulation finish:** CPF/4 PVC jacket for exposed piping

PIPE SERVICE	DIAMETER	INSULATION THICKNESS
DOMESTIC HOT WATER, SUPPLY & RECIRCULATION	TO 40 MM	25 MM
	LARGER THAN 40 MM	50 MM
TEMPERED DOMESTIC WATER	ALL	25 MM
LOW PRESSURE (140 KPA) STEAM	TO 40 MM	25 MM
	LARGER THAN 40 MM	50 MM
LOW PRESSURE CONDENSATE	TO 40 MM	25 MM
	LARGER THAN 40 MM	50 MM
MEDIUM PRESSURE (140-415 KPA) STEAM	TO 40 MM	40 MM
	LARGER THAN 40 MM	50 MM
MEDIUM PRESSURE CONDENSATE	TO 40 MM	40 MM
	LARGER THAN 40 MM	50MM
STEAM BOILER FEED WATER	ALL	40 MM
STEAM BOILER BLOWDOWN	ALL	40 MM
REFRIGERANT SUCTION & HOT GAS (SEE NOTE # 1)	ALL	25 MM
REFRIGERANT HOT GAS BY-PASS (SEE NOTE # 1)	ALL	25 MM
HEAT PUMP EARTH LOOP	ALL	25 MM
HEATING WATER, SUPPLY & RETURN	TO 50 MM	25 MM
	LARGER THAN 50 MM	40 MM
HEATING GLYCOL SOLUTION, SUPPLY & RETURN	TO 50 MM	25 MM
CHILLED GLYCOL SOLUTION, SUPPLY & RETURN	LARGER THAN 50 MM	40 MM
	TO 50 MM	25 MM
PIPING TO BE TRACED WITH HEATING CABLE	LARGER THAN 50 MM	40 MM

5. TIAC Standard 1501 Code A6 foamed elastomeric insulation may be used in lieu of Type A2, with 1501-CA application and specified finish.

9.3.6 PIPE INSULATION REQUIREMENTS – INSIDE BUILDING & ABOVE GROUND (TEMPERATURE RANGE BELOW HIGHEST AMBIENT DEW POINT AND ABOVE 0 °C)

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

Table 1 Pipe Requirements Inside Above 0 °C

PIPE SERVICE	DIAMETER	INSULATION THICKNESS
CHILLED WATER SUPPLY & RETURN	TO 100 MM	25 MM
	LARGER THAN 100 MM	40 MM
CHILLED GLYCOL SOLUTION SUPPLY & RETURN	TO 100 MM	25 MM
	LARGER THAN 100 MM	40 MM
REFRIGERANT SUCTION LINES	ALL	25 MM
HEAT PUMP EARTH LOOP	ALL	25 MM

9.3.7 PIPE INSULATION REQUIREMENTS–INSIDE BUILDING & ABOVE GROUND (TEMPERATURE RANGE BELOW 0 °C)

1. Insulate pipe inside the building and above ground, as scheduled below, in accordance with TIAC Quality Standard 1501, Piping, as follows:
    - **Material:** XPS Extruded Styrofoam, with Henry Blueskin vapour barrier, and PVC jacketing
    - **Insulation application:** 1501-C for cold piping
    - **Insulation finish:** CPF/4 PVC jacket for exposed piping
2. Insulation thickness in accordance with the following table:

NOM PIPE SIZE (IN)	SERVICE TEMPERATURE (°F)					
	-60.0	-40.0	-20.0	00	20.0	40.0
1/2	2.5	2.0	2.0	1.5	1.5	1.0
3/4	2.5	2.5	2.0	2.0	1.5	1.5
1	2.5	2.5	2.0	2.0	1.5	1.5
1 1/4	3.0	2.5	2.5	2.0	1.5	1.5
1 1/2	2.5	2.0	2.5	2.0	1.5	1.5
2	3.0	2.5	2.5	2.0	1.5	1.5
2 1/2	2.5	2.5	2.5	2.0	1.5	1.5
3	3.0	3.0	2.5	2.0	2.0	1.5
4	3.0	3.0	2.5	2.5	2.0	1.5
6	3.5	3.0	3.0	2.5	2.0	1.5
8	3.5	3.0	3.0	2.5	2.0	1.5
10	3.5	3.5	3.0	2.5	2.0	1.5
HORIZONTAL. VESSEL	5	4.5	3.5	3	2.5	2.0
VERTICAL. VESSEL	5	4.5	3.5	3	2.5	2.0

9.3.8 PIPE INSULATION REQUIREMENTS – OUTSIDE BUILDING & ABOVE GROUND (TEMPERATURE RANGE ABOVE 25 °C)

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
    - **Insulation finish:** CPF/3

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

9.3.9 PIPE INSULATION REQUIREMENTS – OUTSIDE BUILDING & ABOVE GROUND (TEMPERATURE RANGE BELOW 5C)

1. Insulate pipe outside the building and above ground, as scheduled below, in accordance with TIAC Quality Standard 1501, Piping, as follows:
    - **Material:** XPS Extruded Styrofoam, with Henry Blueskin vapour barrier, and aluminum jacketing
    - **Insulation application:** 1501-H for hot piping
    - **Insulation finish:** CPF/3
2. Insulation thickness shall be as listed in Table 2.

Table 2 Pipe Insulation Requirements Below 5 °C

NOM PIPE SIZE (IN)	SERVICE TEMPERATURE (°F)					
	-60.0	-40.0	-20.0	00	20.0	40.0
1/2	2.5	2.0	2.0	1.5	1.5	1.0
3/4	2.5	2.5	2.0	2.0	1.5	1.5
1	2.5	2.5	2.0	2.0	1.5	1.5
1 1/4	3.0	2.5	2.5	2.0	1.5	1.5
1 1/2	2.5	2.0	2.5	2.0	1.5	1.5
2	3.0	2.5	2.5	2.0	1.5	1.5
2 1/2	2.5	2.5	2.5	2.0	1.5	1.5
3	3.0	3.0	2.5	2.0	2.0	1.5
4	3.0	3.0	2.5	2.5	2.0	1.5
6	3.5	3.0	3.0	2.5	2.0	1.5
8	3.5	3.0	3.0	2.5	2.0	1.5
10	3.5	3.5	3.0	2.5	2.0	1.5
HORIZONTAL. VESSEL	5	4.5	3.5	3	2.5	2.0
VERTICAL VESSEL	5	4.5	3.5	3	2.5	2.0

9.3.10 PIPE INSULATION REQUIREMENTS – UNDERGROUND INSIDE & OUTSIDE BUILDING (BELOW 10C AND ABOVE 30C)

1. Insulate pipe underground inside and outside the building, as scheduled below, in accordance with TIAC Quality Standard 1501, Piping, as follows:
    - **Material:** Type A7 closed cell cellular glass
    - **Insulation application:** 1501-U
    - **Insulation finish:** weather-proof coating as per insulation manufacturer's instructions

PIPE SERVICE	DIAMETER	INSULATION THICKNESS
HEATING WATER, SUPPLY & RETURN	ALL	50 MM
CHILLED WATER, SUPPLY & RETURN	ALL	50 MM
HEATING GLYCOL SOLUTION, SUPPLY & RETURN	ALL	50 MM
CHILLED GLYCOL SOLUTION SUPPLY AND RETURN	ALL	50 MM
CHILLED BRINE SOLUTION SUPPLY AND RETURN	ALL	50 MM

9.3.11 EQUIPMENT INSULATION REQUIREMENTS – INSIDE BUILDING (ABOVE 40 °C)

1. Insulate equipment inside the building, as scheduled below, in accordance with TIAC Quality Standard 1503, Equipment, as follows:
    - **Material:** Type A1D semi-rigid mineral fiber, with vapour barrier, and PVC jacketing
    - **Insulation application:** 1503-H for hot tanks and equipment
    - **Insulation finish:** CEF/2 for hot tanks and equipment

EQUIPMENT	INSULATION THICKNESS
ALL EQUIPMENT ABOVE 60 °C	50 MM
ALL EQUIPMENT UP TO 60 °C	25 MM

9.3.12 EQUIPMENT INSULATION REQUIREMENTS – INSIDE BUILDING (BELOW HIGHEST AMBIENT DEW POINT AND ABOVE 0 °C)

1. Insulate equipment inside the building, as scheduled below, in accordance with TIAC Quality Standard 1503, Equipment, as follows:
    - **Material:** Fibre Flexible Foam Elastomeric, with vapour barrier, and PVC jacketing
    - **Insulation application:** 1503-C for cold tanks and equipment
    - **Insulation finish:** CEF/1 for cold tanks and equipment

EQUIPMENT	INSULATION THICKNESS
ALL EQUIPMENT	25 MM

9.3.13 EQUIPMENT INSULATION REQUIREMENTS – INSIDE BUILDING (BELOW 0 °C)

1. Insulate equipment inside the building the building, as scheduled below, in accordance with TIAC Quality Standard 1503, Equipment, as follows:
    - **Material:** XPS Extruded Styrofoam, with Henry Blueskin vapour barrier, and PVC jacketing
    - **Insulation application:** 1503-C for cold tanks and equipment
    - **Insulation finish:** CEF/1 for cold tanks and equipment

Table 3 Pipe Insulation Thickness

NOM PIPE SIZE (IN)	SERVICE TEMPERATURE (°F)					
	-60.0	-40.0	-20.0	00	20.0	40.0
1/2	2.5	2.0	2.0	1.5	1.5	1.0
3/4	2.5	2.5	2.0	2.0	1.5	1.5
1	2.5	2.5	2.0	2.0	1.5	1.5
1 1/4	3.0	2.5	2.5	2.0	1.5	1.5
1 1/2	2.5	2.0	2.5	2.0	1.5	1.5
2	3.0	2.5	2.5	2.0	1.5	1.5
2 1/2	2.5	2.5	2.5	2.0	1.5	1.5
3	3.0	3.0	2.5	2.0	2.0	1.5
4	3.0	3.0	2.5	2.5	2.0	1.5
6	3.5	3.0	3.0	2.5	2.0	1.5
8	3.5	3.0	3.0	2.5	2.0	1.5
10	3.5	3.5	3.0	2.5	2.0	1.5
HORIZONTAL VESSEL	5	4.5	3.5	3	2.5	2.0
VERTICAL VESSEL	5	4.5	3.5	3	2.5	2.0

9.3.14 EQUIPMENT INSULATION REQUIREMENTS – REMOVABLE/REUSABLE TYPE

1. Provide custom designed and manufactured removable and reusable insulation covers for the following:
    - Plate type heat exchanger(s)
    - 150 mm (6") diameter and larger piping strainers, backflow preventers,

9.3.15 APPLICATION OF INSULATING AND PROTECTIVE COATINGS

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:
    - 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.
    - Paint all bare metal surfaces associated with mechanical systems with an operating temperature above 60 °C (140 °F) with "ThermaLite" insulating coating.
    - Paint all seismic restraint hardware such as hanger rods, braces, anchors, etc., as specified on the first two points above.

END OF SECTION

10 CONTROLS

10.1 GENERAL

10.1.1 QUALITY ASSURANCE

1. Control system must be thoroughly tested for functionality following the integration of all new equipment to ensure proper operation in all scenarios.
2. Proof of proper operation is to be provided to the Owner and to the Consultant.
3. Contractor is responsible for providing the Consultant with control system remote access for the first year of operation.

10.2 PRODUCTS

10.2.1 CONTROLS SYSTEM

1. Acceptable controls system manufacturers include Delta, Reliable and any equivalent brand with respect to options, functionality, quality, and control.
2. Contractor shall modify and integrate with the existing controls system unless noted otherwise.
3. Contractor to provide a controls system that can be accessed and controlled remotely using an internet connection.
4. The controls system must not be locked down by the Contractor. The Contractor must ensure that all programs are editable by the Owner, Consultant, or other contractors.
5. The Contractor must deliver a copy of the program, graphics, and remote access information to the Owner.

10.2.2 VARIABLE FREQUENCY DRIVES (VFD)

1. Contractor to provide all VFDs. Existing VFDs may be reused with approval from the Consultant or the Owner.
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.
3. VFD shall have a digital start signal and an analog speed signal.
4. VFD shall be provided with bypass contactors unless specified otherwise.
5. VFD shall include a NEMA 1 enclosure, load reactors, drive fusing and disconnect switch.

6. VFD for motors greater than 10HP(7.5kW), shall be provided with passive harmonic filters to limit the total harmonic distortion from the VFD to 5%.
7. Passive harmonic filters shall consist of an inductive-capacitive network in parallel with the load.
8. 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).

10.2.3 TEMPERATRE TRANSMITTERS

1. All temperature transmitters are to be mounted in wells with the probe in the fluid flow.
2. All temperature transmitters are to have operating temperature ranges suitable for the application.

10.2.4 CURRENT TRANSMITTERS

1. Current transmitters shall be sized to measure the entire operating current range of the electrical load they are controlling.

10.2.5 AMMONIA SENSORS

1. Ammonia sensors shall meet all requirements of the currently adopted revision of the CSA B52.

10.3 EXECUTION

10.3.1 CONTROL SYSTEM

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

10.3.2 GRAPHICS PACKAGE

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

1. All sensors, wiring, and mounting locations shall be installed per the controls section of the detailed design drawings.
2. CTs will be installed on all mechanical loads above 5 hp to allow for energy modeling.
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.
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

1. All wires must be neat and orderly.
2. All exposed wires are to be routed in conduit.
3. All outdoor wiring and sensors are to be installed in the appropriate NEMA enclosures, conduit, and terminal boxes.

10.3.5 VFDS

1. All VFD will be controlled by a digital start command and a 0 to 10V or 4-20mA signal from the main controls system.
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.
3. DV/DT filters are to be used any time a VFD is over 50ft away from the load it is controlling.
4. Install VFD in a clean and dry location per the manufacturer's specifications.
5. VFDs that can be subjected to splashes or leaks from nearby mechanical equipment must be provided with a suitable NEMA enclosure.
6. Integrate VFD with the main controls system.
7. Install VFD with load reactors if the wire between the VFD and the load is longer than 50 feet.
8. At minimum, install VFD controlling the following items with a bypass:
    - Primary glycol and brine pumps
    - Cooling tower and condenser fan motors
    - Cooling tower and condenser water pumps

10.3.6 POST INSTALLATION

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

10.3.7 TRAINING AND MANUAL

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

END OF SECTION

11 ARENA FLOOR REPLACEMENT

11.1 GENERAL

11.1.1 SUMMARY

1. Design of concrete materials, installation and finishing, admixtures, reinforcing materials, infill materials, and under-slab insulation are to be provided by a structural engineer. Any details about these topics found in this specification will be overridden by structural and/or architectural.
2. Drawings, General Conditions, Division 1 Specification and documents that apply to all work referred to in this section.
3. Contractor to provide experienced management and supervision over the workmanship of skilled tradesmen participating in this scope of work.
4. Contractor to provide quality materials, products, modern specialty tools, and all equipment required to ensure a complete and high-quality install of the refrigerated slab.
5. The contractor shall perform all HDPE fusion joints in strict accordance with the pipe and fitting manufacturers' procedures and specifications. Only approved fusion methods, equipment, and parameters shall be used, and all work must be completed by personnel certified for the applicable fusion techniques.
6. Contractor responsible for all components of the installation, including placement, consolidation, finishing, and curing of concrete refrigerated slab, as required and/or indicated on drawings and specified within this section.
7. Acceptable Contractors:
    - Brysand Ice Arena LTD 780-461-6734
    - Reward Construction Ltd. 1-877-725-8001
    - Gustaldo Concrete 604-525-3636
8. The Successful Contractor must have all required Licencing to carry out this project in the Province of BC.

11.1.2 REFERENCES

1. CAN/ULS S701-05 Thermal Insulation, Polystyrene, Boards and Pipe Covering
2. CAN/CSA-A23.2-14 Standard Test Method for Determining Average Elevation, Slope and Waviness

11.1.3 SUBMITTALS

1. All submittals and shop drawings must be submitted for approval at least two weeks prior to starting work on the item in question.
2. **Product Data:** Submit data for each accessory, admixture, and curing material proposed for the work.
3. **Shop Drawings:** Submit shop drawings for concrete reinforcement, bar support, and accessories for review by the Consultant at least 14 days prior to the placement of the rebar.
    - Clearly indicate reinforcement sizes, spacing, locations and quantities of reinforcing, bending and cutting schedules, splicing, and supporting and spacing devices.
    - Shop drawings should indicate procedures, equipment, and all components pertinent to the refrigerated concrete floor, including but not limited to, insulation, piping, electrofusion couplings, pipe chairs, reinforcing steel, placing, and finishing of concrete.
4. **Quality Control Submittals:** Data sheets shall be submitted on the following items at least two weeks prior to ordering them: All slab reinforcing materials, all arena floor piping, arena floor return bends, arena floor U-bends, 6 mil vapour barrier, insulation, sand, expansion joint, and main cooling and heating headers.
5. **Certifications:**
    - Submit certificates for cement, fly ash, and aggregates, if required by engineer.
6. **Closeout Submittal:** Provide an isometric weld map for the piping network, detailing all fusion joints. Each joint shall be assigned a unique identification number and supported with photographic documentation, HDPE Fusion Record sheet, and data sheet for any pre-fabricated fittings used.
7. **Closeout Submittal:** Submit maintenance instructions to the owner's representative and the consultant for all finishes within this section.
8. **Closeout Submittal:** Submit a slab floor tolerance report to the owner's representative and consultant. A maximum grid size of 1500mm X 1500mm is to be used when taking measurements.

11.1.4 QUALITY ASSURANCE

1. Initiate a pre-pour conference a minimum of 14 days prior to the refrigerated concrete floor pour.
2. Notify Consultants at least 48 hours before concrete is scheduled to pour.

3. **Qualifications:** The refrigerated floor contractor must provide sufficient proof to the Consultants that all of the conditions below can be met, prior to issuing a contract for the work.
    - Work shall be performed by a company regularly engaged in the installation of refrigerated concrete floors and the application of concrete materials. Provide proof to the Consultants that the contractor has successfully completed at least five (5) projects of similar size and complexity in the past five (5) years.
    - Concrete slab work shall be performed by an established concrete floor finishing contractor with a proven track record of satisfactory, consistent-quality workmanship for a minimum period of five years related to refrigerated floor slab and other stringent floor tolerance specified concrete floor slabs.
    - HDPE piping work shall be performed only by a contractor who holds valid and current certification for all HDPE fusion welding methods required for the construction of the refrigerated floor, including butt fusion, saddle fusion, socket fusion, electrofusion, and any other applicable fusion techniques.
4. **Warranty:** Provide written warranty against defects which appear in the finished work within a period of 1 year after acceptance of the building by the Owner, and which are judged by the Consultant to be the result of lack of bond, faulty workmanship or materials provided under this section.
5. **Coordination:**
    - Coordinate the work of this section with the Ice Refrigeration Section and Caulking and Sealant Section.
    - Coordinate the location of inserts for hockey goals, dasher boards, ice creation enclosures, and inserts for other events.
    - Coordinate refrigeration contractor to ensure at least two refrigeration contractor representatives are onsite during the pour to fix issues with refrigerated floor piping.

11.1.5 SITE CONDITIONS

1. **Protection:**
    - Keep traffic which would affect or disturb the curing procedures off the surfaces for a period of 7 days minimum.

- Protect exposed concrete finishes against damage until the building is accepted by the Owner.
- Protect items set into floors from damage; ensure that alignment is not disturbed.

11.1.6 INSPECTIONS AND TESTING

1. The arena slab contactor shall hire a third-party geotechnical firm to perform the following work. To ensure a successful project, the Owner retains the right to obtain a separate third-party geotechnical firm to confirm testing and inspection results. All testing and inspection reports must be provided to the Owner's Representative and the Consultants for review.
    - Test compaction and condition of the sub-base once the excavation is complete.
    - Advise on the need for any sub-floor drainage system.
    - Test level of compaction of the final layer of sand per this specification.
    - Inspect the top of the first layer of insulation and remove any high points in the sand prior to the installation of the second layer of insulation.
    - Test the top of the insulation for elevation and flatness. The project engineer reserves the right to have the sand re-levelled by the arena slab contractor if proper elevation is not met, or if rocking/cracking of insulation panels occurs.
    - Test the top of reinforced slab assembly prior to pour for elevation and flatness.
    - Review and approval of concrete mix design.
    - Provide concrete testing service during the pouring of the ice rink slab.
    - Test the finished floor for level and flatness per this specification.
2. Before starting the concrete pour the arena slab contractor must conduct a floor walk-through and bend all wire mesh, ties, and any other foreign objects that could either penetrate the floor piping or slick up above the top of slab and cause a rust point.

11.1.7 PIPING TESTING

1. All brine piping pressure and leak testing shall be complete in the presence of the Consultant or Owner's Representative.

2. Pneumatic pressure testing of the heating floor piping shall be completed prior to bulk sand placement and construction of the refrigerated slab assembly. Testing shall be performed at 50 PSI and maintained throughout the duration of the arena floor construction.
3. Test heating and cooling floor piping with air to 50 psi for a minimum of 24 hours prior to the concrete pour. Take pictures of testing gauge with time stamp at the beginning and end of the leak test and provide pictures to the Consultant and the Owner's Representative.
    - Ensure that adequate protection is provided for all accessories when performing pressure testing.
4. Air pressure within the piping must not deviate more than 1 psi during a period of 24 hours prior to placing concrete.
    - If the above condition cannot be met, repair leaks and retest as required.
5. Heating and cooling floor piping is to remain pressurized to 50 psi throughout the concrete pour. Air pressure within the piping must not deviate more than 1 psi throughout the concrete pour.
    - The contractor must complete an hourly logbook recording the pressure in the cooling and heating floor piping throughout the concrete pour. Timestamped photos of each pressure gauge to be taken at hourly intervals throughout the pour and provided to the client and consultant.

11.2 PRODUCTS

11.2.1 INSULATION

1. Rigid closed cell, board insulation under rink slab: Extruded polystyrene (XPS) board complying with, Type 4 RSI-1 per 25mm (R-5) thickness.
    - Compressive strength requirements of the insulation material to be specified by the structural consultant.

11.2.2 RINK VAPOUR BARRIER

1. Above sand, below insulation vapour barrier: Minimum (6 mil) thick polyethylene sheet. Polyethylene film must not be bonded to the insulation.
2. Above insulation, below concrete vapour barrier: Minimum (6 mil) thick polyethylene sheet. Polyethylene film must not be bonded to the insulation.

11.2.3 COLD BRINE HEADERS

1. Contractor to provide all cold brine headers, as indicated in the associated drawing package.
2. **Cold brine headers:**
   - Header size: As indicated in associated drawing package.
   - Header Material: SDR 11 HDPE piping
3. **Cold brine header pipe nipples:**
   - Size: 1" SDR 11 HDPE Saddles
   - Spacing on header: 50mm in from outside edges of refrigerated slab and 100mm spacing on remainder of header.
   - Install one perimeter loop on the outside of the dashboard anchors, unless otherwise noted in the associated drawing package.
4. Provide butterfly valves to isolate the cold supply header in mechanical room.
5. Provide 1" drain and 1" purge valves at both ends of the cold supply header and at the inlet side of each floor isolation valve.

11.2.4 COLD FLOOR PIPING

1. Contractor to provide all cold floor piping, as indicated in the associated drawing package.
2. All cold floor piping circuits are to be run parallel and connected to each header saddle.
   - Material: 25mm (1" ID) SDR 11 High Density Polyethylene rink pipe.
3. **Cold floor piping header connection:** All nipple joints to be socket fused on to header saddles with appropriate socket fusing irons. .
4. Cold floor piping return bends:
   - Premanufactured SDR 11 HDPE U-bends.
   - Joints to be socket fused with appropriate socket fusing irons.
   - U-bends to be attached to rebar at the end of the ice surface opposite to the header to ensure proper placement during concrete pour.

11.2.5 HEATING BRINE/GLYCOL HEADERS:

1. Contractor to provide all heating brine/glycol headers, as indicated in the associated drawing package.
2. **Heating brine/glycol headers:**
   - Header size: As indicated in associated drawing package.

- Header Material: SDR 11 HDPE piping

3. Heating brine/glycol header pipe nipples:
    - Size: 1" SDR 11 HDPE Saddles
    - Spacing on header: 300mm
4. Provide butterfly valves to isolate each heating brine/glycol header for each floor.
5. Provide 1" drain and 1" purge valves at both ends of each header and at the inlet side of each floor isolation valve.

11.2.6 HEATING FLOOR PIPING

1. Contractor to provide all heating floor piping, as indicated in the associated drawing package.
2. All heating floor piping circuits are to be run as they are shown in the associated drawing package.
    - Material: 25mm (1" ID) SDR 11 High Density Polyethylene rink pipe.
3. Heating floor header connection: All nipple joints to be socket fused on to header saddles with appropriate socket fusing irons.
4. If indicated in the associated drawing package, Contractor to provide manual balancing valves appropriate for the fluid on each heating floor circuit.
5. Heating floor return bends: Use continuous floor pipe at a minimum radius of 18" for the return bend.

11.2.7 EXPANSION JOINT

1. Provide 1" cold joint expansion joint caulking around slab perimeter: Sikaflex 2C SL self-levelling expansion joint material or RHC900 Tremco self-levelling polyurethane expansion joint material.

11.3 EXECUTION

11.3.1 PRE-CONSTRUCTION

1. There must be no overhead work or adjacent construction work taking place in the ice arena that could result in screws, nails or sharp objects entering the works of the refrigerated slab.
2. There is to be no smoking on the entire property, including around the refrigerated floor work area, and all work is to be carried out to the latest Work Safe BC Regulations.

3. Overhead lighting or adequate temporary lighting must be in place and functioning.
4. The Consultant, Concrete Contractor, Dasher board Contractor, Ice Maker and the Owner must all sign off on the length and width of the refrigerated floor.
5. The length and width of the warm perimeter deck opening must be measured and documented before the perimeter concrete is poured.
6. The expected finish elevation of the rink pipes must be reviewed and documented before the insulation is put in place. The objective is to achieve 1.5" concrete cover over all cold floor piping using M-style pipe chairs to lift the pipe, unless otherwise noted by the structural consultant.
7. Total refrigerated slab depth of 6", unless otherwise noted in the associated drawing package.
8. Secure and tape off all entrances and clearly mark that the refrigerated floor must not be walked on during construction. Contractor is responsible to secure the floor from being damaged and walked on.

11.3.2 INSPECTION

1. Prior to starting work, carefully examine installed work of other trades and verify that such is complete to the point where work of this section may properly commence. Notify Consultant in writing of conditions detrimental to the proper and timely completion of the work.
2. Do not begin installation until all unsatisfactory conditions are resolved.
3. Verify that sub-slab has been properly placed and levels are within acceptable tolerances.

11.3.3 INSTALLATION – SAND BED

1. Before placing sand, the contractor shall inspect the sub-base and remove all large rocks, construction debris, and any foreign objects that could damage the rink piping.
2. Unless otherwise noted, provide a minimum 12" sand bed.
3. Place sand in a minimum of two lifts, one below the heating floor piping and one above. Compact sand between each lift.
4. All heating floor piping must have a minimum of 2" of sand below to ensure pipe is protected from any material in the sub-base. Install warm floor rink pipe in conjunction with the sand bed.
5. Ensure that the sand is graded to the required tolerance:

- 6 mm variation within a 3000 mm straight edge
- Overall variation of ± 6 mm

11.3.4 INSTALLATION – HEATING FLOOR HDPE PIPING

1. Install heating floor piping per drawings and onsite meetings.
2. Heating floor pipe spacing to be 12" on center, unless otherwise noted in the drawing package.
3. Contractor shall maintain a log verifying that each HDPE saddle is properly drilled at the header, including joint ID number, joint location, date, and installer.
4. Provide cast-in-place access boxes for air purging on each side of the arena slab, as indicated in the associated drawing package.
    - The cast-in-place box and lid shall be rated to support the intended arena loads, including dry-floor events such as monster trucks, agricultural exhibitions, or similar activities, if applicable.
5. Install 1" purge valves at both ends of the supply and return headers to vent air during commissioning. Route purge piping to cast-in-place access boxes.
6. HDPE piping shall transition to steel when entering the ammonia mechanical room or other fire-rated spaces. Exposed HDPE piping within any fire-rated space shall be protected with a fire-rated collar, sleeve, or insulation in accordance with the Fire Code and other applicable standards.
7. Prior to completing the bulk sand fill, place piping under 50 psi pneumatic pressure test to confirm air tightness. Ensure heating floor piping remains pressurized for the duration of the arena floor installation.

11.3.5 INSTALLATION – VAPOUR BARRIER

1. Install polyethylene sheet with 150 mm lapped joints to provide a surface effectively resistant to absorption or moisture transmission.
2. The bottom layer of vapour barrier must be provided in a quantity that allows it to wrap around the insulation at the edges and overlap the top layer of vapour barrier by a minimum of 24 inches.
3. Polyethylene sheets must be sealed at laps.
4. Any damage to the slip sheet shall be effectively repaired to preserve the integrity of the moisture resistant surface prior to pouring the refrigerated slab.
5. Maintain slip sheet surfaces clean and free of contaminates at all times.

11.3.6 INSTALLATION – UNDER SLAB INSULATION

1. Install insulation under rink slab area in the quantity and thickness indicated in the associated drawing package.
2. Lay insulation boards tightly butted with joints staggered and secure such that insulation is not damaged or displaced when concrete is placed.
3. Following installation of the first insulation layer, install subsequent layers in a way that ensures that the joints do not line up with the joints of the previous layer.
4. Complete top of insulation elevation and level survey and submit to the Consultant and Owner's Representative. Detailed elevation and level report to be submitted in a topographical manner. This is a critical point in the installation of a subbase as it will ensure the top of slab is at the correct elevation.
    - Surveyor to stand on top of insulation board being tested to ensure air below has been removed.
    - Surveyor to use blunt survey rod to prevent indentation of foam insulation.

11.3.7 INSTALLATION – CHAIRS, REINFORCING

1. Place "M" style pipe chair supports of continuous metal base type at 600mm centres on the top layer of vapour barrier.
2. Grind off any sharp ends that could potentially damage the rink piping,
3. Ensure that chairs are properly installed for top drop rebar placement with 6M longitudinal piece on the bottom and 6m latitudinal piece on the top.
4. All chairs to be placed to ensure top layer of rebar will be at the bottom of the cooling floor piping. This will ensure the cooling floor piping is supported every 12".
5. Do not secure the cooling floor piping to the cross-support rebar.

11.3.8 INSTALLATION – THERMAL WELLS

1. Install two thermal wells inside the heating floor, and another two inside the cooling floor, at the locations indicated in the drawing package. The two thermal wells in each set (heating and cooling) are to offset by a minimum distance of 20ft.
2. Thermal wells to penetrate at least 10' into the cooling floor and heating floor from the edge of the refrigerated slab.

3. Thermal wells to be accessible for maintenance after the installation of the slab. Route thermal wells to access box and provide label indicating cold or warm floor service.
4. Provide cast-in-place access boxes to serve as temperature probe pull station, allowing temperature probes to be calibrated and replaced as required.
    - The cast-in-place box and lid shall be rated to support the intended arena loads, including dry-floor events such as monster trucks, agricultural exhibitions, or similar activities, if applicable.
5. Final location of access boxes and thermal wells to be approved by the Owner's Representative and Refrigeration Consultant prior to construction.
6. A shear sleeve shall be installed around each thermal well passing through the perimeter slab to accommodate differential movement at the refrigerated slab interface.

11.3.9 INSTALLATION – COOLING FLOOR HDPE PIPING

1. Install systems and related controls in accordance with reviewed shop drawings.
2. Install cooling floor piping per project drawings, reviewed shop drawings, and onsite meetings.
3. Ensure that all cooling floor headers installed below the refrigerated slab are installed with at least 2" of direct burial insulation and vapour barrier intended for this purpose. Please see insulation specification for more information.
4. Direct burial piping and insulation to be installed per civil engineering instructions.
5. Install cooling and heating headers per project drawings and support piping appropriately.
6. Install cooling floor piping on a two-pass configuration. Cooling floor piping to be placed on a 4" centre to centre layout, unless otherwise noted.
7. If indicated in the associated drawings, install one perimeter loop to ensure adequate cooling under arena dasher boards.
8. Do not tie pipes to the chairs in any way that would prevent normal sliding within the chair. This said, piping may be tied to the chairs with plastic zap straps.
9. Contractor shall maintain a log verifying that each HDPE saddle is properly drilled at the header, including joint ID number, joint location, date, and installer.

10. Once piping is installed, place under 50 psi pneumatic pressure test and ensure cold floor piping remains pressurized for the duration of the arena floor installation.
11. Provide cast-in-place access boxes for air purging on each side of the arena slab, as indicated in the associated drawing package.
    - The cast-in-place box and lid shall be rated to support the intended arena loads, including dry-floor events such as monster trucks, agricultural exhibitions, or similar activities, if applicable.
12. Install 1" purge valves at both ends of the supply and return headers to vent air during commissioning. Route purge piping to the cast-in-place access boxes.
13. Purge piping shall be sleeved from the access box through the perimeter concrete slab to accommodate differential movement caused by thermal expansion and contraction.
14. Install expansion tank as shown in project drawings.
    - Unless otherwise noted, connect low point of tank to return header and high point of tank to supply header.
    - Unless otherwise noted, expansion tank to be open to the air and transparent to allow for checking of brine level during arena operation.
15. Run all connection piping as per drawings to minimize service conflicts.
16. Contractor to provide all secondary support structures and hangers as required.
17. All cutting, patching, and coring, as required to install piping, is the responsibility of the installing arena floor contractor or the general contractor, at the discretion of the general contractor. Location of all wall penetrations and concrete cutting must be approved by the site Structural Consultant and Owner's Representative prior to work beginning.
18. As required by CSA B52, the arena floor contractor must ensure all piping penetrations going in and out of a Class "T" mechanical room have appropriate fire stopping.
19. Unless otherwise noted, HDPE piping shall transition to steel when entering the ammonia mechanical room or other fire-rated spaces. Exposed HDPE piping within the mechanical room shall be protected with a fire-rated collar, sleeve, or insulation, in accordance with the Fire Code and other applicable standards.

11.3.10 INSTALLATION – HDPE ELECTROFUSION JOINTS

1. All HDPE electrofusion joints shall be installed in strict accordance with the pipe and fitting manufacturer's instructions and specifications. Only trained and certified personnel may perform fusion.
2. Pipe surfaces shall be properly cleaned, scraped, and free of contaminants before fusion, per manufacturer guidelines. Environmental conditions (temperature, moisture) must meet manufacturer requirements.
3. Electrofusion shall be performed using approved control units with calibrated output. Fusion parameters, including voltage, time, and cooling duration, shall be recorded and follow manufacturer specifications exactly.
4. Pipes and fittings must be properly aligned and restrained to prevent movement during fusion and cooling.
5. Each joint shall be visually inspected for proper bead formation and logged in a fusion record, including joint ID, date, installer, and photo documentation. Defective joints shall be removed and replaced.

11.3.11 INSTALLATION – EXPANSION JOINT

1. Place closed cell expanded, polystyrene insulation 25 mm (wide), expansion strip around perimeter of the refrigerated slab. Joint material shall be properly set in place against concrete bulkhead and must run from top of insulation to finished elevation of rink slab.
2. Expansion joint shall be sealed with premium-grade, polyurethane-based, elastomeric sealant.

11.3.12 FLOOR SLAB TOLERANCE

1. See structural for more information regarding concrete finishing and slab tolerance.

11.3.13 REFRIGERATED SLAB COMISSIONING

1. The concrete slab shall be cured in accordance with the instructions of the structural consultant.
2. Concrete testing shall be performed by the contractor and reviewed by the structural consultant prior to placing the new refrigerated slab into service.
3. The floor should be thoroughly cleaned and rinsed prior to pulldown. A non-oil-based detergent maybe applied with warm water via power scrubber or hand mop to ensure any traces of petroleum-based distillates have been removed.

4. Pull the floor slab temperature down from its initial temperature to 2°C at a rate of 5°C per day. The refrigeration slab must not be cooled at a rate greater than 5°C per day, unless approved by the Refrigeration and Structural Consultants. Full refrigeration system capacity will be employed to minimize the time required to reduce the floor slab temperature.
5. Hold the floor slab at 2°C for a minimum of 48 hours.
6. Pull down the floor slab at a rate of 3°C per day until the desired refrigerated slab temperature setpoint is reached.
7. Begin ice installation and painting process.

END OF SECTION

12 ARENA DASHER BOARD REPLACEMENT

12.1 GENERAL

12.1.1 GENERAL

1. Comply with requirements of General and Supplementary Conditions, and Division 1, General Requirements.

12.1.2 SECTION INCLUSION

1. The work of this Section shall include, but not be limited to, the following:
    - Manufacture, supply and installation of a complete factory prefabricated, arena board system with spectator shielding, including team, penalty and officials' boxes.

12.1.3 RELATED SECTIONS

1. Provide clear access into the rink area by forklift.
2. Final cleaning to be carried out by others as specified in Division 1, General Requirements.

12.1.4 UNIT PRICES

1. Submit unit prices stating the increase or decrease to the Contract Price for all additional or deleted work listed. Unit prices shall include all labour, materials, products, equipment, services and respective overhead, profit, PST, disbursements and related charges, and shall represent the actual addition or credit to the Contract Price.

12.2 PRODUCTS

12.2.1 MANUFACTURERS

1. The following manufacturers are acceptable:
    - Athletica Sport Systems
      554 Parkside Drive, Waterloo, Ontario, Canada N2L 5Z4
      Phone: 519-747-1856 Toll-free 1.877.778.5911
    - Cascadia Sport Systems 3012C Murray St, Port Moody BC V3H 1X2
      Phone: 604-461-5208

- Alternate manufacturers will be accepted, provided that the proposed dasher board system meets the requirements laid out in this specification. Alternate products proposed by the Contractor are subject to review by the Consultant and Client.

12.2.2 MATERIALS

1. The following dasher board materials are acceptable:
   - Aluminum Extrusions: ASTM B221, 6005-T5 or T6 alloy and temper.
   - High Density Polyethylene (HDPE): High impact, integrally coloured, virgin, high-density polyethylene, bright white and other colours as specified, ½" thickness.

12.2.3 FABRICATION

1. As far as practical, execute fitting and assembly in the shop with the various parts or assemblies ready for erection at the project site.
2. Accurately fit together all joints, corners and intersections. Match components carefully to produce continuity of line and design.
3. Provide devices for anchoring the assemblies to the substrate with adjustment to permit correct and accurate alignment.
4. Fabricate anchoring devices required to secure the work of this Section. Supply anchors and layout drawing.
5. System components shall be numbered for ease of installation, disassembly, and reinstallation.

12.2.4 ARENA PANELS

1. Arena panels shall be factory prefabricated in demountable sections. The design of all panels whether straight, curved or in which a gate is located shall be similar. Each panel to be 42" (1066mm) in height, and shall be made of extruded structural aluminum box sections assembled into frames using high strength fasteners. Welded steel frame panels are not acceptable. Aluminum to be mill finish. Frames shall allow for fastening of the HDPE facing and anchoring at base. Ensure flush mating of the HDPE facing at arena panel joints.

2. Typical sections shall consist of a minimum two vertical posts and three horizontal stringers. Sections over 5' (1524mm) shall have 3 vertical posts. Frames shall be connected end to end with heavy duty, 5/8" (16mm) bolts and shall be connected to rink slab/perimeter concrete structure with minimum 5/8" (16mm) threaded rods and nuts or bolts, preset into the concrete slab at the time of the pour. All frames must be designed to include a middle back horizontal stringer on the spectator side of the frames to accommodate fastening of spectator-side panels.
3. Cladding: Panels to be clad with ½" (12mm) white High Density Virgin Polyethylene (HDPE) facing the full height of each panel, with ½" (12mm) colour impregnated yellow kickplate, and ½" (12mm) colour impregnated yellow cap rail. Both edges of cap rail shall have a smooth and radiused edge. Top edge of kick plate to have a radiused edge.
4. The HDPE facing shall be attached to the arena board framing with ¼" (6 mm) diameter screws. Screws to be zinc-plated. Heads of screws shall be painted to colour match the facing, kick plate or top cap as appropriate. Spacing of the screws shall not exceed 9" (225 mm) on centre.
5. Colour extensions of red and blue game lines shall be coloured HDPE strips inlaid flush to the HDPE facing and inlaid flush to the HDPE kickplate in conformance with rink layout requirements per governing bodies.

12.2.5 PLAYERS, PENALTY, AND OFFICIALS' BOXES/BENCHES

1. Box back and divider and end walls shall consist of arena board enclosures similar to rink arena boards.
2. Boxes shall consist of two (2) team boxes, two (2) penalty boxes and one (1) timekeeper's box; as located on the drawings. Bench locations and coach's walkways, as located on the drawings.
3. Interior finish of boxes shall be of similar construction as ice-side of arena boards, utilizing 3/8" (10mm) thick HDPE, to height of mid-stringer on front side, full height on other sides. Framing shall be similar construction as arena boards. Provide a water bottle shelf.

4. Player boxes shall be up to 30’ 0” (9144mm) long by 5’ 0” (1524mm) deep, as shown on the drawings. Overall box lengths to remain as existing. Access via open ends on the end of the boxes as existing and shown on the drawings. A divider wall with tempered glass shielding and a padded termination pad, similar in construction to the dasher frames, shall be provided between the players boxes, and located as confirmed by Owner. Ice side access by one gate at each end of the players’ boxes (4 gates). Box sizes to be confirmed on site.
5. Penalty boxes shall be approximately 8’ 0” (2438mm) long by 5’ (1524mm) deep, to match existing locations and sizes and as shown on the drawings, with access via a gated opening on one end, as shown on the drawings. Ice side access by one gate in each penalty box (2 gates) at the end of the box furthest away from the timekeeper. Box sizes to be confirmed on site.
6. Timekeepers' box shall be approximately 80” (2032mm) long by 4’ 8” (1422mm) deep, as existing and indicated on drawings, accessed via the penalty box on each end of the boxes as existing and shown on the drawings. Box sizes to be confirmed on site. Existing audio-visual panel to remain. Resurface existing audio-visual panel with 3/8" (10mm) thick HDPE to match surrounding panels.
7. Benches shall be up to 24’ 0” (7315mm) long in player boxes and full box width in penalty boxes. Benches shall be a nominal 9 1/2” (240mm) deep. Benches shall be extruded aluminum with the seating surface being clad with 1/2" (12.7mm) HDPE.
8. Penalty box benches to be mounted on 22" (560mm) pedestals at 22" (560mm) above floor. Players box benches to be mounted to the existing elevated concrete. Bench pedestals shall be of a ¼” (6mm) zinc plated steel base plate with 1 1/2” x 3” (38.1mm x75mm) steel post. Bench pedestal locations to be positioned along the length of the bench as required.

12.2.6 SPECTATOR SHIELDING

1. Provide ½” (12mm) “Arena Ready” clear tempered glass at the sides, at a height of 72” (1828mm) above the top of the boards in all areas except in front of the players boxes. Shielding in front of the scorers table shall have a 3.25” (82mm) speaker hole.
2. Provide 5/8” (15mm) “Arena Ready” tempered glass at the ends and radius corners at a height of 96” (2438mm) above the top of the boards.

3. Provide new ½" (12mm) "Arena Ready" clear tempered glass at a height of 48" (1220mm) above the dasher frames on the back and sides of the new players and penalty box back and side walls. End and divider wall glass to be rectangular and not sloped.
4. Tempered Safety Glass CAN/CGSB-12.1, Type 2, clear, colourless, fully toughened, heat tempered safety glass. The roll-wave distortion shall not exceed 0.127 mm (0.005") from peak to valley.
5. Each piece of tempered glass shall bear the stamp of approval from the American National Standards Institute (ANSI), in a location that will be visible and legible after boards and shielding are installed.

12.2.7 SPECTATOR SHIELDING SUPPORTS

1. Provision for attachment of shielding glazing to the vertical supports shall be by means of an extruded, mill finish aluminum "Quick Release" shield support. This aluminum support shall run continuously to within 12" (300mm) of the top of the glazing; an extruded face plate will slot into aluminum support with no screws. Plastic "U" shaped gaskets protect the glass edges. At the gates only, the support is a two piece with a screw-applied face plate. The shield support system must facilitate the replacement of shields from the ice side without requiring additional support or securing of the adjacent shields.
    - Shielding and supports shall be designed for easy removal without tools for events when arena boards will remain in place but shielding and shielding supports are to be removed, including the gates.
    - Posts at all shield terminations to be covered on 3 sides by foam padding covered by a vinyl outer layer, that has been tested and certified by engineers approved for this task by the National Hockey League.

12.2.8 GATES

1. Access and Machine gates in locations as shown on drawings, with 1" (25mm) and 1-1/2" (37mm) thick replaceable white HDPE Thresholds.
2. Six (6) players gates shall be built into standard 2440 mm (8' 0") sections and shall be 812mm (32") wide, left or right hand swing, as indicated on the drawings. Gate latch to be a single latch type. The penalty box gates are to be shielded and included ice side push button openers.

3. Provide a flush mounted push-button latch release in the cap rail on the ice entrance gates where shields would otherwise prevent latch operation. The push-button shall be designed to be simple to operate from both sides of the shielding (suitable for opening gates with hockey glove on hand), yet prevent accidental opening.
4. Two corner equipment gates on the north end of the rink shall be a double wing gate with a 10' 0" (3050mm) opening. Each equipment gate unit shall be equipped with one sliding closure bar and two retractable flush cane bolts into the threshold or floor.
5. Two corner access gates on the south end of the rink shall be a double wing gate with a 8' (2438mm) opening. Each gate unit shall be equipped with one latch and push button ice side opener to allow access from the ice side, and 1 sliding closure bar and two retractable flush cane bolts into the threshold or floor to allow the gates to be secured during competitive sports events.
6. Each double wing equipment and access gate unit shall be equipped with adjustable heavy duty spring loaded casters with the direction of travel fixed to the arc of each door, a slide closure bar, 2 cane bolts, and heavy duty adjustable hinges.
7. All machine, access, and player gates to have heavy duty adjustable stainless-steel hinges, stainless steel latches, and hardware.
8. Provide "Gate Levelling Screws" at all gate locations (so the gates can be realigned with the ice in).

12.2.9 BOARD ANCHORS

1. Cast in place, adjustable stainless-steel anchors with 5/8" (16mm) diameter bolt. Anchors to be supplied, located, and installed by Dasher Board Contractor.
2. The dasher board manufacturer shall provide a supervisor on site during the concrete pour to ensure anchor integrity.

12.2.10 PROTECTIVE NETTING

1. Install new 1.5" mesh x 2 mm twine black nylon protective netting, 12-0" (3657mm) high above the glass, from radius to radius in both ends.
2. Install all protective netting on conduit and attach the lower edge of the netting to the shield supports.

12.2.11 DESIGN AND PERFORMANCE REQUIREMENTS

1. Arena board system shall conform to National Hockey League (NHL) dimensions.
2. Design loadings (Specified):
   - Concentrated load P = 2.7 kN (600 lbf) applied at mid span of top rail (i.e. top of arena board assembly). {Note: Player impact load}
   - Uniformly distributed load of 2.7 kN/m (180 lb./ft.) applied along top rail. {Note: Player impact load; OBC 4.1.10.1.(c)}
   - Uniformly distributed load of 4.8 kPa (100 psf) applied across the entire face of the arena board. {Note: Stacking load case}
3. Member Resistances (Factored):
   - Axial Resistance:
     - ♦ Tension: Tr = An.Fy; Tr = 85 An.Fu
     - ♦ Compression: Cr = A.Fc
   - Shear Resistance:
     - ♦ Vr = 0.60 Aw.Fc; 0.60 Aw.Fy; hNWR
   - Moment Resistance:
     - ♦ Mr = S.Fy (Class 2 Sections)

12.2.12 SITE SURVEY

1. Prior to submitting shop drawings and manufacturing of the new dasher system, the contractor is to visit the site and conduct a detailed site survey to confirm accurate placement and sizes of the anchors, dashers, gates, boxes, and all materials used in the project. Drawings provided by the owner and consultant are for reference only and are not reflective of all existing details.

12.2.13 SUBMITTALS

1. Shop Drawings
   - Shop drawings shall bear the professional stamp and signature of a professional engineer licensed to design structures in the jurisdiction of manufacture.

- Shop drawings shall show, in appropriate scale, dimensions, details of arena board system, glazing assemblies, methods of joining, fastening, joint locations, methods of anchoring, sizes of anchorage's, glazing details and glazing methods, hardware, details of other pertinent components of the work, and adjacent constructions to which work of this Section will be attached.
- Shop drawings shall include a shield layout showing sizes and location of all tempered glass shields.
- Shop drawings shall indicate dimensioned layout and placement drawings for installation of floor anchors.

2. Samples
   - Submit samples of materials, finishes and colours for review.
3. Operation and Maintenance Data
   - On completion of installation, supply three copies of instructions covering removal and replacement of panel system, reglazing, adjustments and other relevant operating and maintenance data.
   - Provide "As Built" drawings showing overall layout of the boards and glass.

12.2.14 QUALITY ASSURANCE

1. Arena board system shall be provided by a firm having minimum of 5 years satisfactory experience in manufacturing and installing aluminum arena dasher boards, using persons trained and skilled in the type of work required for both manufacturing and installing. Arena board contractor is to have completed a minimum of 10 similar aluminum dasher installations and provide 10 references and a completed jobs list that match the scope of this project.

12.2.15 WARRANTY

1. Warrant the work of this Section against defects in materials and workmanship for a period of one (1) year from the date of substantial completion of the contract. Misuse, abuse and/or accident not caused by normal use is excluded. Glass breakage is excluded. Board misalignment from ice build-up underneath, excessive ice edge or ice thickness beyond 1-1/2" is excluded. Exclusions are considered maintenance requirements.

12.2.16 MAINTENANCE – EXTRA MATERIALS

1. Supply, in addition to quantities required for the Work, extra materials and "attic stock" products to be stored by the Owner as follows:
    - Fifty additional painted screws of each colour required for fastening of HDPE facings.
    - Two extra pieces of tempered glass shielding of each standard size required.
    - Four extra pieces of yellow kick strip.
    - Four extra pieces of red sill cap (SoftCap®, if selected as optional price)
2. Deliver extra stock to Owner in cartons or wooden crates clearly labelled to identify contents. Place extra stock in the owner designated storage area.

12.3 EXECUTION

12.3.1 EXAMINATION

1. Before commencing erection and installation, examine the work of other Sections to which the work of this Section will be attached.
2. Report immediately in writing to the Contractor/Engineer, all discrepancies in accuracy and suitability, conditions that will adversely affect the installation and permanency of the work of this Section.

12.3.2 INSTALLATION

1. General
    - Provide a complete installation of the board system by the manufacturer or manufacturer approved dealer in accordance with the drawings and specifications.
2. Gates
    - Provide quantity and location of equipment and access gates as indicated on the drawings.
3. Spectator Shielding
    - Spectator shielding glazing shall be installed along side of but not in front of team boxes. At shielding external corners on ice side, an easily replaceable NHL Approved protective corner bumper pad shall be provided to a height of not less than 36" above boards.
4. Resilient Flooring at Boxes
    - Existing Rubber Flooring to remain in place.

12.3.3 ADJUSTING

1. Upon completion of the Work of this Section, inspect, test and adjust installation.
2. Test all operable elements and ensure easy and smooth operation.
3. Upon completion of installation do a general clean-up.

12.3.4 CLEANING

1. Final cleaning, by others, to be carried out as part of General Conditions.

12.4 OPTIONAL PRICES

12.4.1 DASHER BOARD OPTIONAL PRICES

Submit unit prices stating the increase or decrease to the Contract Price for additional or deleted work listed below. Unit prices shall include all labour, materials, products, equipment, services and respective overhead, profit, taxes, disbursements and related charges, and shall represent the actual addition or credit to the Contract Price.

4. Impact Absorbing Safety Sill
    - Provide blue or red SoftCap® or similar impact absorbing safety top sill. Extruded thermoplastic elastomer (polyurethane) cap rail with built-in voids to increase the deflection upon player impact at the front (ice side) of the cap rail. 1" SoftCap on front of glass and .750" polyethylene on back side. Performance Standards are below:
        - Durometer reading shall be rated 70A or less.
        - ASTM D638 Standard Test Method for Tensile Properties of Plastics
            - Average Peak Load 60 lbf
            - Average Peak Stress 800 psi
            - Average Strain at Break 500 %
        - ASTM D695 Standard Test Method for Compressive Properties of Rigid Plastics
            - Average Peak Load 115 lbf
            - Average Peak Stress 70 psi
            - Modulus 850 psi
        - ASTM D790 Standard Test method for Flexural Properties
            - Peak Load 12 lbf
            - Peak Stress 165 psi
            - Modulus 6800psi

5. Spectator Side Paneling
    - Spectator side of dashers to be clad with 3/8" (9mm) white virgin high density polyethylene (HDPE) facing the full height of each panel for the entire dasher system.
6. Rubber Flooring in the Boxes
    - Supply and install new ½" (12mm) loose laid black rubber flooring to be installed in the player, penalty, and time boxes.
7. Access Gates At End of Players Boxes
    - Supply and install one new 32" access gate at the end of each player's box Gates to be complete with shielding and push button openers to allow access from either side.
8. Drainage Scupper
    - Additional price to supply one of the dasher board sections on the players box side of the rink with a removable 24" (609mm) x 8" (204mm) high removable bottom section to allow for allow for snow and ice removal into the drainage trench.

END OF SECTION