MECHANICAL SPECIFICATION

Coquitlam

Evergreen Cultural Centre – HVAC Piping Retrofit

Coquitlam, B.C.

Prepared by

FirstLight Energy Solutions

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Specification Seals Page – Mechanical

The following Consultants' Seal refers to specific Sections of the Specification completed by First Light Energy Solutions as noted in Section 00 01 10 – Table of Contents except Specification Sections and Appended Reports which have been prepared and/or signed and sealed by other professional engineers and consultants.

Mechanical

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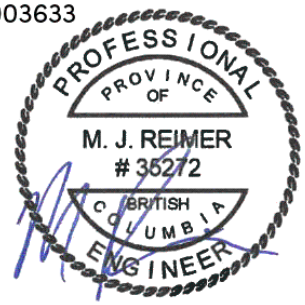
Name, Title

35272
Professional Registration No.

Permit to
Practice No:
1003633



Professional Seal & Signature

END OF SECTION

END OF SECTION

Part 1 General

1.1 Summary

A. This Section describes general project requirements related to all other Divisions and supplements the General and Supplementary Conditions that form part of the Contract for Construction between the Owner and the General Contractor (or Construction Manager, or Design-Build Contractor).

B. Should any provisions of these Division 1 Specifications conflict with the Contract or Supplemental Conditions, the Contract and Supplemental Conditions shall govern.

1.2 Summary of Work

A. The Mechanical Contractor shall be the Prime Contractor for the project and shall include all required subtrades including general contract trades and any others as required to ensure a complete installation.

B. Contractor to allow for the design, furnish, and install of all equipment and systems specified herein and as required for a complete and fully functional system. All work that is required shall be provided by the Contractor, including but not limited to the following:

1. Demolition
2. Rigging
3. Excavation and backfill.
4. New equipment
5. New and/or expanding existing concrete curbs and bases as required.
6. Roofing and wall penetration repair and sealing.
7. Temporarily removing then repairing doors, walls, or roof sections for access as required.
8. Seismic restraints.
9. Electrical power wiring, disconnects, etc. for new equipment.
10. Testing and Balancing.
11. Equipment start-up and functional Commissioning.
12. Operator training.
13. Warranty, maintenance manuals and documentation.
14. Permits and fees.
15. Overtime labour, if required.

C. HVAC Piping:

1. Replace existing underground chilled water piping from chiller enclosure to mechanical room.

D. Work Excluded:

1. Cost of repairing existing equipment that is specified to be reused, if required.
2. Asbestos abatement. If asbestos is discovered during the course of the Work, Contractor shall notify Owner who will retain abatement contractor.
3. Building Permit fees (paid by owner). Other trade permit and regulatory permits to be paid by Contractor.

E. Future Work:

1. Ensure that Work avoid encroachment into areas defined in the Drawings and Specifications as for future work.

F. Work Sequence:

1. Construct Work in stages to accommodate Owner's continued use of the premises during construction.
2. Construct Work in stages to provide for continuous public usage. Do not close off public usage of facilities until use of one stage of Work will provide alternate usage.
3. Maintain fire access/control.
4. Protect workers and public safety.

G. Contractor Use of Premises:

1. Limited use of premises for Work, for storage, and for access to allow Owner and tenant occupancy, public usage, and work by other contractors during construction period.
2. Coordinate use of premises under direction of Owner's Representative.
3. Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
4. Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
5. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by the Consultant.
6. Ensure that operating conditions of existing work at completion are still the same, equal to or better than those which existed before new work started.

H. Owner Occupancy:

1. Owner will occupy premises during entire construction period for execution of normal operations.

2. Cooperate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.3 Work Restrictions

A. Use of Site and Facilities

1. Execute work with the least possible interference or disturbance to normal use of premises. Make arrangements with the Owner's Representative to facilitate work as stated.
2. Maintain existing services to building and provide for personnel and vehicle access.
3. Where security is reduced by work provided temporary means to maintain security.
4. Use elevators, conveyors or escalators existing in buildings for moving workers and material.
    a. Protect walls of passenger elevators to approval of Owner's Representative prior to use.
    b. Accept liability for damage, safety of equipment and overloading of existing equipment.
    c. **Where existing elevators, conveyors or escalators are not sufficient for moving material, arrange and pay for the cost of cranage and street permits.**
5. Closures: protect work temporarily until permanent enclosures are completed.

B. Alterations, Additions or Repairs to Existing Building

1. Execute work with least possible interference or disturbance to building operations, occupants, public and normal use of premises. Arrange with Consultant to facilitate execution of work.

C. Existing Services

1. Where Work involves breaking into or connecting to existing services, give Owner's Representative 72 hours' notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions to a minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
2. Where work involves a system shut-down, the Contractor shall submit a request for each shutdown to the Owner's Representative at least 7 days before the requested shut-down date. The request shall state what system is to be shutdown, what areas will be affected, how long the period will be, and what contingency plan is provided if the work cannot be completed within the specified time. **No system shutdown is permitted without the written approval of the Owner's Representative.**
3. Provide alternative routes for pedestrian and vehicular traffic.
4. Establish location and extent of service lines in area of work before starting Work. Notify Owner's Representative and Consultant of findings.

5. Submit schedule for approval by Owner's Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
6. Provide temporary services to maintain critical building and tenant services.
7. Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
8. Where unknown services are encountered, immediately advise the Consultant and confirm findings in writing.
9. Protect, relocate, or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
10. Record locations of maintained, re-routed, and abandoned service lines.
11. Construct barriers, as required, in accordance with Paragraph 1.14.

D. Special Requirements

1. Hours of Work shall be on Monday to Friday from 07:00 to 14:00 hours and on Saturdays, Sundays and statutory holidays for any work that is located in occupied space. There are no work hour restrictions for mechanical and electrical rooms. All work affecting occupied spaces needs to be coordinated with Owner's representative to avoid disruption to schedules activities within the building.
2. Carry out noise generating Work Monday to Friday from 07:00 to 14:00 hours and on Saturdays, Sundays, and statutory holidays. Do not carry out noise generating work during schedules shows or events.
3. Ensure Contractor's personnel employed on site become familiar with and obey Owner and building specific regulations including safety, fire, traffic and security regulations.
4. Keep within limits of work and avenues of ingress and egress.
5. Deliver materials outside of peak traffic hours 07:00 to 12:00 unless otherwise approved by Owner's Representative.
6. The chiller plant shall remain operational between May to October each calendar year.
7. The heating plant shall remain operational between September to May each calendar year.
8. Air handling units shall remain operational between normal occupied hours, except where schedule allows for shut-down for replacement. Refer to acceptable shut-down windows for each air handling unit

E. Security

1. Where security has been reduced by Work of Contract, provide temporary means to maintain security.

2. Security clearances: Personnel employed on this project may be subject to Owner's security check. Obtain clearance, as instructed, for each individual who will require to enter premises.

1.4 Payment Procedures

A. Applications for Progress Payment

1. Refer to Project Contract and Supplementary Conditions.
2. Make applications for payment on account as provided in Agreement as Work progresses.
3. Date applications for payment last day of agreed payment period and ensure amount claimed is for value, proportionate to amount of Contract, of Work performed and Products delivered to Place of Work at that date.
4. Submit to Consultant and Owner, at least 15 days before first application for payment. Schedule of values for parts of Work, aggregating total amount of Contract Price, to facilitate evaluation of applications for payment.

B. Schedule of Values

1. Refer to Project Contract and Supplementary Conditions.
2. Provide schedule of values supported by evidence as the Consultant may reasonably direct and when accepted by the Consultant, be used as basis for applications for payment.
3. Include statement based on schedule of values with each application for payment.
4. Support claims for products delivered to Place of Work but not yet incorporated into Work by such evidence as the Consultant may reasonably require to establish value and delivery of products.

C. Progress Payment

1. Refer to Project Contract and Supplementary Conditions.
2. The Consultant will issue to Owner, no later than 10 days after receipt of an application for payment, certificate for payment in amount applied for or in such other amount as Consultant determines to be due. If Consultant amends application, Consultant will give notification in writing giving reasons for amendment.

D. Substantial Performance of Work

1. Refer to Project Contract and Supplementary Conditions.
2. Prepare and submit to the Consultant comprehensive list of items to be completed or corrected and apply for a review by the Consultant to establish Substantial Performance of Work. Failure to include items on list does not alter responsibility to complete Contract.

3. No later than 10 days after receipt of list and application, the Consultant will review Work to verify validity of application, and no later than 7 days after completing review, will notify Contractor if Work or designated portion of Work is substantially performed.
4. Consultant: state date of Substantial Performance of Work or designated portion of Work in certificate.
5. Immediately following issuance of certificate of Substantial Performance of Work, in consultation with the Consultant, establish reasonable date for finishing Work.

E. Payment of Holdback upon Substantial Performance of Work

1. Refer to Project Contract and Supplementary Conditions.
2. After issuance of certificate of Substantial Performance of Work:
    a. Submit application for payment of holdback amount.
    b. Submit sworn statement that accounts for labour, subcontracts, products, construction machinery and equipment, and other indebtedness which may have been incurred in Substantial Performance of Work and for which Owner might in be held responsible have been paid in full, except for amounts properly retained as holdback or as identified amount in dispute.
3. After receipt of application for payment and sworn statement, The Consultant will issue certificate for payment of holdback amount.
4. Where holdback amount has not been placed in a separate holdback account, Owner will, 10 days prior to expiry of holdback period stipulated in lien legislation applicable to Place of Work, place holdback amount in bank account in joint names of Owner and Contractor.
5. Amount authorized by certificate for payment of holdback amount is due and payable on day following expiration of holdback period stipulated in lien legislation applicable to Place of Work. Where lien legislation does not exist or apply, holdback amount is due and payable in accordance with other legislation, industry practice, or provisions which may be agreed to between parties. Owner may retain out of holdback amount sums required by law to satisfy liens against Work or, if permitted by lien legislation applicable to Place of Work, other third party monetary claims against Contractor which are enforceable against Owner.

F. Final Payment

1. Refer to Project Contract and Supplementary Conditions.
2. Submit application for final payment when Work is completed.
3. The Consultant will, no later than 10 days after receipt of application for final payment, review Work to verify validity of application. Consultant will give notification that application is valid or give reasons why it is not valid, no later than 7 days after reviewing Work.

4. Consultant will issue final certificate for payment when application for final payment is found valid.

1.5 Project Meetings

A. Administrative

1. Schedule and administer project meetings throughout the progress of the work at the call of The Owner's Representative or Consultant.
2. Prepare agenda for meetings.
3. Distribute written notice of each meeting four (4) days in advance of meeting date to Consultant and Owner's Representative.
4. Facilitate virtual meetings or on-site meetings are required for the context of the meeting.
5. Preside at meetings.
6. Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
7. Reproduce and distribute copies of minutes within three (3) days after meetings and transmit to meeting participants and, affected parties not in attendance.
8. Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

B. Preconstruction Meeting

1. Within fifteen (15) days after award of Contract, request a meeting of parties in Contract to discuss and resolve administrative procedures and responsibilities.
2. Senior representatives of Consultant, Contractor, major Subcontractors, and Owner's Representative will be in attendance.
3. Establish time and location of meeting and notify parties concerned minimum [5] days before meeting.
4. Agenda to include:
    a. Identify prime contact for each party including contact information.
    b. Schedule of Work.
    c. Schedule of submission of shop drawings in accordance with Paragraph 1.6.
    d. Requirements for temporary facilities, site sign, offices, storage sheds, etc. in accordance with Paragraph 1.14.
    e. Delivery schedule of specified equipment.
    f. Site security and access.
    g. Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.

h. Owner provided products.

i. Record drawings in accordance with Paragraph 1.21.

j. Maintenance manuals in accordance with Paragraph 1.21.

k. Take-over procedures, acceptance, warranties in accordance with Paragraph 1.20.

l. Monthly progress claims, administrative procedures, photographs, hold backs.

m. Appointment of inspection and testing agencies or firms.

n. Insurance, transcript of policies.

C. Progress Meetings

1. During course of Work and two (2) weeks prior to project completion, schedule progress meetings bi-weekly during active construction and monthly otherwise.

2. The Contractor, major Subcontractors involved in Work, Consultant and Owner are to be in attendance.

3. Notify parties minimum four (4) days prior to meetings.

4. Record minutes of meetings and circulate to attending parties and affected parties not in attendance within three (3) days after meeting.

5. Agenda to include the following:

a. Review and approval of minutes of previous meeting.

b. Review of Work progress since previous meeting.

c. Field observations, problems, conflicts.

d. Problems which impede construction schedule.

e. Review of off-site fabrication delivery schedules.

f. Corrective measures and procedures to regain projected schedule.

g. Revision to construction schedule.

h. Progress schedule, during succeeding work period.

i. Review submittal schedules: expedite as required.

j. Maintenance of quality standards.

k. Review proposed changes for effect on construction schedule and on completion date.

l. Other business.

1.6 Submittal Procedures

A. General:

1. Submit to Consultant a submittals list for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
2. Do not proceed with Work affected by submittal until review is complete.
3. Present shop drawings and product data in units of Project (SI or IP).
4. Review submittals before submission to the Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
5. Notify Consultant, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reason for deviations.
6. Verify site measurements and affected Work are coordinated.
7. Contractor's responsible for errors and omissions in submission is not relieved by Consultant's review of submittals.
8. Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by the Consultant review.
9. Schedule: Allow five (5) business days for Consultant's review of each submission.

B. Shop Drawings and Product Data

1. The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
2. Submit drawings stamped and signed by professional engineer registered or licensed in British Columbia, Canada.
3. Indicate materials, methods of construction and attachment and anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed.
4. Adjustments made on shop drawings by the Consultant are not intended to change the Contract Price. If adjustments affect value of Work, state such in writing to the Consultant before proceeding with Work.
5. Make changes in shop drawings as the Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.
6. Submissions to include a transmittal letter containing:
    a. Date.

b. Project title and number.

c. Contractor's name and address.

d. Identification and quantity of each shop drawing, product data, and sample.

e. Other pertinent data.

7. Submission to include:

   a. Date and revision dates.

   b. Project title and number.

   c. Name and address of Subcontractor, Supplier, and Manufacturer.

   d. Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of site measurements and compliance with Contract Documents.

   e. Details of appropriate portions of Work as applicable:

      1. Fabrication

      2. Layout, showing dimensions, including identified site dimensions and clearances.

      3. Setting or erection details.

      4. Capacities.

      5. Performance characteristics.

      6. Standards.

      7. Operating weight.

      8. Wiring diagrams.

      9. Piping diagrams.

      10. Single line and schematic diagrams.

      11. Relationship to adjacent work.

8. After the Consultant's review, distribute copies.

9. Submit an electronic copy of shop drawings for each requirement requested in specification Sections and as the Consultant may reasonably request.

10. Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by the Consultant where shop drawings will not be prepared due to standardized manufacturer of product.

11. Submit electronic copies of manufacturer's instructions for requirements requested in specification Sections and as requested by the Consultant.

1. Pre-printed material describing installation of product, system or material including special notices and Safety Data Sheets concerning impedances, hazards and safety precautions.

12. Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by the Consultant.

13. Delete or cross out information not applicable to project. Alternatively, highlight information applicable to project.

14. If upon review by the Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned, and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

15. **The cost of the Consultant review of submittals after first resubmittal will be borne by the Contractor at Consultant standard billing rates**.

C. Test Reports

1. Submit an electronic copy of test reports for requirements requested in specification Sections and as requested by the Consultant.

   a. Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accordance with specified requirements.

   b. Testing must have been within 3 years of date of Contract award for project.

D. Manufacturer's Site Reports & Certificates

1. Submit electronic copies of certificates for requirements requested in specification Sections and as requested by the Consultant.

   a. Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product system or material meets specification requirements.

   b. Certificates must be dated after award of Contract complete with project name.

2. Submit electronic copies of Manufacturer's Site Reports for requirements requested in specification Sections and as requested by the Consultant.

   a. Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

E. Equivalency

1. Manufactured products listed in these specifications are provided as materials or equipment already reviewed and accepted for inclusion in the Work. These listed materials or equipment demonstrate the minimum quality and performance of materials and equipment that manufacturers offering and requesting equivalency must demonstrate in order to be considered for inclusion in the project.
2. Unless stated "no equivalent", manufacturers, their agents or representatives may and are invited to submit materials or equipment for consideration as equivalent to listed materials or equipment by submitting written request to the Consultant and providing information for submittals as detailed within these specifications.
3. All requests for equivalency must be submitted no later than seven (7) business days prior to the close of tender or request for pricing.

F. Samples

1. Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
2. Deliver samples prepaid to Consultant's business address.
3. Where colour, pattern or texture is criterion, submit full range of samples.
4. Adjustments made on samples by the Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to the Consultant before proceeding with Work.
5. Make changes to samples which Consultant may require, consistent with Contract Documents.
6. Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

G. Photographic Documentation

1. Submit an electronic copy of colour digital photography in fine resolution as direct by the Consultant.

H. Certificates and Transcripts

1. Immediately after award of Contract, submit Worksafe BC clearance letter.
2. Submit proof of insurance immediately after award of Contract.

1.7 Health and Safety

A. Be responsible for the health and safety of persons on site, safety or property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.

B. Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial, and local statutes, regulations, and ordinances.

C. Comply with Workers Compensation Act, B.C.

D. Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

E. Immediately address health and safety non-compliance issues identified by authority having jurisdiction, Owner's Representative, or Consultant.

1.8 Regulatory Requirements

A. Perform Work in accordance with the applicable Building Code including amendments up to bid closing and other codes or provincial or local application including:

1. Current Provincial Building Code
2. Current Provincial Plumbing Code
3. Current Provincial Fire Code
4. Canadian Electrical Doe
5. Worksafe BC requirements
6. Canadian Standards Association (CSA)
7. Pollution Control Board
8. Refrigerant Code and CSA Codes governing refrigeration plants
9. Canadian Gas Code CAN/CSA B-149.1
10. Boiler and Pressure Vessel Act
11. AABC – Associated Air Balance Council
12. AMCA – Air Moving and Conditioning Association
13. ANSI – American National Standards Institute
14. ARI – Air Conditioning and Refrigeration Institute
15. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers
16. ASME – American Society of Mechanical Engineers
17. ASTM – American Society for Testing and Materials
18. EEMAC – Electrical Equipment Manufacturers' Association Council
19. ETL – Intertek Semko (Formerly Electrical Testing Laboratories)
20. IEEE – Institute of Electrical and Electronic Engineers
21. NEMA – National Electrical Manufacture's Association
22. NFPA – National Fire Protection Association
23. SMACNA – Sheet Metal and Air Conditioning Contractors National Association
24. ULc – Underwriters' Laboratories of Canada
25. WHMIS – Health Canada/Workplace Hazardous Materials Information System

B. Published specifications, standards, tests or recommended methods of trade, industry or governmental organizations as listed above apply to all work in this Section.

C. If any of the above requirements are in conflict with one another, or with the Specification's requirements, the most stringent requirement shall govern. Where codes are silent on an issue, NFPA Standards shall apply.

D. When drawings or specifications exceed requirements of applicable laws, ordinance, rules, and regulations, comply with documents establishing the more stringent requirement.

E. Nothing in the drawings or specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules, and regulations.

F. Industry standards and manufacturers' recommendations, diagrams or requirements shall be strictly adhered to for installation of materials and equipment.

1.9 Definitions

A. Where there is a conflict of definition between CCDC-2 and this specification, the CCDC-2 definition shall govern.

Term	Definition
BAS	Means building automation system. BAS, BMS, FMS and DDC generally mean same.
Concealed	Means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
Construction Equipment	Means all machinery and equipment, either operated or not operated, that is required for preparing, fabricating, conveying, erecting, or otherwise performing the Work but is not incorporated into the Work.
Consultant	The person or entity engaged by the Owner or identified as such in the Agreement. The Consultant is the Architect, the Engineer or entity licensed to practice in the province or territory of the Place of the Work.
Contract	Is the undertaking by the parties to perform their respective duties, responsibilities and obligations as prescribed in the Contract Documents and represents the entire agreement between the parties.
Contract Documents	The Contract Documents consist of those documents listed in the Contract and amendments agreed upon between the parties. The Drawings and Specifications are considered part of the Contract Documents.
Contractor	is the person or entity identified as such in the Agreement.
Control or Actuating Devices	Means automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

Term	Definition
Delete or Remove or Demo	Means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with Consultant.
Electrical Divisions	Refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or Drawings is the responsibility of the Electrical Contractor, unless noted otherwise.
Exposed	Means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
Finished	Means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
Governing Authority	Means government departments, agencies, standards, rules and regulations that apply to an govern work and to which work must adhere. Authority Having Jurisdiction, Regulatory Authority, and Municipal Authority mean the same.
Indicated / shown / noted / listed	Wherever these words, or similar words and phrases, are used in the Contract Documents they are understood to mean product referred to is as indicated in Contract Documents.
Install	Means secure in position, connect complete, test, adjust, verify and certify.
Mechanical Divisions	Refers to Division 20, 21, 22, 23 and 25 and other Divisions specifically noted, and which work as defined in Specifications and/or Drawings is responsibility of Mechanical Contractor, unless noted otherwise.
Motor Controllers	Means manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.
Notice in Writing	Where identified in the Contract Documents, is a written communication between the parties or between them and the Consultant.
OSHA / OHSA	Stands for Occupational Safety and Health Administration and Occupational Health and Safety Act. Wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.

Term	Definition
Owner	Is the person or entity identified as such in the Agreement.
Piping	Means pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and related items.
Place of the Work	Is the designated site or location of the Work identified in the Contract Documents.
Product	Means material, machinery, equipment, and fixtures forming part of the Work, but does not include Construction Equipment.
Project	Means the total construction contemplated of which the Work may be the whole or a part.
Provide (Provision)	Means to supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted otherwise.
Ready-for-Takeover	Ready-for-takeover shall have been attained when conditions setout in the Contract have been met, as verified by the Consultant.
Reviewed / satisfactory / as directed / submit	Wherever these words, or similar words and phrases, are used in the Contract Documents they are understood to mean that work or product referred to is "reviewed by", "to the satisfaction of", submitted to", etc. the Consultant.
Similar / Equal	Means of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified project, conforming to PART 2 materials and drawing schedules.
Specifications	Are that portion of the Contract Documents, wherever located and whenever issues, consisting of the written requirements and standards for Products, systems, workmanship, quality, and the services necessary for the performance of the Work.
Substantial Performance of the Work / Substantial Performance	As defined in the lien legislation applicable to the Place of the Work.
Supply	Means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.

Term	Definition
Temporary Work	Means temporary supports, structures, facilities, services, and other temporary items, excluding Construction Equipment, required for the execution of the Work but not incorporated into the Work.
Wiring	Means raceway, fittings, wire, boxes, and related items.
Work	Means the total construction and related services required by the Contract Documents. Includes labour, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.10 Hazardous Material Discovery

A. Asbestos: Demolition of spray or trowel-applied asbestos is hazardous to health. Stop work immediately when material resembling spray or trowel-applied asbestos is encountered during demolition work. Notify Consultant and Owner's Representative.

B. PCB: Polychlorinated Biphenyl: Stop work immediately when material resembling Polychlorinated Biphenyl is encountered during demolition work. Notify Consultant and Owner's Representative.

C. Mould: Stop work immediately when material resembling mould is encountered during demolition work. Notify Consultant and Owner's Representative.

1.11 Permits and Fees

A. Except as otherwise specified, Contractor shall apply for, obtain, and pay fees associated with permits, licenses, certificates, and approvals required by regulatory requirements and Contract Documents, based on General Conditions of Contract.

B. Building Permit:

1. The Owner has applied for and will be paying for building permit. Contractor is responsible for obtaining or coordinating other permits required for Work and its various parts.

2. Contractor will require that specific Subcontractor's obtain and pay for permits required by authorities having jurisdiction, where their Work is affected by Work requiring permits including but not limited to mechanical, electrical, and plumbing, gas installation and trade permits.

3. The Contractor shall display building permit and other permits in a conspicuous location at Place of Work.

1.12 Quality Control

A. Having inspection and testing agencies by Contractor does not relieve the Contractor of their responsibility to perform Work in accordance with Contract Documents.

B. Allow and coordinate access to Work on site, manufacturing off site, and fabrication off site with inspection and testing agencies.

C. Retain and pay for inspection and testing that are designated for Contractor's own quality control plan, and when testing and inspection are required by Authorities Having Jurisdiction.

D. Give advanced notice to the Consultant and to each inspection/testing agency for inspection and testing required by Contract Documents or by AHJ.

E. In advance of each test, notify the appropriate agency and Consultant in the order that attendance arrangements can be made.

F. Submit one digital copy of each quality assurance and control inspection and test report to the Consultant, except where a technical specification Section indicates otherwise.

G. Submit reports for inspection and testing required by Contract Documents or by AHJ and performed by Contractor retained inspection and testing agencies within ten (10) days after inspection or test is completed, except where a technical specification Section indicates a different time period.

H. Correct defects and deficiencies when they are revealed during inspection or testing as advised by Owner's Representative or the Consultant at no change to Contract Price or Contract Time. Pay costs for retesting and re-inspection. The appointed agency will request additional inspections or tests to ensure the full degree of defects or deficiencies are revealed and corrected.

1.13 Construction Facilities

A. Installation and Removal: Provide construction facilities as required to execute work expeditiously. Remove from site all such work after use.

B. Scaffolding: Provide and maintain scaffolding, ramps, ladders, and platforms as required. Scaffolding to be in accordance with CAN/CSA-S269.2.

C. Hoisting: Provide, operate, and maintain hoists or cranes required for moving materials and equipment. Hoists and cranes to be operated by qualified operator.

D. Elevators and Stairs: Designated existing elevators and stairs may be used by construction personnel and for transporting materials. Coordinate use with the Owner's Representative. Provide protective coverings for the finish surfaces of cars and entrances.

E. Site Storage/Loading: Refer to Contract and Supplemental Conditions. Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.

1. Do not load or permit to load any part of the Work or existing building with weight or force that will endanger the Work or existing building.

F. Construction Parking: Parking will not be permitted on site. Provide and maintain adequate access to project site.

G. Washroom Facilities: Provide and maintain portable washroom facilities for Contractor's staff as required. Washroom facilities within the facility are not available for Contractor use.

H. Clean-Up: Remove construction debris, waste materials, packaging material from work site daily. Clean dirt or mud tracked onto paved or surfaced roadways. Store materials resulting from demolition activities that are salvageable.

1.14 Temporary Barriers and Enclosures

A. Installation and Removal: Provide temporary controls to execute Work expeditiously. Remove from site all such work after use.

B. Guard Rails and Barricades: Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs. Provide as required by governing authorities.

C. Weather Enclosures: Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs. Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.

D. Dust Tight Screens: Provide dust tight screens or partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public. Maintain and relocate protection until such work is complete.

E. Access to Site: Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.

F. Public Traffic Flow: Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect public.

G. Fire Routes: Maintain access to property including overhead clearances for use by emergency response vehicles.

H. Protection for Off-Site and Public Property: Protect surrounding private and public property from damage during performance of Work. Be responsible for damage incurred.

I. Protection of Building Finishes:

1. Provide protection for finished and partially finished building finishes and equipment during performance of Work.
2. Provide necessary screens, covers, and hoardings.
3. Confirm with Owner locations and installation schedule 3 days prior to installation.
4. Be responsible for damage incurred due to lack of or improper protection.

1.15 Common Product Requirements

A. Quality

1. Products, materials, equipment, and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, provide evidence as to type, source and quality of products provided.
2. Procurement policy is to acquire, in cost effective manner, items containing the highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.
3. Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility but is a precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
4. Should disputes arise as to quality or fitness of products, decision rests strictly with the Consultant based upon requirements of Contract Documents.
5. Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
6. Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.
7. Supply all equipment and accessories in compliance with the applicable standards listed in Paragraph 1.8 and with all applicable federal, provincial, and local codes.

B. Availability

1. Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in the supply of products are foreseeable, notify the Owner's Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
2. In event of failure to notify the Owner's Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the Owner's Representative reserves the right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

C. Storage, Handling and Protection

1. Handle and store products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
2. Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
3. Store products subject to damage from weather in weatherproof enclosures.

4. Store cementitious products clear of earth or concrete floors, and away from walls.
5. Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
6. Store and mix paints in a heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
7. Remove and replace damaged products at own expense and to the satisfaction of the Consultant.
8. Touch-up damaged factory finished surfaces to the Consultant's satisfaction. Use touch-up materials to match original. Do not paint over nameplates.

D. Transportation

1. Pay costs of transportation of products required in performance of Work.
2. Transportation cost of products supplied by Owner will be paid for by Owner. Unload, handle and store such products.

E. Manufacturer’s Instructions

1. Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
2. Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant will establish course of action.
3. Improper installation or erection of products, due to failure in complying with these requirements, authorizes the Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.

F. Quality of Work

1. Ensure Quality of Work is of the highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Consultant if required Work is such as to make it impractical to produce required results.
2. Do not employ anyone unskilled in their required duties. Consultant reserves right to require dismissal from site, workers deemed incompetent or careless.
3. Decisions as to the standard or fitness of Quality of Work in cases of dispute rest solely with the Consultant, whose decision is final.

G. Coordination

1. Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
2. Be responsible for coordination and placement of openings, sleeves and accessories.

H. Concealment

1. In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
2. Before installation inform the Consultant if there is any interference. Install as directed by the Consultant.

I. Remedial Work

1. Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
2. Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

J. Location of Fixtures

1. Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
2. Inform the Consultant of conflicting installation. Install as directed.

K. Fastenings

1. Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
2. Prevent electrolytic action between dissimilar metals and materials.
3. Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
4. Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
5. Keep exposed fastenings to a minimum, space evenly and install neatly.
6. Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

L. Fastenings – Equipment

1. Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
2. Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
3. Bolts may not project more than one diameter beyond nuts.
4. Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

M. Protection of Work in Progress

1. Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated without written approval of the Consultant.

N. Existing Utilities

1. When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants and pedestrian and vehicular traffic.

2. Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

1.16 Examination and Preparation

A. Existing Services

1. Before commencing work, establish location and extent of service lines in area of Work.

B. Location of Equipment and Fixtures

1. Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.

2. Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

3. Submit field drawings to indicate relative position of various services and equipment when required by the Consultant.

C. Records

1. Maintain a complete, accurate log of control and survey work as it progresses.

2. On completion of foundations and major site improvements, prepare a certified survey showing dimensions, locations, angles and elevations of Work.

3. Record locations of maintained, re-routed and abandoned service lines.

1.17 Execution

A. Common Installation / Application / Erection Requirements

1. Fit several parts together, to integrate with other Work.

2. Remove and replace defective and non-conforming Work.

3. Unless otherwise indicated in specifications, install, or erect products in accordance with manufacturer’s instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.

4. Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant will establish course of action.
5. Improper installation or erection of products, due to failure in complying with these requirements, authorizes Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.
6. Provide openings in non-structural elements for penetrations of mechanical and electrical work.
7. Conceal pipes, ducts and wiring in floor, wall, partition, and ceiling assemblies in finished areas, except where indicated otherwise.
8. In addition to the manufacturer's recommendations for safety, access, accessibility, and maintenance, locate equipment, fixtures, and distribution systems where it shall provide minimal interference and shall maximize on usable space.
9. Location of equipment, fixtures, and outlets indicated on Drawings and specifications are approximate.

B. Bracing and Anchoring

1. Anchors and Fasteners: Unless otherwise indicated elsewhere:
   a. Provide any necessary anchors and fasteners to fasten each component securely for its intended purpose. Allow for building movement, including from thermal expansion and contraction of materials and assemblies;
   b. prevent electrolytic reaction between dissimilar metals and materials;
   c. Provide hot-dip galvanized or stainless steel anchors and fasteners for securing exterior work;
   d. locate anchors and fasteners within individual load limit or shear capacity. Ensure anchors and fasteners are permanently secured;
   e. Where exposed to view, evenly distribute anchors and fasteners in a single area; and
   f. Where exposed to view, provide metal anchors, fasteners, and related accessories with the same texture, colour, and finish as adjacent materials.
2. Non-Conforming Work: Anchors and fasteners installed which cause substrate cracks or spalling are not acceptable.

C. Cutting and Patching

1. Perform cutting, fitting, and patching to complete Work in accordance with related technical specification Sections.
2. Use special techniques to avoid damaging existing conditions that will remain, and which will result in proper surfaces to receive patching and finishing.
3. Employ original installer to perform cutting and patching for weather-exposed elements, moisture-resistant elements, and surfaces exposed to view.

4. Cut rigid materials using masonry saw, core drill, or other tool recommended by the product manufacturer or applicable industry association.
5. Fit Work to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
6. Refinish surfaces to match adjacent finishes. Refinish continuous surfaces to nearest intersection (e.g., edges of partition). Provide the entire surface with uniform finish, colour, and texture.

1.18 Cleaning

A. Project Cleanliness

1. Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner or other Contractors.
2. Remove waste materials from site at daily regularly scheduled times or dispose of as directed by the Owner. Do not burn waste materials on site.
3. Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
4. Provide on-site containers for collection of waste materials and debris.
5. Provide and use marked separate bins for recycling.
6. Dispose of waste materials and debris off site.
7. Clean interior areas prior to the start of finishing work and maintain areas free of dust and other contaminants during finishing operations.
8. Store volatile waste in covered metal containers and remove from premises at end of each working day.
9. Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
10. Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
11. Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

B. Final Cleaning

1. When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
2. Remove waste products and debris other than that caused by others and leave Work clean and suitable for occupancy.
3. Prior to final review remove surplus products, tools, construction machinery and equipment.
4. Remove waste products and debris other than that caused by Owner or other Contractors.

5. Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

6. Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.

1.19 Waste Management and Disposal

A. Coordination: Coordinate waste management requirements with all Divisions of the Work for the Project and ensure that requirements of the Construction Water Management Plan are followed.

B. Storage Requirements: Implement a recycling/reuse program that includes separate collection of waste materials as appropriate to the Project waste and the available recycling and reuse programs in the Project area.

C. Handling Requirements: Clean materials that are contaminated before placing in collection containers and ensure that waste destined for landfill does not get mixed in with recycled materials:

1. Deliver materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process.

2. Arrange for collection by or delivery to the appropriate recycling or reuse facility.

D. Hazardous Waste and Hazardous Materials: Handle in accordance with applicable regulations.

E. Subcontractor's Responsibility

1. Subcontractors shall cooperate fully with the Contractor's waste management plan.

2. Failure to cooperate may result in the Owner not achieving their environmental goals may result in penalties being assessed by the Contractor to the responsible Subcontractor's.

1.20 Closeout Procedures

A. Contractor's Inspection: Contractor to conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

1. Notify Consultant in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.

2. Request Consultant's review.

B. Consultant's Review:

1. Consultant and Contractor to review Work and identify defects and deficiencies.

2. Contractor to correct Work as directed.

C. Completion Tasks: submit written certificated that tasks have been performed as follows:

1. Work: completed and inspected for compliance with Contract Documents.

2. Defects: corrected and deficiencies completed.
3. Equipment and systems: tested, adjusted and balanced and fully operational.
4. Certificates required by Boiler Inspection Branch, Fire Commissioner, Utility companies, municipal inspections: submitted.
5. Operation of systems: demonstrated to Owner's personnel.
6. Commissioning of mechanical systems has been completed in accordance with Contract Documents and copies of final Commissioning Report submitted to the Consultant.
7. Work: complete and ready for final review.

D. Final Consultant Review:

1. When completion tasks are done, request final review of Work by Consultant, and Contractor.
2. When Work is incomplete according to Owner and Consultant, complete outstanding items and request re-inspection.

E. Declaration of Substantial Performance: when Consultant considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

F. Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.

G. Final Payment:

1. When Consultant considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.
2. Refer to Contract and Supplemental Conditions: when Work deemed incomplete by the Consultant, complete outstanding items and request re-review.

H. Payment of Holdback: after issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with contractual agreement.

I. Final Cleaning

1. Clean in accordance with Paragraph 1.18. Remove surplus materials, excess materials, rubbish, tools, and equipment.

1.21 Closeout Submittals

A. Provide submittals in accordance with Paragraph 1.6.

B. Operation Instructions & Maintenance Manuals

1. Before requesting acceptance of work, submit in word-searchable format such as PDF via email for review by the Consultant. File shall include bookmarks for each piece of equipment. Paper copies will not be accepted.
2. After review and making corrections noted, furnish three (3) printed and bound sets for the Owner. Assemble with separate tabs for each piece of equipment in heavy three-ring 'D' binder(s). In addition to hard copies, submit in word-searchable format such as PDF via email to the Consultant and Owner.
3. O&M manual shall include all submittal data submitted herein above, as installed. The intent of this section is that a single document contains all relevant information about each piece of equipment.
4. In addition to the submittal data, the O&M manual shall also include the following information for each item of equipment and each system:
    a. Manufacturer's name, model number, service manual, spare-parts list, illustrations, assembly drawings, and descriptive literature for all components.
    b. Description of unit or system, and component parts. Give function, normal operation characteristics and limiting conditions.
    c. Panel board circuit directories: provide electrical service characteristics, controls, and communications.
    d. Include installed colour coded wiring diagrams.
    e. Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down and emergency instructions. Include summer, winter, and any special operating instructions.
    f. Maintenance instructions. Include routine procedures and guide for troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
    g. Provide servicing and lubrication schedule, and list of lubricants required.
    h. Include sequence of operation by controls contractor.
    i. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
    j. Detailed and simplified one line, colour coded flow and wiring diagram.
    k. Name, address and phone number of contractors equipment suppliers and service agencies.
    l. Guarantee period, including start and end period.
    m. Start-up test readings, dated and signed by testing technician.
    n. Testing & balancing reports.

C. Record Drawings

1. Update design/shop AutoCAD drawings to "as-built" conditions:
    a. Fully incorporate all revisions made in the course of work.
    b. Include all field changes, adjustments, variances, substitutions, and deletions, including all Change Orders.
    c. Exact location, type, and function of concealed valves, dampers, controllers, piping, air vents and piping drains.
    d. Exact size, elevations, and horizontal location of piping and ducts.
    e. Revise equipment schedules to reflect all substitutions.
    f. Complete drawings of all systems, both new and existing.
2. Submit in electronic format per Submittals above for review.
3. Once reviewed by the Consultant:
    a. Provide one set of original CAD files including all referenced background drawings as well as PDF files of each drawing to Consultant and Owner via email or data transfer.
    b. Load complete PDF copy onto control system front end with link from the BAS interface.
    c. Provide one full-size set of drawings on bond paper to the Owner's Representative.

D. Maintenance Materials

1. Provide spare parts, extra stock materials, and special tools, in quantities specified in individual specification Sections. Deliver to site; place and store as directed by Owner.

E. Warranties

1. Provide a warranty letter to the Owner.
    a. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
2. Submit manufacturer warranty sheets to Owner and assist with completion of warranty forms to assure Owner receives warranties to which they are entitled.
3. Respond in a timely manner to oral or written notification of required construction warranty repair work.

Part 2 PRODUCTS

2.1 Not Used

A. Not used.

Part 3 EXECUTION

3.1 Not Used

A. Not Used.

END OF SECTION

Part 1 General

1.1 Related Requirements

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code requirements, the contractor shall notify the Engineer of the conflict in writing. If direction is not provided prior to the submission of the bid, the contractor shall price the more extensive system.

1.2 Summary

A. Section Includes general requirements and materials for Divisions 20, 21, 22, 23 and 25.

1.3 Reference Standards

A. The latest revisions of the following standards shall apply unless noted otherwise.

B. British Columbia Codes:

1. British Columbia Fire Code 2018.
2. British Columbia Building Code 2018
3. British Columbia Plumbing Code 2018.
4. Technical Safety BC regulations and regulator notices.

C. American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE):

1. ASHRAE 90.1-2016, Energy Standard for Buildings except Low-Rise Residential Buildings.

1.4 Definitions

A. Definitions below include synonyms and tenses of the defined term.

Term	Definition
Concealed	Means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
Exposed	Means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
Finished	Means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.

Term	Definition
Provide (Provision)	Means to supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted otherwise.
Install	Means secure in position, connect complete, test, adjust, verify and certify.
Supply	Means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.
Delete or Remove or Demo	Means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with Consultant.
BAS	Means building automation system. BAS, BMS, FMS and DDC generally mean same.
Governing Authority	Means government departments, agencies, standards, rules and regulations that apply to an govern work and to which work must adhere. Authority Having Jurisdiction, Regulatory Authority, and Municipal Authority mean the same.
OSHA / OHSA	Stands for Occupational Safety and Health Administration and Occupational Health and Safety Act. Wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
Mechanical Divisions	Refers to Division 20, 21, 22, 23 and 25 and other Divisions specifically noted, and which work as defined in Specifications and/or Drawings is responsibility of Mechanical Contractor, unless noted otherwise.
Electrical Divisions	Refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or Drawings is the responsibility of the Electrical Contractor, unless noted otherwise.
Consultant	Means person, firm, corporation identified as such in Agreement, or Documents, and is licensed to practice in Place of Work, and has been appointed by the Owner to act for the Owner in a professional capacity in relation to the Work.

Term	Definition
Indicated / shown / noted / listed	Wherever these words, or similar words and phrases, are used in the Contract Documents they are understood to mean product referred to is as indicated in Contract Documents.
Reviewed / satisfactory / as direct / submit	Wherever these words, or similar words and phrases, are used in the Contract Documents they are understood to mean that work or product referred to is "reviewed by", "to the satisfaction of", submitted to", etc. the Consultant.
Work	Means labour, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
Piping	Means pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and related items.
Wiring	Means raceway, fittings, wire, boxes, and related items.
Similar / Equal	Means of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified project, conforming to PART 2 materials and drawing schedules.
Motor Controllers	Means manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.
Control or Actuating Devices	Means automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

1.5 Summary of Work

A. Refer to Section 01 00 01 – General Requirements and general notes on drawings.

B. Provide complete, fully tested, and operational systems to meet the requirements described herein and in accordance with applicable codes and ordinances.

C. Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material, and installation quality but are not detailed installation instructions.

D. Follow manufacturers' recommended installation instructions, details, and procedures for equipment, supplemented by requirements of the Contract Documents.

E. Install equipment generally in locations and routes indicated. Run piping and ductwork close to building structure, parallel to building lines, maximize headroom and maintain minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Consultant at no extra cost.

F. For work within existing facilities, confirm locations and elevations of existing piping and equipment prior to commencement of new work.

G. Install equipment to provide service access, maintain service clearance and for each of maintenance.

H. Connect to equipment specified in other Sections and to equipment supply and installed by other Contractors of by the Owner where indicated. Uncreate equipment, move in placed and install complete; start up and test.

I. Install control valves, control dampers, thermal wells, and other devices on piping and ductwork, furnished by Division 25.

1.6 Coordination of Work

A. Cooperate and coordinate with other trades on the project.

B. Make reference to electrical, mechanical, structural, and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any material or equipment.

C. Where dimensional details are required, work with the applicable architectural and structural drawings.

D. Full size and detailed drawings shall take precedence over scale measurements from drawings.

E. Any areas indicated as space for future materials or equipment shall be left clear.

1.7 Permits and Fees

A. All work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.

B. Obtain all permits and pay all fees appliable to the Scope of Work.

C. Contractor shall arrange for inspections of the work by the Authorities Having Jurisdiction and shall provide certificates indicating Final Approval.

1.8 Examination of Site

A. Before submitting price, visit and examine the site and note all characteristics and features affecting the work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing thereon, which is visible or know to exist at the time of pricing.

1.9 Action and Informational Submittals

A. Submit in accordance with Section 01 00 01 – General Requirements.

B. Refer to specific Specification Sections for submittal requirements.

C. Submit the following shop drawings for material covered under this Section:

1. Heat Tracing: submit information on heat tracing cables, components, layouts and controls.

2. Variable Frequency Drives: Submit for each drive:
    a. Outline dimensions, conduit entry locations, and weights.
    b. Field wiring and power wiring diagrams.
    c. Complete technical product description, indicate options provided.
    d. Seismic certification and installation requirements.

1.10 Closeout Submittals

A. Submit in accordance with Section 01 00 01 – General Requirements.

1. Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Consultant.
2. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.
3. Shop drawings shall be reviewed by the General Contractor and Mechanical Sub-Contractor indicating that the shop drawings have been reviewed, coordinated with the work and that the shop drawings are submitted without qualifications. Shop drawings shall bear the 'reviewed' stamp dated and initialed by the General Contractor and Mechanical Sub-Contractor prior to submitting the shop drawings to the consultant. Shop drawings, which do not bear the contractors and sub-trades 'reviewed' stamp, initials and date will be rejected and sent back as 'not reviewed'.
4. Submit samples, in addition to drawings, of all items, which in the Consultant's judgment, can be better examined for capacity, quality, finish or detail by sample rather than by drawings. Samples shall be submitted before equipment or material is ordered.
5. If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the Owner shall revert to the specified product and manufacturer for this project.

B. Requirements for Contractor Retained Engineers

1. Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
2. Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
3. Unless otherwise specified in Division 00 or 01, liability insurance requirements are as follows:

a. Coverage is to be a minimum of $1,000,000.00 CDN inclusive of any one occurrence;

b. Insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;

c. Liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work.

4. Retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above.

5. Evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

C. Submit shop drawings for all products identified in the relevant specification sections of Divisions 21, 22, 23 and 25. Provide drawings as electronic files (file format: .dwg, .dxf, pdf, or comparable). When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include a complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.

D. Shop drawings and product data shall be accompanied by:

1. Detailed drawings of bases, supports, and anchor bolts.

2. Acoustical sound power data, where applicable.

3. Capacity and performance characteristics indicated on performance curves.

4. Manufacturer to certify current model production.

5. Certification for compliance to applicable codes.

E. Shop drawings to indicate:

1. Material Specification including CSA or ULC reference numbers.

2. Clearly mark submittal material using arrows, underlining or circling to show differences from specified ratings, capabilities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps, seals, material, or painting.

3. Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with mounting point loads.

4. Weights of all major equipment for review by the appropriate Consultant.

5. Mounting arrangements and installation details to suit the applications on this project.

6. Motor efficiencies on motors 1H.P. and larger.
7. List of the manufacturers and figure numbers for all valves, traps and strainers.
8. Control explanation and internal wiring diagrams for packaged equipment.
9. Control system drawings including a written description of control sequences relating to the schematic diagrams. Refer to additional requirements in controls sections.
10. Operating and maintenance requirements.
11. Submit as a shop drawing, an electrical equipment list for any equipment supplied by the mechanical contractor or his subtrades. The list is to be submitted in a timely fashion so that the electrical contractor can utilize the list as a final check prior to ordering motor control centres, starters, or disconnects. The list is to indicate the following:
    a. The horsepower size and number of motors.
    b. The minimum circuit amps (MCA) for packaged equipment such as roof top units.
    c. The voltage and phase of the motors.
    d. Whether or not a starter or a disconnect is included as part of the package.

F. Material Safety Data Sheets (MSDS):

1. Submit Material Safety Data Sheets (MSDS) in accordance with Division 01 Submittal Procedures for the following products. Indicate VOC emissions, prior to installation or use:
    a. Adhesives.
    b. Caulking compounds.
    c. Sealants.
    d. Insulating materials.
    e. Fireproofing or fire stopping materials.

G. Closeout Submittals:

1. Provide mechanical operation and maintenance data in compliance with Division 01 Closeout Submittals and the following:
    a. The Contractor shall furnish and pay for three (3) complete sets of operating and maintenance manuals for the complete mechanical installation plus two (2) copies of the digital version of the manuals on USB type flash drive.
    b. Supply indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:
        1. Front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;

2. Introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
3. Equipment manufacturer's authorized contact person name, telephone number and company website;
4. Table of Contents sheet, and corresponding index tab sheets;
5. Copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;

c. Operation and maintenance manual approved by, and final copies deposited with the Consultant a minimum of 7-days before final inspection.

d. Operation data to include but not limited to:

1. Pressure test reports, and certificates issued by governing authorities
2. Control schematics for systems including environmental controls.
3. Wiring and connection diagrams.
4. A description of the systems and associated controls.
5. Description of operation of systems at various loads together with reset schedules and seasonal variances.
6. Operational instructions for systems and associated components.
7. A description of actions to be taken in the event of equipment failure.
8. Valves schedule and flow diagrams.
9. Colour coding chart.

e. Maintenance data to include:

1. Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.
2. Data to include schedules of tasks, frequency, tools required and task time.
3. Recommended maintenance practices and precautions.
4. Complete parts lists with numbers.

f. Performance data to include:

1. Equipment manufacturer's performance datasheets indicating point of operation as left after commissioning is complete.

2. Equipment performance verification test results and final commissioning report.
3. Special performance data as specified.
4. Testing, adjusting, and balancing.

g. Digital Version of Manuals

1. The digital version of the manuals and the hard copy version shall be prepared by the same company.
2. Utilize latest version of Adobe Acrobat, Portable Document Format (pdf).
3. The digital manual shall be enhanced with the following features: Bookmarks, Internet Links, Internal Documents Links and Optical Character Recognition (OCR).
4. All shop drawings shall be scanned to a minimum 8.5" x 11" size. If the original page is 11" x 17", the digital copy shall also be 11" x 17".
5. Provide a minimum 300 DPI for all scanned pages.
6. All scanned material may be searched for text with minimum 60% Optical Character Recognition (OCR).
7. Rotation of scanned page images/texts shall be displayed within +/- 20 degrees.
8. Digital manual shall be organized in the same manner as the hard copy manual. Bookmark all major tabs and sub-sections and each set of shop drawings. Link the Table of Contents to the referenced section. Insert Internet Links to the Mechanical Equipment Manufacturers/Suppliers/Contractors official websites

h. Approvals:

1. Submit 1 copy of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
2. Make changes as required and re-submit as directed by Consultant.

i. Warranties

1. Include copy of all equipment warranty and extended warranty certificates into the Operation and Maintenance Manual.

j. Additional data:

1. Prepare and insert into operation and maintenance manual additional data when need as it becomes apparent during demonstrations and instructions.
2. Chemical treatment reports.
3. Back-flow preventer test certificates.

4. Results of Owner's Orientation (demonstrations).
5. List of spare parts turned over to owner's forces.

2. Site records:
   a. Contractor shall maintain 1 set of white prints at contractors cost to mark changes as work progresses and as changes occur.
   b. Use different colour waterproof ink for each service. Do not use pencil or black ink.
   c. Transfer information weekly to show work as actually installed.
   d. Make available for reference purposes and inspection.
   e. Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.
3. Record drawings:
   a. Prior to start of Testing, Adjusting and Balancing for Mechanical, finalize production of record drawings.
   b. Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant
   c. Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
   d. Submit to Consultant for approval and make corrections as directed.
   e. Perform testing, adjusting and balancing for HVAC using record drawings.
   f. Submit completed reproducible record drawings with Operating and Maintenance Manuals.
   g. Cost to transfer record information onto reproducible media & Auto-CAD are this contractor's responsibility. Consultant will release drawings to contractor after signing a copyright form.
   h. Should the Contractor choose to utilize this consultant for transferring as built information, allow $400 / sheet for all drawings in the construction set. This will cover costs for drafting time & printing costs.

i. Submit copies of record drawings for inclusion in final testing and balancing report.

j. Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with AutoCAD software release version confirmed with Consultant.

1.11 Maintenance Material Submittals

A. Submit in accordance with Section 01 00 01 – General Requirements.

B. Provide additional spare parts as outlined in associated Specification Sections.

C. Provide one set of special tools if required to service equipment as recommended by manufacturer.

1.12 Delivery, Storage and Handling

A. Deliver, store and handle materials in accordance with Section 01 00 01 – General Requirements and with manufacturer's written instructions.

1.13 Quality of Work

A. All work shall be by qualified tradespeople with valid Provincial Trade Qualification Certificates.

B. Work which does not conform to standards accepted by the Consultant and the trade may be rejected by the Consultant. The Contractor shall remediate rejected work to the accepted standard at no cost to the Owner.

1.14 Units

A. Provide submittals in the units used on the drawings (SI or IP).

B. Equivalent Nominal Diameters of Pipes:

1. Where pipes are specified with SI dimensions and IP sized pipes are available, provide equivalent nominal IP sizes pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all SI sized fittings, equipment, and piping.

Equivalent Nominal Diameter of Pipes					
mm	NPS (Inches)	mm	NPS (inches)	mm	NPS (inches)
3	1/8	50	2	300	12
6	1/4	65	2-1/2	350	14
10	3/8	75	3	375	15
15	1/2	100	4	400	16

Equivalent Nominal Diameter of Pipes					
mm	NPS (Inches)	mm	NPS (inches)	mm	NPS (inches)
20	3/4	125	5	450	18
25	1	150	6	500	20
30	1-1/4	200	8	550	22
40	1-1/2	250	10	600	24

2. Duct Sizes: SI duct sizes are expressed as 25 mm = 1 inch.

1.15 Drawings and Specifications

A. Drawings and Specifications are complementary to each other; what is called for by one shall be binding as if called for by both.

B. Should any discrepancy appear between the Drawings and Specifications, which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications; obtain written clarification from the Consultant during the pricing period. Without a written clarification, the better quality and/or greater quantity of work or materials shall be allowed for in the price.

C. Examine all contract documents, including Drawing and Specifications, and work of other trades to ensure that work is satisfactory carried out without changes to building.

1.16 Cutting, Coring, and Patching

A. Layout all cutting, digging, canning, coring and patching required to accommodate the mechanical work. The performance of actual cutting and patching under this Contract.

B. Provide all openings required under this Contract, including duct openings. Allow for oversized openings for fire dampers, where required.

C. Verify the locations of existing service runs and structural reinforcement within existing concrete structure prior to core drilling and cutting. Provide X-ray or penetrating sonar scans for each proposed opening.

D. Coring and cutting of structural building components shall only take place upon the receipt of specific written approval of a Structural Engineer, paid by the Contractor.

E. Control water to limit areas affected by the coring and clean up after completion.

F. Provide holes and sleeves, cutting and fitting required for mechanical work. Relocated improperly located holes and sleeves.

G. Drill for expansion bolts, hanger rods, brackets, and supports.

H. Perform x-rays and obtain written approval from the Structural Consultant before cutting or burning structural members. Use of Ground Penetrating Radar (GPR) to located concealed electrical conduit, structural rebar, post-tensioned cables, etc. is also acceptable.

I. Patch building where damaged from equipment installation, improperly located holes, etc. use matching materials as specified in the respective section.

J. Removal of any existing pipe, conduit, or ductwork within a slab core hole or slab opening through floors, walls, and roofs must be removed completely, including any associated sleeving, a safe manner. Provisions are to be made during the removal process to protect any occupants and/or finishes of space below.

K. Filling of any existing slab core or opening is to be with an engineered design of concrete fill complete with doweling for adhesion and/or fire stopping system as appropriate.

1.17 Installation of Equipment

A. Pipe all equipment drains to building drains except systems containing glycol.

B. Unions and flanges shall be provided in piping and ductwork to permit easy removal of equipment.

C. Maintain permanent access to equipment for maintenance.

1.18 Connections to Existing Services

A. Maintain communication with the Owner and provide a mutually acceptable schedule to interrupt, reroute or connect to existing building services with the minimum of interruption of those services.

B. Major services shall not be interrupted before all preparatory work is completed and all required materials are on site. Provide a minimum of 48 hours notice for all service shutdowns. Allow for major service interruptions outside of normal operating hours of the facility.

C. Interruptions and shutdowns of existing services shall be by the building maintenance staff. Advice building maintenance staff of the duration of service interruption or shutdown.

D. Advise the local Fire Department of any shutdown or disruption of the fire suppression systems and provide fire-watch as required.

1.19 Selective Demolition

A. Remove from site all equipment, ducting or piping which is no longer required because of work under this Contract.

B. Visit and examine the site and note all characteristics and irregularities affecting the work of this Section.

C. Protection:

1. Prevent movement or settlement of adjacent work. Provide and place bracing or shoring and be responsible for safety of such work. Be liable for any such movement or settlement and any damage or injury causes.
2. Cease operations and notify the Prime Consultant immediately for special protective and disposal instructions when any asbestos materials are uncovered during the work in this Section.
3. Precent debris from blocking surface drainage inlets and all types of drainage piping systems which remain in operation.

D. Salvageable Materials

1. Except as otherwise stated, salvageable materials from area of demolition shall become the property of the Owner at their discretion. All material not taken over by the Owner or removed from the building under this contract shall be removed from this site and disposed of as required by any applicable disposal regulations.
2. Turnover to and deliver to the Owner's storage area all items which have been determined to have salvage value and has been removed due to the Work.

1.20 Equipment and Materials

A. Materials and equipment installed shall be new, CSA approved and of quality specified.

B. Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place.

C. Where two or more products of the same type are required, products shall be of the same manufacturer.

D. Notify the Consultant in writing ten (10) days prior to the RFP close, any materials or equipment specified which is not currently available or will not be available for use as called for herein. Failing this, the contract will assume that the most expensive alternate has been included in the proposal price.

E. All equipment supplied to the project will meet efficiencies as defined in ASHRAE Standard 90.1 and NECB (current versions).

1.21 Cleaning

A. Provide cleaning in accordance with Section 01 00 01 – General Requirements.

1.22 Delivery, Storage and Handling

A. Deliver, store and handle materials in accordance with Section 01 00 01 – General Requirements and as follows:

1. Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping, equipment and duct systems.

2. Protect equipment and open-end duct with polyethylene covers and maintain equipment on crates until installation.
3. Operate, drain and flush out unsealed bearings and refill with fresh oil before final acceptance.
4. Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.
5. Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
6. Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.23 Miscellaneous Metals

A. Provide all necessary miscellaneous metals to hand or support materials, equipment and provide access for work under the Mechanical Divisions.

B. All miscellaneous metals shall be prime painted.

C. Miscellaneous metals shall include, but are not limited to:

1. Hanger for equipment, piping and ductwork.
2. Support for equipment.
3. Access platforms and catwalks.

1.24 Scaffolding, Hoisting and Rigging

A. Unless otherwise specified, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from the Owner.

B. Immediately remove site scaffolding, rigging and hoisting equipment when no longer required.

C. Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from the Owner.

1.25 Pipe Sleeves

A. Pipe sleeves shall be provided for piping passing through walls and floors. Minimum schedule 40 steel pipes or factory fabricated, flanged, high-density polyethylene sleeves with reinforced nail bosses. Sleeves shall extend 25 mm on either side of the wall.

B. Schedule 40 steel pipes shall be used as floor pipe sleeves in wet areas with a 50 mm up-stand.

C. Review and coordinate sleeve diameters with fire stop installation details as applicable.

D. Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

1.26 Water Proofing Materials

A. Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.

B. Acceptable products are:

C. Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;

D. The Metraflex Co. "MetraSeal" type ES

1.27 Escutcheons and Plates

A. Provide escutcheons and plates on all piping and ductwork passing through finished walls, floors and ceilings.

B. Escutcheons shall be one piece, stainless or chrome plated steel.

1.28 Progress Claim Breakdown

A. Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.

B. Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.

C. Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.29 Notice for Required Field Reviews

A. Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.

B. If Consultant is unable to attend a field review when requested, arrange an alternative date and time.

C. Do not conceal work until Consultant advises that it may be concealed.

D. When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.30 Changes in Work

A. Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation being proposed cost for executing change or revision.

B. Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.

C. Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.

D. Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.31 Temporary or Trial Usage

A. Temporary or trial usage by the Owner or Consultant of mechanical equipment supplied under contract shall not represent acceptance.

B. Repair or replace permanent equipment used temporarily.

C. Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.32 Guarantee / Warranty

A. Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work, which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

B. Use of permanent systems for temporary heat shall not modify terms of the manufacturers' warranty or the guarantee.

C. If the equipment is used during construction, the warranty or guarantee period shall not be shortened or altered.

1.33 Substantial and Total Performance

A. Prior to requesting an inspection for Substantial Performance, provide a complete list of items, which are deficient.

B. A certificate of Substantial Performance will not be granted unless the following items are completed and available to the Owner's Consultant:

1. Final Plumbing Inspection Certificate from the Authority having Jurisdiction.

2. Systems have been chemically cleaned. Flushed and water treatment initiated. Provide report from manufacturer's representative to confirm status of treatment and final inspection.
3. Mechanical identification is complete.
4. Warranty forms have been mailed to the manufacturer. Provide copy of the original warranty for equipment, which has a warranty period longer than one year.
5. Operating and Maintenance demonstrations have been provided to the Owner.
6. Written inspection report by manufacturer's representative has been submitted for noise and vibration control devices and flexible connections.
7. Record drawings have been submitted.
8. All previously identified deficiencies have been corrected and accepted.

C. Prior to a Total Performance Inspection, provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:

1. Submit final air and water balance reports.
2. Submit final operating and maintenance manuals.
3. Complete final calibration.

D. The Consultant shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations if required shall be at the expense of the Contractor.

E. The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.34 Alternate Materials and Equipment

A. The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.

B. Requests for alternate equivalent materials or equipment must be submitted to the Consultant no later than seven (7) working days prior to the Mechanical trades' closing RFP date. Submit all applicable technical data, including performance curves and physical details for review. Approval of requests shall only be given by addendum.

C. Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, and meet the space, capacity, and noise requirements outlined.

D. The Contractor shall be fully responsible for any additional labour and materials required by any trades or other Contractors to accommodate the use of other than specified materials or equipment. The Contractor shall bear any and all costs for design/system modifications to accommodate the "alternate" equipment. Extras will not be approved to cover such work.

1.35 Final Site Review

A. Advise the Consultant five (5) days prior to the date desired for the final site view. All systems are to be fully operational before the site review is requested. If at this time it is determined on site that the work is not complete and warrants a second field review by the Consultant, all costs incurred will be billed to the Contractor.

B. Prior to site review, the balancing contractor shall issue to the Consultant's office a draft balancing report for review.

C. At time of the site review the Contractor shall have on site a technician to demonstrate system operation to the Consultant and Owner.

D. The Consultant will issue a deficiency list within two (2) business days of the site review.

E. All deficiencies shall be completed within two (2) weeks of the final site review and letter submitted to the Consultant within that time advising that the work is complete. Failure to complete work may result in work being done by the Owner and the costs deducted from final payment.

Part 2 PRODUCTS

2.1 Acceptable Manufacturers

A. The Contractor shall base their price on the goods specified or they may submit a price using alternate material, provided such alternate material receives the written approval of the Consultant prior to close of RFP. Requests must be submitted at least five (5) full working days prior to the closing of the RFP.

B. Where the Contractor proposes to use alternative material which requires any redesign, changes, or additions to the structure, piping, ductwork, wiring, etc., the cost of all such redesign, new drawings, changes, and additions required shall be borne by the Contractor.

C. Where, in the opinion of the Consultant, any alternative equipment or materials proposed do not meet the requirement of the specification, are of inadequate capacity, or are too large or are of a size unsuitable to the space allocated, such equipment and material will be rejected for use on this project.

D. Refer to specific Specification Sections for acceptable manufacturers.

2.2 Acceptable Agencies and Contractors

A. The following is a list of contractors that are acceptable for this project.

B. Any request for an alternative must be submitted during the RFP period with a list of past applicable projects and resumes of field technicians that will be assigned to the project.

Scope	Acceptable Agencies & Contractors
Chemical Water Treatment	Existing Supplier

Part 3 EXECUTION

3.1 Examination

A. Verification of Conditions: verify that conditions of substrate previously installed under other Sections of Contracts are acceptable system and equipment installation in accordance with manufacturer's written instructions.

1. Inform the Consultant of unacceptable conditions immediately upon discovery.
2. Proceed with installation only after unacceptable conditions have been remedied.

3.2 Existing Services

A. Disconnect and cap all mechanical services in accordance with requirements of the authority having jurisdiction. Natural gas supply lines shall be removed by the local gas company or by a qualified tradesman in accordance with gas company instructions.

B. Building Mechanical Services: Maintain activity of all building services during demolition/removal of existing services required of this contract.

C. Maintain all trap seals and cap open-end pipe to ensure no sewer gas enters the building during renovations or demolition work. Maintain all existing sewer piping in a wet condition daily.

3.3 Demolition

A. Completely demolish the items scheduled and remove all materials from the premises unless otherwise requested by the Owner.

B. Carry out demolition in a manner to cause as little inconvenience to the occupied building area as building area as possible. Co-ordinate this activity with the Owner and/or the Consultant.

C. Carry out demolition in an orderly and careful manner.

D. All coring, patching and removal of existing equipment, pipes, and ductwork, which may affect the operation of occupied areas of the building, shall be carried out outside of regular office hours or as scheduled with the Owner.

3.4 Core Drilling

A. Clearly identify all proposed piping penetrations through existing slabs, walls etc. and advise the General Contractor. Obtain x-rays or GPR scanning of the locations to ensure penetration will avoid any existing post tension cables or reinforced steel. Advise the Structural Consultant of any conflicts as a result of the x-rays or GPR scans and obtain the Structural Consultant approval before any coring take place.

3.5 Asbestos

A. The intent is for a Haz-Mat Contractor to remove all asbestos containing material prior to the proposed project work taking place. Notify the Consultant if asbestos containing material is suspected to remain on site.

B. When new work is required to be connected to existing plumbing, piping, ductwork or equipment, which contains asbestos insulation or products the following, shall apply:

C. Keep disruption to existing piping and equipment to a minimum

D. Protect the site and all Contractors from the work

E. Remove the asbestos at piping and equipment for new connections and carry out work in accordance with Work Safe BC requirements for asbestos removal.

3.6 Common Installation Requirements for HVAC Pipework

A. Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

B. Connections to Equipment:

1. In accordance with manufacturer's instructions unless otherwise indicated.
2. Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
3. Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

C. Clearances:

1. Provide clearances around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
2. Provide space for disassembly, removal or equipment and components as recommended by manufacturer, and as indicated, without interrupting operation of other systems, equipment, and components.

D. Drains

1. Install piping with grade in direction of flow except as indicated.
2. Install drain valve at low points in piping systems, at equipment and at section isolating valves.
3. Pipe each drain valve discharge separately to above floor drain.
4. Discharge to be visible.
5. Drain valves: NPS 3/4 full-port ball valves unless indicated otherwise, with hose end male thread, cap and chain.

E. Air Vents

1. Install air vents at high points in piping systems.
2. Install isolating valve at each automatic air vent.
3. Install drain piping to approved location and terminate where discharge is visible.

F. Dielectric Couplings

1. General: compatible with system, to suit pressure rating of system.
2. Locations: where dissimilar metals are joined.
3. NPS 2 and under: isolating unions or bronze valves.
4. Over NPS 2: isolating flanges.

G. Pipework Installation

1. Install pipework to applicable standards. See Specification Sections for installation codes and standards.
2. Screwed fittings jointed with Teflon tape.
3. Protect openings against entry of foreign material.
4. Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
5. Assemble piping using fittings manufactured to ANSI standards
6. Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
    a. Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
7. Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
8. Install concealed pipework to minimize furring space, maximize headroom, conserve space.
9. Slope piping, except where indicated, in direction of flow for positive drainage and venting.
10. Install, except where indicated, to permit separate thermal insulation of each pipe.
11. Group piping wherever possible [and as indicated].
12. Ream pipes, remove scale and other foreign material before assembly.
13. Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
14. Provide for thermal expansion as indicated.
15. Valves:
    a. Install in accessible locations.

b. Remove interior parts before soldering.

c. Install with stems above horizontal position unless indicated.

d. Valves accessible for maintenance without removing adjacent piping.

e. Install globe valves in bypass around control valves.

f. Use ball or butterfly valves at branch take-offs for isolating purposes except where specified.

g. Install butterfly valves between weld neck flanges to ensure full compression of liner.

h. Use chain operators on valves NPS 2 1/2 and larger where installed more than 2,100 mm (7 feet) above floor in Mechanical Rooms.

16. Check Valves:

a. Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.

b. Install swing check valves in horizontal lines on discharge of pumps and as indicated.

H. Sleeves

1. General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.

2. Material: schedule 40 black steel pipe.

3. Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

4. Sizes: 6 mm (1/4 inch) minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

5. Installation:

a. Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

b. Other floors: terminate 25 mm (1 inch) above finished floor.

c. Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181

I. Sealing:

1. Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

2. Elsewhere:

a. Provide space for fire stopping.

b. Maintain the fire-resistance rating integrity of the fire separation.

3. Sleeves installed for future use: fill with lime plaster or other easily removable filler.
4. Ensure no contact between copper pipe or tube and sleeve.

J. Escutcheons

1. Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
2. Construction: one piece type with set screws.
    a. Chrome or nickel plated brass or type 302 stainless steel..
3. Sizes: outside diameter to cover opening or sleeve.
    a. Inside diameter to fit around pipe or outside of insulation if so provided.

K. Preparation for Fire Stopping

1. Coordinate the installation of fire stopping around pipes, insulation and adjacent fire separation.
2. Pipes subject to movement: conform to fire stop system design listing to ensure pipe movement without damaging fire stopping material or installation.
3. Insulated pipes: ensure integrity of insulation and vapour barriers.

L. Flushing Out of Piping Systems

1. Flush system in accordance with Section 23 25 00 – HVAC Water Treatment.

M. Pressure Testing of Equipment and Pipework

1. Advise Consultant 48 hours minimum prior to performance of pressure tests.
2. Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
3. Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
4. Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
5. Conduct tests in presence of Consultant.
6. Pay costs for repairs or replacement, retesting, and making good.
7. Insulate or conceal work only after approval and certification of tests by Consultant.

N. Existing Systems

1. Connect into existing piping systems at times approved by Owner.
2. Be responsible for damage to existing plant by this work.

3.7 Pipe Welding

A. Qualifications:

1. Welders:

a. Welding qualifications in accordance with CSA B51.

b. Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.

c. Each welder to possess identification symbol issued by authority having jurisdiction.

d. Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.

2. Inspectors:

a. Inspectors qualified to CSA W178.2.

3. Certifications:

a. Registration of welding procedures in accordance with CSA B51.

b. Copy of welding procedures available for inspection.

c. Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

B. Quality of Work:

1. Welding to be in accordance with ANSI/ASME B31.1, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0 and AWS C1.1.

C. Installation

1. Obtain a hot work permit for welding if required prior to starting work.

2. Arrange for the temporary disconnection of smoke sensors with the facility manager.

3. All welding to be performed in accordance with the requirements of Technical Safety BC, ANSI/ASME B31.1, and ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX.

4. Welding shall only be carried out by skilled welders meeting the qualifications above and who hold current welding certificates for the work being performed.

5. 2-1/2 NPS pipe size and larger shall be electric arc welded, except where flanged or grooved connections are allowed per this Specification. All welds shall be multiple pass. The ends of all pipe to be joined by welding shall be machine cut, properly and cleanly beveled, and properly spaced to ensure uniformity of the weld throughout the entire joint.

D. Inspection and Testing

1. Provide inspection and testing to ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51, and requirements of authority having jurisdiction.

2. Hydrostatically test welds to ANSI/ASME B31.1.

3.8 Access Doors

A. Installation:

1. Provide all access doors required to access work installed by Divisions 21, 22, 23 and 25. Be responsible for coordinating locations, cutting opening and installing panels. Any secondary supports, blocking etc. will be by the ceiling or wall contractor.
2. Access doors in mechanical equipment to be provided by this Division.
3. Access panel requirements and locations shall be fully coordinated with all involved contractors prior to the installation of any mechanical systems or equipment.

B. Location:

1. Ensure that equipment is within view and accessible for operating, inspecting, adjusting, servicing without using special tools.
2. Provide 3 sets of each type of access door key to the Owner at substantial completion. Obtain a signed receipt indicating date, quantity of keys and person receiving keys. Submit receipt to the Owner's Consultant.

3.9 Painting, Repairs and Restoration

A. Prime and touch up marred finished paintwork to match original.

B. Restore to new condition, finishes which have been damaged.

C. Clean exposed bare metal surfaces supplied under Divisions 21, 22, 23 and 25. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.

D. Paint all pipe hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer.

3.10 Field Quality Control

A. Site Tests: conduct the following tests in accordance with Section 01 00 01 – General Requirements.

B. Manufacturer's Field Services:

1. Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in Part 1 – Action and Informational Submittals.
2. Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer' instructions.

3.11 Cleaning

A. Provide cleaning in accordance with Section 01 00 01 – General Requirements.

B. During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of the Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.

C. Clean equipment and devices installed as part of this project.

D. Clean interior and exterior of all systems including strainers. Commercially vacuum interior of ductwork and air handling units.

3.12 Demonstration

A. Consultant and/or Owners representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

B. Supply tools, equipment and personnel to demonstrate and instruct the operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

C. Where specified elsewhere in Division 21, 22, 23 or 25 manufacturers to provide demonstrations and instructions.

D. Use operation and maintenance manual, record drawings, and audio visual aids as part of instruction materials.

E. Instruction duration requirements shall be as specified in the appropriate sections.

F. Contractor will record these demonstrations on digital video for future reference.

3.13 Protection

A. Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 Related Requirements

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 Summary

A. Section Includes: materials and installation for the identification of mechanical piping, ductwork, equipment and controls.

1.3 Action and Informational Submittals

A. Submittals are not required for this Section.

Part 2 PRODUCTS

2.1 Manufacturer's Equipment Nameplates

A. Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by the manufacturer.

B. Lettering and numbers raised or recessed.

C. Information to include, as appropriate:

1. Equipment: manufacturer's name, model, size, serial number, capacity.
2. Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 System Nameplates

A. Colours:

1. Hazardous: red letters, white background.
2. Elsewhere: black letters, white background (except where required otherwise by applicable codes).

B. Construction:

1. 3 mm (1/8 inch) thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.

C. Sizes:

1. Confirm to the following table:

Size #	Sizes mm (inch)	No. of Lines	Height of Letters mm (inch)
1	10 x 50 (0.4 x 2)	1	3 (0.12)

2	13 x 75 (0.5 x 3)	1	5 (0.20)
3	13 x75 (0.5 x 3)	2	3 (0.12)
4	20 x 100 (0.75 x 4)	1	8 (0.31)
5	20 x 100 (0.75 x 4)	2	5 (0.20)
6	20 x 200 (0.75 x 8)	1	8 (0.31)
7	25 x 125 (1 x 5)	1	12 (0.47)
8	25 x 125 (1 x 5)	2	8 (0.31)
9	35 x 200 (1.4 x 8)	1	20 (0.79)

2. Use a maximum of 25 letters/numbers per line.

D. Locations:

1. Terminal cabinets, and control panels: use size #5.
2. Equipment in Mechanical Rooms: use size #9.

2.3 Existing Identification Systems

A. Apply existing identification system to new work.

B. Where the existing identification system does not cover for new work, the use identification system specified in this section.

2.4 Piping Systems Governed by Codes

A. Identification:

1. Natural gas: to CSA B149.1.

2.5 Identification of Piping Systems

A. Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise

B. Pictograms:

1. Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

C. Letter Height:

1. 1-1/4 NPS pipe & smaller: 13 mm (1/2 inch) height.
2. 1-1/2 NPS through 2-1/2 NPS pipe: 25 mm (1 inch) height.
3. 3 NPS pipe and larger: 50 mm (2 inches) height.

D. Arrows showing the direction of flow:

1. Outside diameter of pipe or insulation less than 75 mm (3 inches): 100 mm (4 inches) long x 50 mm (2 inches) high.
2. Outside diameter of pipe or insulation 75 mm (3 inches) and greater: 150 mm (6 inches) long x 50 mm (2 inches) high.
3. Use double-headed arrows where flow is reversible.

E. Extent of background colour marking:

1. To full circumference of pipe or insulation.
2. Length to accommodate pictogram, the full length of legend and arrows.

F. Materials for background colour marking, legend, arrows:

1. Pipes and tubing 20 mm (3/4 inch) and smaller: waterproof and heat-resistant pressure-sensitive plastic marker tags.
2. Other pipes: pressure-sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C (302°F) and intermittent temperature of 200°C (392°F).

G. Colours and Legends:

1. Where not listed, obtain direction from the Consultant.
2. Colours for legends, arrows: to the following table:

Background Colour	Legend, arrows:
Yellow	Black
Green	White
Red	White

3. Background colour marking and legends for piping systems:

Contents	Background Colour	Legend
Chilled water return	Green	CHWR
Chilled water supply	Green	CHWS
Condensate Drain	Green	COND
Dom. HWS recirculation	Green	DHWR
Domestic cold water supply	Green	DCW
Domestic hot water supply	Green	DHW

Contents	Background Colour	Legend
Dual Temperature Return	Yellow	DUAL TEMP RETURN
Dual Temperature Supply	Yellow	DUAL TEMP SUPPLY
Gas regulator vents	to Codes	-
Hot water heating return	Yellow	HWR
Hot water heating supply	Yellow	HWS
Make-up water	Yellow	MAKE-UP WTR
Natural gas	to Codes	-
Refrigeration hot gas	Yellow	REF. HOT GAS
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration suction	Yellow	REF. SUCTION

2.6 Identification of Ductwork Systems

A. 50 mm (2 inches) high stencilled letters and directional arrows 150 mm (6 inches) long x 50 mm (2 inch) high.

B. Colours: black, or coordinated with the base colour to ensure strong contrast.

2.7 Ductwork Access Identification

A. Secure 50 mm (2 inches) high, self-adhesive stick-on letters on duct access panels to identify their usage according to the following:

1. Cleaning and service access, colour black, tag C.A.
2. Controls including sensors, colour black, tag C.
3. Backdraft dampers, balancing dampers and control dampers, colour black, tag D.
4. Fire dampers, colour red, tag F.D.
5. Smoke dampers and duct smoke detectors, colour red, tag S.D.

2.8 Valves and Controllers Identification

A. Tags shall be brass, aluminum, metal photo, lamicoid or fibreglass, stamped or engraved with 12 mm (1/2 inch) high identifier markings.

B. Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, and location of tagged item.

2.9 Controls Components Identification

A. Refer to Section 25 05 01 – BAS Requirements.

2.10 Ceiling Access Identification

A. Provide 6 mm (1/4 inch) self-adhesive coloured dots to the T-bar framing, adjacent to the panel to be removed or to access doors in solid ceilings. Identify the location of equipment concealed above as follows:

1. Yellow: Concealed equipment and cleaning access.
2. Black: Control equipment including control valves, dampers and sensors.
3. Red: Fire and smoke dampers, fire protection equipment and fire system drains.
4. Green: Heating water, chilled water, domestic cold water, and domestic hot water isolation valves.

2.11 Language

A. Identification in English.

Part 3 EXECUTION

3.1 General

A. Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions.

B. Identify each system and system components according to the nomenclature used in the Drawings and Specifications. Identification is to be consistent throughout the project.

C. When identifying systems and components in existing buildings, the new items shall be numbered sequentially with existing systems.

3.2 Timing

A. Provide identification only after painting has been completed.

3.3 Nameplates

A. Each piece of equipment shall be identified with its equipment schedule identification tag.

B. Install nameplates in a conspicuous location to facilitate easy reading and identification from the operating floor.

C. Provide standoffs for nameplates on hot and/or insulated surfaces.

D. Do not paint, insulate or cover nameplates.

3.4 Location of Identification on Piping and Ductwork Systems

A. Provide on long straight runs in open areas in boiler rooms, equipment rooms, galleries, and tunnels: at not more than 17 m (55 foot) intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

B. Provide adjacent to each change in direction.

C. Provide at least once in each small room through which piping or ductwork passes.

D. Provide on both sides of visual obstruction or where run is difficult to follow.

E. Provide on both sides of separations such as walls, floors, and partitions.

F. Provide where the system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

G. Provide at beginning and end points of each run and at each piece of equipment in run.

H. Provide at a point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on the upstream side.

I. Ensure identification is easily and accurately readable from usual operating areas and from access points. Position of identification approximately at right angles to the most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 Valves and Controllers Identification

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

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

C. Number valves in each system consecutively.

D. Tag the following valves at a minimum:

1. Valves on main piping circuits.
2. Valves on major branch lines.
3. Valves on minor branch lines in horizontal or vertical service spaces and mechanical rooms.
4. All valves in mechanical rooms.
5. Drain valves and hose bibbs on systems containing glycol.
6. Control valves.

E. Do not tag the following valves:

1. Valves on control valve stations.
2. Valves on steam trap stations.
3. Plumbing fixture stops or hose bibbs.
4. System drain valves.

F. Provide a valve tag schedule. Include in the identification of each tagged item, valve type, service, function, normal position and location of tagged item.

END OF SECTION

Part 1 General

1.1 Related Requirements

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code requirements, the contractor shall notify the Engineer of the conflict in writing. If direction is not provided prior to the submission of the bid, the contractor shall price the more extensive system.

1.2 Summary

A. Section Includes:

1. HVAC & plumbing piping insulation, jackets and accessories.

1.3 References

A. ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ASTM A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate

C. ASTM B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

D. ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation

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

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

G. ASTM C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

H. ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation

I. ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

J. ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation

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

L. ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation

M. ASTM C1729, Standard Specification for Aluminum Jacketing for Insulation

N. ASTM C1767, Standard Specification for Stainless Steel Jacketing for Insulation

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

P. CGSB 51-GP-53M (ASTM D1785)

Q. Green Seal Environmental Standard GS-36, Commercial Adhesives

R. South Coast Air Quality Management District (SCAQMD) Rule 1168, Adhesive and Sealant Applications

S. Thermal Insulation Association of Canada (TIAC), National Insulation Standards

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

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

V. CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings

W. CAN/ULC-S702.2, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines

1.4 Definitions

A. For the purposes of this section:

1. Concealed: insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
2. Exposed: ductwork, piping and equipment in mechanical rooms and not “concealed” as previously defined.
3. Insulation Systems: insulation material, fasteners, jackets, and other accessories
4. “k” Value: thermal conductivity of insulating material per unit of thickness.

B. TIAC Codes:

1. CRD: Code Round Ductwork
2. CRF: Code Rectangular Finish
3. CPF: Code Piping Finish

1.5 Action and Informational Submittals

A. Provide submittals in accordance with Section 01 00 01 - General Requirements.

B. Product Data:

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

2. Submit an insulation schedule. For each application include the following information:
    a. Materials
    b. “k” value
    c. Thickness
    d. Density
    e. Finish
    f. Jacketing
3. Submit product data and test reports when requested to substantiate that insulation and recovery assemblies meet flame/smoke development ratings and performance requirements for the assembly and thickness used.

1.6 Quality Assurance

A. Qualifications
    1. Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, [member of TIAC].

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products listed and labeled in accordance with UL 723 or in accordance with ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
    1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
    2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.7 Coordination

A. Coordinate sizes and locations of supports, hangers, and insulation shield specified in Section 20 05 29 – Hangers and Supports for HVAC Piping and Equipment

B. Coordinate clearance requirements with sheet-metal, piping and equipment installers for insulation application.

C. Coordinate installation and testing of heat tracing.

1.8 Scheduling

A. Schedule: insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment or plastic materials as rapidly as possible in each area of construction.

Part 2 PRODUCTS

2.1 Manufacturers

A. For each type of equipment, and subject to compliance with requirements, provide products by one of the listed manufacturers or pre-bid approval.

1. Acoustic duct insulation, fibre-free: K-flex, Armacell, Evonik (solcoustic)
2. Acoustic duct insulation: Manson, Knauf, CertainTeed, Johns Manville, Owens Corning, Evonik
3. Canvas Jacket: Robson, Fattal, Tai-Can
4. Fabric Adhesive Coatings: Robson, Bakor, Childers, Epolux, Foster
5. High Temperature Pipe Insulation (Calsil): Johns Manville – IIG
6. Low Temperature Preformed Pipe Insulation: Areoflex, Armacell, Therma-Cel, Kingspan
7. Low to Intermediate Temperature Pipe Insulation: Knauf, Owens Corning, Roxul, Johns Manville, Manson
8. PVC Jacket: Knauf, Speedline, Proto, Zeston, Shur-fit, Belform
9. Thermal Duct Insulation: CertainTeed, Manson, Kanuf, Johns Manville, Owens Corning
10. Thermal Pipe Insulation: Manson, Knauf, Johns Manville, Owens Corning
11. Vapour Barrier Jacket Adhesive: Bakor, Epolux, Nacan, Foster, Childers
12. Vapour Barrier Jacket: Kanuf ASJ, Kingspan ASJ, Manson ASJ, Johns Manville AP-T Plus, Owens Corning ASJ, Roxul ASJ, VentureWrap 1555U.

2.2 General Requirements

A. Products shall not contain asbestos, lead, mercury, mercury compounds or polybrominated diphenyl ethers (PBDE).

B. Thermal conductivity (“k” factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C335.

C. Insulation and jacketing materials shall not exceed 25 flame spread, 50 smoke developed ratings when tested in accordance with CAN/ULC-S102 and NFPA 90A.

D. Foam insulation products shall not use CFC or HCFC blowing agents in the manufacturing process and shall be formaldehyde free.

E. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

F. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

G. For all thermal and acoustical applications of glass mineral wool insulation, insulation shall be UL GREENGUARD Certified.

2.3 Insulation Materials

A. Comply with requirements in Part 3 "Insulation System Schedules" for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, formed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Block Insulation: ASTM C522, Type I.
2. Special Shaped Insulation: ASTM C552, Type III.
3. Board Insulation: ASTM C552, Type IV.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C522, Type II, Class I.
5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C552, Type II, Class 2.
6. Factory fabricated shapes according to ASTM C450 and ASTM C585.

G. Mineral-Fibre Blank Insulation: Mineral or glass fibres bonded with a thermosetting resin. Comply with ASTM C533, Type II and ASTM 1290, Type III with factory-applied FSK jacket. Factory-Applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corporation
   b. Johns Manville
   c. Knauf Insulation

d. Manson Insulation

e. Owens Corning

H. Mineral-Fibre Board Insulation: Mineral or glass fibres bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed

b. Johns Manville

c. Knauf Insulation

d. Manson Insulation

e. Owens Corning

I. Mineral-Fibre, Preformed Pipe Insulation

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville

b. Knauf Insulation

c. Mason Insulation

d. Owens Corning

2. Type I, 454C (850 F) Materials: mineral or glass fibres bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Type II, 649C (1,200F) Materials: Mineral or glass fibres bonded with a thermosetting resin. Comply with ASTM C547, Type II, Grade A with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Mineral Fibre, Pipe and Tank Insulation: Mineral or glass fibres bonded with thermosetting resin. Semirigid board material with factory applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 40 kg/m3 (2.5 lb/ft3) or more. Thermal conductivity (k value) at 38C (100F) is 0.042 W/mK (0.29 Btu-in/h-ft2-F) or less. Factory applied jacket requirements are specified in "Factory Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation

b. Johns Manville

c. Knauf Insulation

d. Manson Insulation

e. Owens Corning

2.4 Insulating Cements

A. Mineral-Fibre Insulating Cement: Comply with ASTM C195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

C. Mineral-Fibre, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.5 Adhesives

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with service temperature range of minus 73 to plus 93C (minus 100 to plus 200F).

1. Adhesives shall have a VOC content of 50 g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers.

C. Flexible Elastomeric and Polyolefin Adhesive (regular and high temperature): Comply with SCAQMD Rule 1168.

1. Adhesives shall have a VOC content of 50 g/L or less.

2. Adhesives shall comply with the testing and product requirements of the MAS Certified Green Program.

D. Mineral Fibre Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Fibreglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from indoor Sources Using Environmental Chambers".

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Fibreglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from indoor Sources Using Environmental Chambers".

F. PVC Jacket Adhesive: Compatible with PVC Jacket.

1. Fibreglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from indoor Sources Using Environmental Chambers".

2.6 Mastics

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. VOC Content: [300] <Insert value> g/L or less.
2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
2. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.7 Lagging Adhesives

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Adhesives shall have a VOC content of [50] <Insert value> g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
5. Color: White.

2.8 Sealants

A. Cellular-Glass Joint Sealants:

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.
5. Sealant shall have a VOC content of 420 g/L or less.

6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.
5. Sealant shall have a VOC content of 420 g/L or less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.9 Factory-Applied Jackets

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
4. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
5. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.10 Field-Applied Fabric-Reinforcing Mesh

A. Woven Glass-Fiber Fabric:

1. Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
2. Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering ducts.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe and ducts.

2.11 Field-Applied Cloths

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

2.12 Field Applied Jackets

A. Field applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft paper backing.

1. Water Vapour Permeance: ASTM E96 / 96M: 0.02 perms or less.

C. PVC Plastic Jacket: High-impact resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C, roll stock ready for shop or field cutting and forming, one-piece molded type fitting covers.

1. Thickness: 0.5 mm (0.02 inch).
2. Colour: white / off-white unless noted otherwise.
3. Temperature limits: -20°C to 65°C (-4°F to 150°F)
4. Securement: Pressure sensitive adhesive, PVC weld cement, or matching vinyl tape. Tacks may be used to hold PVC jacketing and fittings in place on above ambient systems only. For below ambient systems, seal joints with perma-weld adhesive.
5. Fittings: Factory-fabricated fitting covers, tank heads and tank side panels to match jacket if available; otherwise, field fabricate.

D. Aluminum Pipe Jacket: Comply with ASTM B209/B209M, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Factory cut and rolled to size for piping when available. Sheet and roll stock ready for shop or field sizing for other applications.
2. Thickness: 0.41 mm (0.016 inch).
3. Finish: stucco embossed.
4. Joining: longitudinal and circumferential slip joints with 50 mm (2 inch) laps.

5. Fittings: 0.5 mm (0.02 inch) thick die-shaped fitting covers with factory-attached protective liner. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
6. Securement: Stainless steel bands at 300 mm (12 inch) spacing only. No screws, rivets or any other securement device capable of puncturing the underlying vapour retarder shall be used on systems below ambient temperature.
7. Moisture Barrier:
    a. Moisture Barrier for Indoor Applications: 1-mil (0.025 mm) thick, heat-bonded polyethylene and kraft paper.
    b. Moisture Barrier for Outdoor Applications: 3-mil (0.075 mm) thick, heat-bonded polyethylene and kraft paper or 2.5-mil (0.063 mm) thick polysurlyn.

E. Stainless Steel Pipe Jacket: ASTM A167, or ASTM A240/A240M

1. Factory cut and rolled to size for piping when available. Sheet and roll stock ready for shop or field sizing for other applications.
2. Thickness: 0.25 mm (0.010 inch).
3. Finish: smooth or embossed finish.
4. Joining: longitudinal and circumferential slip joints with 50 mm (2 inch) laps.
5. Fittings: 0.41 mm (0.016 inch) thick die-shaped fitting covers with factory-attached protective liner. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
6. Securement: Stainless steel bands at 300 mm (12 inch) spacing only. No screws, rivets or any other securement device capable of puncturing the underlying vapour retarder shall be used on systems below ambient temperature.
7. Moisture Barrier:
    a. Moisture Barrier for Indoor Applications: 1-mil (0.025 mm) thick, heat-bonded polyethylene and kraft paper.
    b. Moisture Barrier for Outdoor Applications: 3-mil (0.075 mm) thick, heat-bonded polyethylene and kraft paper or 2.5-mil (0.063 mm) thick polysurlyn.

F. Underground Direct-Buried Jacket: 3.2 mm (125 mil) thick vapour barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fibre or polyester scrim and laminated aluminum foil.

G. Self-Adhesive Outdoor Jacket: 1.5 mm (60 mil) thick, laminated vapour barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

H. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

I. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

J. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.13 Tapes

A. Seal Tape: Self-adhering tape specifically engineered to cover butt joints of self-adhering elastomeric tube material. Equal to ArmaFlex Black LapSeal Tape.

B. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

C. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

D. PVC Tape: White vapour retarder type matching field applied PVC jacket with acrylic adhesive, suitable for indoor and outdoor applications.

1. Width: 50 mm (2 inches).
2. Thickness 0.15 mm (6 mils).

3. Adhesion: 0.7 N/mm (64 ounces force/inch) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 3.3 N/mm (18 lbf/inch) in width.

E. Aluminum-Foil Tape: Vapour retarder tape with acrylic adhesive

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

F. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches (75 mm).
2. Film Thickness: 4 mils (0.10 mm).
3. Adhesive Thickness: 1.5 mils (0.04 mm).
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

G. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches (75 mm).
2. Film Thickness: 6 mils (0.15 mm).
3. Adhesive Thickness: 1.5 mils (0.04 mm).
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.14 Securements

A. Bands

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, [1/2 inch (13 mm)] [3/4 inch (19 mm)] wide with wing seal or closed seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, [1/2 inch (13 mm)] [3/4 inch (19 mm)] wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [0.106-inch- (2.6-mm-)] [0.135-inch- (3.5-mm-)] diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [0.106-inch- (2.6-mm-)] [0.135-inch- (3.5-mm-)] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

    b. Spindle: [Copper- or zinc-coated, low-carbon steel] [Aluminum] [Stainless steel], fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

    a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.

    b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).

    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

    a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

    b. Spindle: [Copper- or zinc-coated, low-carbon steel] [Aluminum] [Stainless steel], fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

    c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, [galvanized-steel] [aluminum] [stainless-steel] sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    a.

C. Staples: Outward-clinching insulation staples, nominal 19 mm (3/4 inch) wide, stainless steel or Monel.

D. Wire: 1.6 mm (0.062 inch) soft-annealed, stainless steel.

Part 3 EXECUTION

3.1 Examination

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
    1. Verify that systems to be insulated have been tested and are free of defects.
    2. Verify surfaces are clean and dry, with foreign material removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
    1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 0.127 mm (5 mils) thick and an epoxy finish 0.127 mm (5 mils) thick if operating in a temperature range between 60 to 149°C (140 to 300°F). consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
    2. Carbon Steel: Coat carbon steel operating at a service temperature between 0 to 149°C (32 to 300°F) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water, if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 General Installation Requirements

A. Requirements in this article apply to all insulation materials except where more specific requirements are specified in various insulation material installation articles.

B. Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

C. Install in accordance with TIAC National Standards.

D. Apply materials in accordance with manufacturer's instructions and this specification.

E. All insulation shall be installed by a licensed applicator and applied in accordance with the manufacturer's recommendations.

F. All work shall conform with accepted industry and trade standards for commercial insulations.

G. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ductwork, piping and equipment including fittings, valves, and specialties.

H. Install insulation materials, forms, vapour barriers or retarders, jackets, and thicknesses required for each item of ductwork, piping, and equipment as specified in insulation system schedules.

I. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

J. Install insulation with longitudinal seams at top and bottom of horizontal runs.

K. Install multiple layers of insulation with longitudinal and end seams staggered.

L. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialities.

M. Keep insulation materials dry during application and finishing.

N. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

O. Install insulation with least number of joints practical.

P. Where vapour barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapour-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

Q. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

R. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 75 mm (3-inch) wide strips of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 100 mm (4 inches) on centre.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

S. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

T. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

U. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

V. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

W. Specified adhesives, mastics and coatings shall be applied at the manufacturer’s recommended minimum coverage.

A. Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm (3 inch).

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

3.4 Penetrations

A. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleave seal. Seal terminates with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 50 mm (2 inches).
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installed at Fire-Rated Wall and Partition Penetrations:

1. Piping: Install insulation continuously through penetrations of fire-rated walls and partitions.
2. Ductwork: Terminate insulation at fire damper sleeves for fire rated wall and partition penetrations. externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 50 mm (2 inches).

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Duct: for penetrations through fire rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 50 mm (2 inches).

3.5 General Pipe Insulation Installation

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 Installation of Cellular-Glass Insulation

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 Installation of Flexible Elastomeric Insulation

A. Installation shall follow the manufacturer's installation instructions or ASTM C 1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Straight Pipes and Tubes:

1. Slit tubular sections and apply onto piping or tubing. Alternatively, slide un-slit sections over the open ends of piping or tubing.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Insulation must be installed in compression to allow for expansion and contraction.
4. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
5. For below-ambient systems, adhere the insulation to the pipe at least every 18 feet (5.5-m) using manufacturer's adhesive. Completely terminate joints at critical points such as flanges, T-sections, elbows, supports, and similar fittings.

D. Insulation Installation on Pipe Flanges:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. Install pipe insulation to outer diameter of pipe flange.
3. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
4. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
5. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. Install mitered sections of pipe insulation.
3. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

F. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 Installation of Mineral-Fibre Insulation

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 Field-Applied Jacket Installation

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 50 mm (2 inch) overlap at seams and joints.
2. Embed glass cloth between two 1.6 mm (0.062 inch) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 38 mm (1-1/2 inch) laps at longitudinal seams and 75 mm (3 inch) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapour-retarder jackets and exposed insulation with vapour-barrier mastic.

C. Where PVC jackets are indicated, install with 25 mm (1 inch) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish head along seam and joint edge.

D. Where metal jackets are indicated, install with 50 mm (2 inch) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 300 mm (12 inches) on centre and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory pre-sized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install pre-sized jackets with an approximate overlap at butt joint of 50 mm (2 inches) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped along length of roll for insulation systems with an outer circumference of 850 mm (33-1/2 inches) or less. The 850 mm (33-1/2") circumference limit allows for 50 mm (2 inch) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing" and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumference to avoid damage to tape edges.

3.10 Piping Insulation Schedule

A. Acceptable preformed pipe and tubular insulation materials and thickness are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. Piping Insulation Application Schedule

Application	Insulation Type	Thickness Ref. # (See Thickness Schedule)
Heating Water up to 200F	Fibreglass	(3)
Chilled Water	Fibreglass	(6)
Cooling Coil Condensate Drain	Fibreglass	(7)
Dual Temperature	Fibreglass	(3)
Cold Piping Outdoors, Above Ground	Fibreglass	(6)
Hot Piping Outdoors, Above Grade	Fibreglass	(2)
Refrigerant Piping	Elastomeric	(8)

D. Piping Insulation Thickness Schedule

Application Schedule Reference #	Temperature Reference	Minimum Insulation Thickness (inches) for Pipe Size (NPS)					
		3/4 and smaller	1 – 1-1/4	1-1/2 - 2	2-1/2 - 3	4 - 6	8 & larger
(1)	250-350F	3.5	4.0	4.5	4.5	4.5	4.5
(2)	200-250F	2.5	2.5	3.0	3.0	3.0	3.0
(3)	140-200F	1.5	1.5	2.0	2.0	2.0	2.0
(4)	105-140F	1.0	1.0	1.5	1.5	1.5	1.5
(5)	60-105F	NA	NA	NA	NA	NA	NA
(6)	40-60F	1.0	1.0	1.5	1.5	1.5	2.0
(7)	40-60F	0.5	0.5	0.5	0.5	0.5	0.5
(8)	<40F	1.0	1.0	1.5	1.5	1.5	2.0

3.11 Indoor, Field-Applied Jacket Schedule

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials list is Contractor's option.

C. Duct and Plenums, Concealed:

1. None.

D. Ducts and Plenums, Exposed:

1. None.

E. Piping, Concealed:

1. None (factory applied ASJ).

F. Piping, Exposed:

1. PVC: 0.5 mm (20 mils) thick.

G. Equipment, Concealed:

1. None.

3.12 Outdoor, Field-Applied Jacket Schedule

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials list is Contractor's option.

C. Piping, concealed:

1. Aluminum, Stucco Embossed: 0.61 mm (0.024 inch) thick.

2. Stainless Steel, Type 304, Smooth or Stucco Embossed: 0.41 mm (0.016 inch) thick.

D. Piping, exposed:

1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.61 mm (0.024 inch) thick.

2. Stainless Steel, Type 304, Smooth or Stucco Embossed with Z-Shaped Locking Seam: 0.41 mm (0.016 inch) thick.

END OF SECTION

Part 1 General

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code requirements, the contractor shall notify the Engineer of the conflict in writing. If direction is not provided prior to submission of the bid, the contractor shall price the more extensive system.

1.2 Summary

A. Section Includes: cleaning and start-up of mechanical piping systems.

Part 2 Products

2.1 Cleaning Solutions

A. Refer to Section 23 25 00 – HVAC Water Treatment.

Part 3 Execution

3.1 Manufacturer's Instructions

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

3.2 Cleaning Hydronic and Steam Systems

A. Refer to Section 23 25 00 – HVAC Water Treatment for cleaning procedures.

B. Conditions at time of cleaning of systems:

1. Only new system piping requires cleaning, unless noted otherwise.
2. Systems: free from construction debris, dirt and other foreign material.
3. Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
4. Strainers: clean prior to initial fill.
5. Install temporary filters on pumps not equipped with permanent filters.
6. Install pressure gauges on strainers to detect plugging.

C. Report on Completion of Cleaning:

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

3.3 Start-up of Hydronic Systems

A. After cleaning is completed and system is filled:

1. Establish circulation and expansion tank level, set pressure controls.
2. Ensure air is removed.
3. Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
4. Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
5. Clean out strainers repeatedly until system is clean.
6. Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment .
7. Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
8. Repeat with water at design temperature.
9. Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
10. Bring system up to design temperature and pressure slowly.
11. Perform TAB as specified in Section 20 05 93 - Testing, Adjusting and Balancing.
12. Adjust pipe supports, hangers, springs as necessary.
13. Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
14. If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
15. Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
16. Check operation of drain valves.
17. Adjust valve stem packings as systems settle down.
18. Fully open balancing valves (except those that are factory-set).
19. Check operation of over-temperature protection devices on circulating pumps.
20. Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

END OF SECTION

Part 1 General

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code requirements, the contractor shall notify the Engineer of the conflict in writing. If direction is not provided prior to submission of the bid, the contractor shall price the more extensive system.

1.2 Summary

A. Section includes pipe and fitting materials and joining methods for the following piping systems. The contractor is responsible for all labour, materials, equipment and tools for the completion of these systems:

1. Chilled water piping.
2. Air-vent piping.
3. Safety-valve-inlet and -outlet piping.

1.3 Reference Standards

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

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

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

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

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

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

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

H. ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.

I. ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

J. ASTM A536, Standard Specification for Ductile Iron Castings.

K. ASTM B61, Standard Specification for Steam or Valve Bronze Castings.

L. ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

M. ASTM E202, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

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

O. CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.

P. MSS-SP-67, Butterfly Valves.

Q. MSS-SP-70, Grey Iron Gate Valves, Flanged and Threaded Ends.

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

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

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

1.4 Action and Informational Submittals

A. Submit in accordance with Section 01 00 01 – General Requirements.

B. Product Data:

1. submit product information of valves. Clearly indicate valve make, model, type, size and pressure rating, CV rating and Provincial CRN for each valve type.
2. Submit product information all groove joint couplings and fittings. Specifically identify make and style or series designation.

1.5 Closeout Submittals

A. Submit in Accordance with Section 01 00 01 – General Requirements.

B. Operation and Maintenance Data: submit operation and maintenance data for valves for incorporation into manual.

1.6 Extra Stock Materials:

A. Supply spare parts as follows:

1. Valve seats: 1 minimum for every ten valves, each size. Minimum one.
2. Discs: 1 minimum for every ten valves, each size. Minimum one.
3. Stem packing: 1 minimum for every ten valves, each size. Minimum one.
4. Valve handles: 2 minimum of each size.
5. Gaskets for flanges: 1 minimum for every ten flanges.

1.7 Quality Assurance

A. Provide all components, products, and fabrication techniques in compliance with the Regulations and Requirements of the Province of British Columbia “Power Engineers Boiler and Pressure Vessel Safety Act and Regulations.”

B. Pipe welding:

1. Installation and repair or alterations to, pressure piping systems shall be performed only by licensed Contractors and licensed Welders, certified for the work being done in accordance with the Regulations and Requirements of the Province of BC "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations."
2. All field welding to be in accordance with the procedures of CSA-W117.2, B31.1 or B31.9 and the BC Boiler and Pressure Vessel Act.
3. Welders must be qualified for the process for which they are welding in.
4. Welders Qualifications:
    a. Welding qualification in accordance with CSA B51.
    b. Use qualified and licensed welders posing certificate for each procedure performed.
    c. Furnish welder's qualification to Consultant upon request.
5. Inspector Qualifications: to CSA W178.2.

C. Grooved Piping:

1. All grooved joint couplings, fittings, valves, and specialties shall be the product of a single manufacturer. Combining products of multiple manufacturers is not acceptable. Grooving tools shall be of the same manufacturer as the grooved components.
2. Manufacturer shall be ISO 9001 certified.
3. All coupling, fitting, and valve (body and component) castings shall be date stamped for quality assurance and traceability.
4. Gaskets shall be molded ad produced by the coupling manufacturer.
    a. EPDM elastomer materials shall be developed, manufactured, and testing in the coupling manufacturer's facility.
    b. The coupling manufacturer's gasket development and production shall be periodically audited by quality and polymer industry professionals.
    c. The Victaulic proprietary blend is the only EHP that is acceptable for hot water heating systems to 120°C (250°F).
5. All grooved joint products shall comply with CSA B242.

1.8 Regulatory Requirements

A. Comply with ASME B31,1 or B31,9, CSA B51 and CSA B214 for materials, products, and installation.

Part 2 PRODUCTS

2.1 Acceptable Manufacturers

A. Subject to compliance with the requirements, provide products by one of the following:

1. Grooved Mechanical Pipe Couplings, Valves, Fittings: Victaulic, no equals.
2. Ball Valves: Apollo, Crane, Kitz, Nibco, Red & White, Toyo, Victaulic, Watts.
3. Butterfly Valves: Apollo, Crane, DeZurik, Grinnell, Kitz, Nibco, Red & White, Toyo, Victaulic, Watts.
4. Check Valves, Swing: Crane, Kitz, Nibco, Red & White, Toyo, Victaulic.
5. Check Valves, Silent: APCO, Nibco, StreamFlo, Val-matic, Victaulic.
6. Circuit Balancing Valves: Armstrong, Bell & Gossett, Griswold, Tour Andersson, Victaulic.

2.2 Pipe Hangers and Supports

A. Refer to Section 20 05 29 – Hangers and Supports.

2.3 Performance Requirements

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 860 kPa (125 psig) at 121°C (250°F)
2. Dual-Temperature Heating and Cooling Water Piping: 860 kPa (125 psig) at 121°C (250°F)
3. Makeup-water Piping: 860 kPa (125 psig) at 60°C (140°F)
4. Air-Vent Piping: to match system pressure rating.
5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.4 Steel Pipe and Fittings

A. Steel Pipe: To ASTM A53/A53M, Grade B, as follows:

1. To NPS 10: Schedule 40.
2. NPS 12 and over, 10 mm (0.40 inch) wall thickness.

B. Applications: Heating water, chilled water, dual temperature water, chemical feed, relief valve vents.

C. Pipe Joints & Fittings:

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

a. Pipe thread: taper.

b. Screw fittings: malleable iron, to ASME B16.3, Class 150.

c. Unions: malleable iron, to ASME B16.3.

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

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

3. NPS 2 to 12: Roll grooved: standard and rigid coupling to CSA B242.

a. Fittings for roll grooved piping: malleable iron to ASTM A47/A47M, ductile iron to ASTM A536.

b. Roll grooved coupling gaskets: type EHP rated to 121°C (250°F).

4. Flanges:

a. Cast iron: to ASME B16.1, class to match system pressure class.

b. Steel: to ASME B16.5, class to match system pressure class.

c. Roll Groove: flange adapter, flat face, ductile iron housing with elastomer pressure responsive gaskets for direction connection to match system pressure class.

d. Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

e. Orifice flanges: slip-on face, 2,100 kPa (305 PSI).

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

2.5 Copper Tubing

A. 2 NPS and smaller.

B. Copper Tubing:

1. Type K hard drawn copper tubing: to ASTM B88/B88M.

a. Applications: Pressure drains, heating water, chilled water, chemical feed, relief valve vents.

2. Type K soft drawn copper tubing: to ASTM B88/B88M.

a. Applications: Air vent overflow where concealed, relief valve vents.

C. Fittings:

1. Cast bronze threaded fittings: to ANSI/ASME B16.15.

2. Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.

3. Cast iron threaded fittings: to ANSI/ASME B16.4.

4. Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

D. Flanges

1. Brass and bronze: threaded.
2. Cast iron: threaded.
3. Orifice flanges: slip-on, raised face, 2,100 kPa (300 PSI).

E. Joints

1. Solder, tin-antimony, 95:5: to ASTM B32.
2. Silver solder BCUP: to ANSI/AWS A5.8.
3. Brazing: as indicated.

2.6 Valves – General

A. Valves shall be of one manufacturer wherever possible.

B. Grooved valve shall be of the same manufacture as the adjoining coupling.

C. Provide vales with manufacturer's name and pressure rating clearly marked on outside of body. All valves must be suitable in all respects for service used.

D. All valves shall have current Provincial CRN.

E. All valves shall be inspected and pressure tested in accordance with MSS SP-82.

2.7 Isolation Valves

A. Ball or butterfly only.

B. Extended neck model for all insulated lines.

C. Provide chain operators on all valves located higher than 2,100 mm (7 feet) above access level.

D. Ball Valves:

1. In compliance with MSS-SP-100
2. Full port for NPS 1/2 to 1; Standard Port NPS 1-1/4 and larger.
3. Provide valve handle with memory stop for balancing applications.
4. NPS 1 and smaller, soldered:
   a. WOG non-shock 4,140 kPa (600 PSI).
   b. Brass two-piece body, blow-out stainless steel proof stem, PTFE seats, stainless steel ball, lever handle operator rating complying with ASTM B283.
5. NPS and smaller, threaded:
   a. WOG non-shock 4,140 kPa (600 PSI).
   b. Brass two-piece body, blow-out stainless steel proof stem, PTFE seats, stainless steel ball, lever handle operator rating complying with ASTM B283.

E. Butterfly Valves

1. ANSI Class 150 or ANSI Class 200 as required for application.
2. Removable seats.
3. Valve stem shall be fastened to disc so that no liquid can reach the stem.
4. External fasteners such as roll pins, cotter, keys, or set screws will not be allowed.
5. Butterfly valve shall be lug type; no wafer type valves allowed.
6. Provide manual fear operator for butterfly valves NPS 8 and larger.

2.8 Drain Valves

A. Minimum 2,070 kPa (300 PSI) WOG rated, 20 mm (3/4 inch) diameter straight pattern bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (3/4 inch) diameter hose, with cap and chain.

2.9 Hose Bibbs

A. Brass ball valve with forged brass cap and chain, NPS 3/4 male threaded hose end. Lockshield in public areas.

B. Rated for 1,724 kPa (250 PSI) at 121°C (250°F).

2.10 Escutcheons

A. Provide stainless steel escutcheons at piping penetrations of walls where exposed public view and required for proper appearance. Provide galvanized steel escutcheons at penetrations of masonry walls elsewhere. Escutcheons not generally required at drywall penetrations where not exposed to public view.

2.11 Sleeves

A. Provide sleeves where pipes pass through floors above grade, roofs, poured-in-place masonry walls, and exterior walls.

B. Sleeves shall be standard weight steel pipe, except sleeves for concealed piping through floors not in structural members may be 25-gauge galvanized sheet metal.

C. Floor sleeves for piping shall extend from the bottom of the slab to 2-inches above the finished floor.

D. Seal between piping and sleeve with fire-rated caulk at all penetrations of fire-rated partitions and floors.

E. Make sleeves through outside walls watertight. Caulk between uninsulated pipe and sleeve.

F. Size sleeves for insulated pipes to allow full thickness insulation.

Part 3 EXECUTION

3.1 General

A. Installation shall meet or exceed all applicable Federal, Provincial and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Install in accordance with manufacturer's instructions.

C. Provide access where valves and fittings are not exposed.

D. Avoid installation of service components (such as valves, air vents, strainers, etc.) in secure areas.

3.2 Clearances

A. Provide clearance around systems, equipment, valves, fittings and components for observation or operation, inspection, servicing, maintenance and as recommended by the manufacturer. Maintain a minimum of 25 mm (1") space between adjacent flanges or pipe insulation, whichever has the larger diameter.

B. Provide space for disassembly, removal of equipment and components as recommended by the manufacturer or as indicated, whichever is greater, without interrupting operation of other systems, equipment and components.

C. Provide adequate clearance for installation of insulation.

3.3 Routing and Grading

A. Route piping in an orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

B. Install piping free of sags and bends.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and services areas.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Avoid piping in exterior walls unless otherwise directed. If required, install this piping protected from the outside by the building insulation and vapour barrier.

F. Avoid locating water and drain piping over electrical equipment. Where this is unavoidable, provide galvanized drip pans under such pipe, and weld piping and fittings. Provide drain and piping from drip pans to satisfactory floor drain.

G. Slope water piping at 0.2% and arrange to drain at low points.

H. Make reductions in water pipe sizes with eccentric reducers to provide drainage and venting.

3.4 Piping

A. Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly.

B. Remove welding slag or other foreign material from piping.

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

D. Where more than one piping system material is specified, ensure system components are compatible, and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

E. Select system components with pressure rating equal to or greater than rated pressure of system piping.

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

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

H. Make screwed joints with full cut standard taper pipe threads with approved non-toxic compound applied to male threads only.

I. Saddle type branch fittings are not acceptable.

J. Saddle type branch fittings may be used on mains, if branch line is half size or smaller than main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.

K. Use long radius elbows. Standard radius elbows may be used in lieu of long radius elbows in grooved piping systems in equipment rooms and where space considerations must be made.

L. Install all thermometer wells and immersion sensor wells specified under the Controls Section. Where wells will restrict flow in small diameter pipes (NPS 1-1/2 and smaller) install a section of oversized pipe at least NPS 2.

M. Remake leaking joints using new materials, do not caulk, or cement leaking threaded joints.

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

O. Do not use thread protection couplings, close nipples, running nipples or street elbows.

P. Bull head tees shall not be used for converging flows.

Q. Make connections to equipment and branch mains with unions.

R. All run-outs shall be installed with swing joints to allow for movement due to expansion and contraction of the main.

S. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

T. Install temperature probe ports and pressure probe ports upstream and downstream of all heating systems components including but not limited to the following items: heat exchangers, all hydronic coils, finned tube elements, radiant heaters, in-floor heating zones, pumps, boilers, chillers, and cogeneration units. The contractor shall coordinate these items with the balancing contractor to ensure that all ports are installed as required by the balancer.

3.5 Soldering and Brazing

A. Pressure fluid systems - with chemical treatment (heating, chilled and condenser water) braze with silver base brazing alloy, 538°C (1000°F) melting point.

B. Pressure fluid systems - without chemical treatment, (heat recovery, domestic water) solder with 95/5 tin-antimony to ASTM B32.

C. Non-pressure systems, (drains) solder with 50/50 tin lead.

D. Piping connections to radiant ceiling panels, solder with 95/5 tin-antimony.

3.6 Roll Groove Piping

A. Use lubricant supplied by Manufacturer and coat gasket. Lubricate gaskets in accordance with manufacturer's recommendation with lubricant supplied by the coupling manufacturer that is suitable for the gasket elastomer and system media.

3.7 Grooved Joint Piping

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

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

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

3.8 Connections to Equipment

A. Connect to equipment in accordance with manufacturer's instruction unless otherwise noted.

B. Provide line sized isolation valves at each piece of equipment.

C. Install unions, flanges, or grooved couplings downstream of isolation valves and at equipment or apparatus connection. Do not use direct welded or threaded connections to valves, equipment, or other apparatus.

D. Install removable sections of pipe or 300 mm (12") spool pieces on the suction side of end suction pumps and where required for ease of maintenance.

E. Arrange piping connections to allow ease of access and for removal of equipment.

F. Align and independently support piping connections adjacent to equipment to prevent piping stresses being transferred.

G. Do not reduce equipment connection sizes by bushing.

H. Use double swing joints when equipment mounted on vibration isolation and when piping is subject to movement.

3.9 Drain Connections

A. Make connections to all equipment drains, drain pans, ductwork drains, discharge from all liquid relief valves, liquid safety valves, high capacity air vents, steam drip pan elbows, equipment blowdowns, water columns, and overflows. Pipe to nearest floor drain or approved connection. Install a brass, bronze or copper receiving funnel on the drain where shown. Where item being drained is under pressure, provide a deep seal trap.

B. If a gravity drained connection cannot be made because of invert elevations, provide a packaged condensate pump with integral float control to be wired by this contractor to the unit power connection. The condensate drain line shall be insulated with continuous 25 mm (1") thick insulation from the point of connection to the indirect waste connection.

C. Drains from drain pans shall be DWV copper NPS 1-1/4 minimum size.

D. Drain and vent piping shall be of the same material as the piping system to which it is connected, except where otherwise specified.

3.10 Expansion of Piping

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

B. It is the contractor's responsibility to retain the services of a qualified professional engineer to design the thermal pipe expansion system for the actual installed layout of all piping systems covered by this specification section.

C. Install flexible piping connections to all equipment that contains rotating components including but not limited to: hydronic coils within fan powered terminal units, isolated boilers, entrance heaters that are externally isolated, air handling units that are externally isolated, isolated pumps, isolated pump packages, cooling towers, chillers, heat pumps, and all compressorized equipment.

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

E. Engage [Victaulic] to provide piping system design services to accommodate thermal movement, seismic movement, and for the settlement of the piping system. The service includes required grooved piping components detailed in CAD on an overlay of the mechanical contract drawing(s), including anchor load calculations and placement of anchors. A calculation report showing thermal movement and accommodation shall also be provided. A design stamped by a qualified professional engineer from the jurisdiction in which the grooved piping products manufacturer is located or where the project is being constructed is required. Include cost in the proposal price.

F. Where applicable, the manufacturer of the anchors shall be the same as the grooved component(s) manufacturer.

3.11 Valves

A. General

1. Install all valves in accordance with manufacturer's recommendations.
2. Install valves in accessible locations with stems upright or angled 45° above horizontal unless approved otherwise. Valves must be accessible without removing adjacent piping.
3. Provide valves suitable to connect to adjoining piping as specified for pipe joints.
4. Use line sized valves unless specifically noted otherwise.
5. Remove interior parts before soldering.
6. Provide stem extensions on all insulated valves.
7. Provide ball valves in piping NPS 2 and smaller and butterfly valves in piping NPS 2-1/2 and larger for shut-off, equipment isolation, throttling, bypass or manual flow control services.
8. Throttling valves are not to be used for shut-off; additional valves shall be installed for isolation purposes.

B. Isolation valves:

1. Provide isolation valves at branch take-offs, to isolate each piece of equipment, upstream of all meters, gauges, automatic air vents, and as indicated.
2. Provide isolation valves in all systems such that floor by floor for horizontal systems, all risers in vertical systems and zone areas on a large horizontal system can be isolated.
3. All pressure service cap-offs for future shall be provided with isolation valves.
4. Ball valves used for shut-off / isolation shall be full port.

C. Drain Valves and Hose Bibbs

1. Install drains, consisting of a tee fittings, NPS 3/4 ball valve, and short NPS 3/4 threaded connection with cap and chain at low points in piping system mains, bases of vertical risers, at equipment, as noted on drawings, and elsewhere as required for system drainage.
2. Provide main piping system drain valves at a low point and pipe to drain. Drain valves shall be two (2) pipe sizes smaller than largest mains but not less than NPS 1.
3. Provide drain valve and hose connections off the bottom of all strainers.
4. Install NPS 3/4 hose bibbs at all downfed terminal heating and cooling units.

3.12 Air Vents

A. Provide manual air vents at high points on lines and equipment connections in exposed piping system and pipe air vent discharge to the nearest drain complete with air gap.

B. Provide automatic air vents at all high points, as indicated on the drawings, and as required for proper operation of the system. Install an isolating valve upstream of each air vent.

C. Pipe air vent discharge to approved location using NPS ¼ diameter hard drawn copper pipe and terminate where discharge is visible.

D. Provide access to all air vents.

3.13 Dielectric Couplings

A. Provide dielectric couplings, of suitable pressure rating for the system, where dissimilar metals are joined.

B. NPS 2 and under: provide isolating unions or bronze valves.

C. NPS 2-1/2 and larger: provide isolating flanges.

D. Dielectric waterway fittings may be used in lieu of unions or flanged connections.

E. Waterways shall be grooved and/or threaded end(s), with inert thermoplastic lining.

3.14 Sleeves

A. Provide Schedule 40 black steel pipe sleeves or factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

B. Construction:

1. Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.

C. Size:

1. Minimum 6 mm (1/4") clearance between sleeve and un-insulated pipe or between sleeve and insulation for insulated pipe.

D. Installation:

1. Terminate flush with finished surface at concrete, masonry walls, and concrete floors on grade.
2. Terminate 25 mm (1") above finished floor for all other floors.
3. Paint exposed exterior surfaces with heavy application of zinc-rich paint before installation.

E. Sealing:

1. Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
2. Elsewhere: Provide space for fire stopping. Maintain fire rating integrity.
3. Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
4. Ensure not contact between copper pipe or tube and sleeve.

3.15 Escutcheons

A. Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

B. Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

3.16 Piping Tests

A. Notify the Consultant and the Inspection Authority having jurisdiction, 48 hours in advance of intended test dates.

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

C. Leave joints, including welds, un-insulated and exposed for examination during test.

D. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

E. Do not insulate, backfill or conceal until tests have been completed and approved by the inspection authorities.

F. Examine all systems under test for leaks.

G. Joints shall remain dry during the test. A general sweating around a weld shall be reason for rejection.

H. Remake all leaking connections and joints.

I. Tests shall be limited to new piping only.

J. New connections to existing piping shall be warranted.

K. Initial Hydrostatic test: 150% of working pressure, but not less than 860 kPa (125 psig) for 1 working day.

L. Final Hydrostatic test: 150% of working pressure.

M. Notify Consultant when pipe tests are being performed. Consultant may review as timing permits. Otherwise, have all pipe pressure tests signed off by the Contractors' Site Foreman Manager.

N. Prepare written report of testing and certificate and submit copies to Consultant.

3.17 Welding Tests

A. Retain a third party Welding Inspector qualified to:

1. CSA W178.1 Certification of Welding Inspection Organizations
2. CSA W178.2 Certification of Welding Inspectors
3. Approved by the Consultant.

B. Conduct testing in compliance with:

1. ASME Boiler and Pressure Vessel Code – Section V
2. ASME B31.1 Power Piping
3. ASME B31.3 process piping (if high pressure piping used)
4. Authority having jurisdiction

C. The Welding Inspector shall provide an "Inspection and Test Plan" in co-operation with the Consultant prior to start of testing.

D. The Welding Inspector shall co-ordinate testing and inspection activities with the Authority having Jurisdiction.

E. The Welding Inspector shall visually inspect welds during early stages of welding procedures.

F. Leave welds uncovered until inspected and approved by the Welding Inspector or Boiler Inspection Branch.

G. Visual examination:

1. In addition to the hydrostatic tests specified under "Pipe Testing" all welds shall be given a non-destructive visual examination.
2. Visual examinations shall include the entire circumference of weld externally and wherever possible internally.
3. The following indications are unacceptable:
    a. Cracks - external surface.
    b. Undercut on surface that is greater than 1 mm (1/32") deep.
    c. Weld reinforcement greater than specified in ASME B31.1 Table 127.4.2.
    d. Lack of fusion on surface.

e. Incomplete penetration (applies only when inside surface is readily accessible).

f. Any other linear indications greater than 5mm (3/16") long.

g. Surface porosity with rounded indications having dimensions greater than 5mm (3/16") or four or more rounded indications separated by 2mm (1/16") or less edge to edge in any direction. Rounded indications are indications that are circular or elliptical with their length less than three times their width.

4. Replace welds of poor or doubtful quality at Contractor's expense to the satisfaction of the Welding Inspector and the Authority having Jurisdiction.

H. Radiographic examination:

1. Radiographic examination shall be undertaken by a third party agency, which is specialized in this type of inspection.

2. Provide radiographic examination in accordance with the ASME Boiler and Pressure Vessel Code, Section V.

3. Provide radiographic examination on 20% of welds for the following NPS 2 and greater piping systems:

a. 827 kPa (120PSI) steam pressure or above

b. Operating temperature 176°C (350°F) or above

c. As directed by the Authority having Jurisdiction

4. Radiograph over full circumference.

5. Radiographs shall be interpreted by the Consultant and representative of the firm carrying out radiographing.

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

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

3.18 Flushing and Cleaning

A. Flushing and cleaning shall commence only after all piping tests have been completed.

B. Refer to Section 23 25 00 – HVAC Water Treatment.

C. Install temporary bypass connections around all heat pump units before commencing chemical cleaning.

D. Chemically clean the following piping systems as recommended by an approved professional chemical cleaning and treatment agency who shall supervise the work:

1. Heating hot water system(s).

2. Chilled water and glycol system(s).

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

F. Install final connections to heat pump units after flushing is complete.

G. Remove, clean and reinstall all strainer baskets.

H. Submit a report signed by a principal of the Agency, which certifies that the cleaning has been satisfactorily completed.

3.19 Filling of System

A. Refill system with clean water adding water treatment as specified.

3.20 Chemical Treatment

A. Chemically treat water systems in accordance with Section 23 25 00 - HVAC Water Treatment.

3.21 Start-Up of Hydronic Systems

A. In accordance with Section 20 08 16 – Start-Up of Piping Systems.

END OF SECTION

Part 1 General

1.1 Related Requirements

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections, apply to this Section.

B. All sections of the project manual are directly applicable to this Specification Section. Should a conflict arise between Specification Sections or between Specifications and Drawings and/or Code Requirements, the Contractor shall notify the Engineer of the conflict in writing. If direction is not provided prior to submission of the bid, the contractor shall price the more extensive system.

1.2 Summary

A. Section Includes:

1. Plastic pipe and fittings.
2. Pre-insulated piping.

1.3 Definitions

A. Invert: Vertical distance from Project datum reference point to bottom interior of pipe surface.

B. Electrofusion: a heat fusion joining process where the heat source is an integral part of the fitting, such that when an electric current is applied, heat is produced that melts and permanently joins two or more plastic components.

C. Heat fusion: a method of joining two similar materials (e.g., HDPE-HDPE) by the application of heat to melt the mating surfaces and then pressing them together with sufficient force to become one monolithic piece.

D. HDPE: High-density polyethylene.

E. Standard dimension ratio (SDR): a specific ratio of the average specified outside diameter to the minimum specified wall thickness (OD/t) for outside diameter-controlled plastic pipe, the value of which is derived by adding one to the pertinent number selected from the ANSI Preferred Number Series 10.

1.4 Action Submittals

A. Product Date: Submit manufacturer's Technical Manual, submittal forms, catalog cuts, brochures, specifications, and installation instructions for the following:

1. Hydronic piping.
2. Pre-insulated piping.
3. Fittings, fasteners, and associated items required for installation of piping.
4. Submit pressure loss and flow information for Project-specific pipe sizes.

B. Shop Drawings: For underground hydronic piping.

1. Calculate requirements for expansion compensation for underground piping.

2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.

3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.

C. Delegated Design Submittal: For underground hydronic piping systems indicated to comply with performance requirements and design criteria, including analysis data and design drawings signed and sealed by the professional engineer responsible for their preparation.

1. Include design calculations and details for selecting thermal expansion and thrust restraints.

2. Include design calculations and details, for excavation, bedding, installation of piping, and backfilling.

1.5 Informational Submittals

A. Coordination Drawings: Shop pipe sizes, locations, and elevations. Show other piping in same trench and clearances from hydronic distribution piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1:50 and at a vertical scale of not less than 1:5.

1. Show locations and inverts of utility system manholes and piping. Show manholes and piping. Show types, sizes, materials, and inverts of other utilities crossing hydronic piping.

2. Show depth of cover from top of hydronic system pipes to finished grade.

C. Qualification Data: For Installer.

D. Material Test Reports: For piping.

E. Source quality-control reports.

F. Field quality-control reports.

G. Butt fusion welding joint reports.

H. HDPE fusion welded joint kit reports.

1.6 Closeout Submittals

A. Joint Images: Provide images of every direct-buried field joint constructed on the project.

1. Include an image (or multiple images) that clearly show location of joint with respect to project area.

2. Include images (or multiple images) of completed joint. Complete perimeter of seam shall be visible. Images shall show jacketing extending 600 mm (2-feet) on both sides of seam.

1.7 Quality Assurance

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.8 Field Conditions

A. Interruption of Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services in accordance with requirements indicated:

1. Notify Owner no fewer than three days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility with Owner's written permission.

1.9 Coordination

A. Coordinate pipe-fitting pressure classes with products specified in related Sections.

1.10 Warranty

A. Provide manufacturer's standard written warranty.

B. Polypropylene Piping:

1. Manufacturer shall warrant pipe and fittings for 10 years to be free of defects in materials or manufacturing.
2. Warranty shall cover labour and material costs or repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
3. Warranty shall be in effect only upon submission by the contractor to the manufacturer valid pressure/leak test documentation indicating that the system was tested and passed the manufacturer's pressure/leak test.
4. All Pre-Fab work performed by the manufacturer for the contractor shall be covered by the manufacturer's 10-year warranty including welded joints and fittings.
5. Installers shall be trained and certified to install the pipe according to the manufacturer's guidelines.

Part 2 PRODUCTS

2.1 Performance Requirements

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

1. Dual-Temperature Piping: 690 kPa (100 psig) at 60°C (140°F).

B. Delegated Design: Engage a qualified professional engineer (Civil Engineer) to design underground hydronic piping systems, including restraints and anchors.

2.2 HDPE Pipes and Fittings

A. Pipe and tubing shall be manufactured from a PE compound that has a pipe material designation code of PE4710 when evaluated in accordance with ASTM D3350 and a color and ultraviolet stabilizer code of C or E. Code E compounds shall be stabilized against deterioration from unprotected exposure to ultraviolet rays for not less than three years, as evidenced by meeting the test criteria specified in AWWA C901.

1. All pipe and tubing shall be certified to the requirements of CSA B137.1, ASTM D2737, ASTM D3035, or ASTM F714.
2. All pipe and tubing shall be listed by the Plastic Pipe Institute's Hydrostatic Stress Board (HSB) in PPI TR-4 with a minimum Hydrostatic Design Stress (HDS) value of 5.5 MPa (800 psi) at 23°C (73°F).
3. The outside diameter of the pipe shall be based upon the IPS or DIPS sizing system.

B. Pipe shall be certified to the requirements of CSA B137.1, ASTM D2737, ASTM D3035, or ASTM F714.

C. Markings: HDPE pipe and tubing shall be marked in accordance with the applicable product standard specified above.

D. Fittings shall be manufactured from a PE compound that has a pipe material designation code of PE4710 when evaluated in accordance with ASTM D3350 and a colour and ultraviolet stabilizer code of C or E. Code E compounds shall be stabilized against deterioration from unprotected exposure to UV rays for not less than three years, as evidenced by meeting the test criteria specified in AWWA C901. All fittings shall be certified by NSF International as complying with NSF 61 and 358-1.

1. Socket-type heat fusions fittings shall comply with ASTM D2683.
2. Butt-type heat fusion fittings, including saddle fittings, shall comply with ASTM D3261.
3. Electrofusion-type fittings, including saddle fittings, shall comply with ASTM F1055.

E. Installation of Fittings:

1. Butt-fusion, socket-fusion, and saddle fusion joints and fittings for HDPE pipe and tubing shall be installed in accordance with ASTM F2620 and the instructions of the pipe or tubing and fitting manufacturer.
2. As recommended in ASTM F2620, consult the pipe or fitting manufacturer for applicable procedures for butt fusion joining of pipes and fittings that have the same outside diameter but a different wall thickness (i.e. DR).
3. Electrofusion joints and fittings for PE pipe and tubing shall be installed in accordance with ASTM F1290 and the instructions of the pipe or tubing and fitting manufacturer.

F. Transition Fittings: HDPE transition fittings to adapt to ferrous or non-ferrous metals or plastics shall be:

1. Polyethylene fusion transition fittings with threads or flanges.

2. Self-restrained HDPE-to-grooved system mechanical couplings for transitions of HDPE pipe conforming to ASTM D3035 and ASTM F714 in SDR 11 to SDR 17 dimension ratios, or PE-RT pipe conforming to ASTM D3350 with a cell class PE445574C in accordance with ASTM F2619 or ASTM F714 in SDR 11 to SDR 17 dimension ratios for NPS 2 to 14 for connections to grooved steel pipe, fittings, and valves.

G. Barbed Fittings: Barbed fittings utilizing mechanical clamps shall not be connected directly to PE pipe in buried locations.

H. Accessibility of mechanical connections: All mechanical connections shall be accessible.

2.3 Pre-Insulated HDPE Pipes and Fittings

A. Carrier Piping: HDPE conforming to ASTM D3350 as previously specified herein.

B. Thermal Insulation: Polyurethane foam either spray applied or injected with one shot into the annular space between carrier pipe and jacket with a minimum thickness of 25 mm (1-inch). Insulation shall be rigid, 90-95% closed cell polyurethane with a 2.0 to 3.0 lb/ft3 density and coefficient of thermal conductivity (K-factor) of 0.16 and shall conform to ASTM C-591.

C. Outer Casing: Extruded, black, high-density polyethylene (HDPE), having a minimum wall thickness of 100 mils for jacket sizes less than or equal to 300 mm (12-inches), and 125 mils for jacket sizes larger than 300 mm (12-inches).

D. Fittings: Pre-insulated fittings (tees and elbows) shall meet the same requirements as noted herein for pre-insulated pipe. Fittings shall have stubs of an extra 900 mm (36-inch) of pipe on each inlet and outlet for ease of insertion into the piping system. Pre-insulator shall provide on-site insulation kit to connect to the pre-insulated system to make a continuous insulation system.

2.4 Detectable Warming Tape

A. Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 150 mm (6-inches) wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 750 mm (30 inches) deep; colored as follows:

1. Red: Electric.

2. Yellow: Gas, oil, steam, and dangerous materials.

3. Orange: Telephone and other communications.

4. Blue: Water systems.

5. Green: Sewer systems.

Part 3 EXECUTION

3.1 Earthwork

A. All excavations shall comply with local regulations.

B. Install piping in trenches according to ASTM D2774 or ASTM F645. All piping shall be placed at minimum depth from grade as shown on the drawings.

C. The pipe embedment materials shall be stable, sufficiently granular to be readily worked under the sides of the pipe to provide satisfactory haunching, and readily compactable to achieve soil densities specified by contract documents. These qualities are available in the following materials:

1. Gravels and sands classified as Soil Types GW, GP, SW, and SP, or by a dual soil classification beginning with one of these symbols, in accordance with Test Method D 2487.

2. Sands and gravels classified as Soil Types GM, GC, SM, and SC in accordance with Test Method D 2487.

D. Initial backfill materials shall be placed in compacted layers or as specified in contract documents and local codes.

E. All native and other materials in the pipe embedment zone shall be free from refuse, organic material, cobbles, boulders, large rocks or stones, or frozen soils.

F. The particle size of material in contact with the pipe shall not exceed the following:

1. 1⁄2 in. for pipe to 4 in.

2. 3⁄4 in. for pipes 6 to 8 in.

3. 1 in. for pipes 10 to 16 in.

4. 1-1⁄2 in. for larger pipes.

5. Each soil layer shall be sufficiently compacted to uniformly develop lateral passive soil forces during the backfill operation.

G. The final backfill shall be placed and spread in approximately uniform layers in such a manner as to fill the trench completely so that there will be no unfilled spaces under or about rocks or lumps of earth in the backfill. Large rocks, stones, frozen clods, and other debris greater than 3 in. (76 mm) in diameter shall be removed. Hand mechanical compaction is the preferred method of compaction to a minimum of 12" of cover. When further compaction is required, rolling equipment or heavy tampers shall only be used to consolidate the final backfill, provided the pipe is covered by at least 18-in. of backfill. Initial backfill materials shall be placed in compacted layers of 6-in. A minimum of 12 to 18-in. of cover is required where light traffic is expected. A minimum cover of 24 in. shall be provided for locations with heavy traffic.

H. Trenches under pavements, sidewalks, or roads shall be backfilled and compacted to the required density specified by contract documents or by the appropriate government jurisdiction.

3.2 Piping Application

A. Dual-Temperature Piping:

1. Polypropylene (PP-RCT) SDR 11 factory pre-insulated with polyurethane carrier-pipe insulation.
    a. Piping Insulation Thickness: 40 mm (1.5 inches).
2. HDPE SDR 13.5 factory pre-insulated with polyurethane carrier-pipe insulation.
    a. Piping Insulation Thickness: 40 mm (1.5 inches).
3. PEXa SDR 11 factory pre-insulated with polyurethane carrier-pipe insulation.
    a. Piping Insulation Thickness: 40 mm (1.5 inches).

3.3 Installation of Piping

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Pipe and tubing shall be inspected before installation and any sections that have cuts, gouges, kinks, or other signs of significant damage shall be removed.

C. To avoid surface abrasion, pipe and tubing shall not be dragged over rough ground or obstructions.

D. Pipe and tubing shall not be bent to form a sharp angle or kink.

E. Where pipe or tubing is dispensed from an uncoiling device, it shall be mounted in such a way that stresses are minimized during installation. The pipe shall not be subjected to reverse curvature.

F. Pipe and tubing shall not be installed in contact with or close to hot surfaces in excess of their highest rated operating temperature.

G. Remove standing water in the bottom of trench.

H. Bed the pipe on a minimum 150 mm (6-inch) layer of pipe system manufacturer's recommended granular fill material with a minimum 150 mm (6-inch) clearance between pipes.

I. Do not backfill piping trench until field quality-control testing has been completed and results approved.

J. Install piping at uniform grade of 0.2 percent. Install required fittings to accommodate capped drains at low points and elsewhere as required for system drainage. Install capped manual air vents at high points.

K. Maintain continuous bedding under piping. Do not leave gaps in pipe bedding, allowing pipe to sag between contact points with the bedding.

L. In conduits, install drain valves at low points and manual air vents at high points.

M. Install components with pressure rating equal to or greater than system operating pressure.

N. Install piping in straight lines. Do not bend pipe.

O. Install fittings for changes in direction and branch connections.

P. See Section 23 05 01 "Common Work Results for HVAC" for sleeves and mechanical sleeve seals through exterior building walls.

Q. Secure anchors with concrete thrust blocks.

1. Thrust blocks are not required with PP-R or PP-RP (RCT) piping.

R. Connect to hydronic piping where it passes through the building wall. Hydronic piping inside the building is specified in Section 23 21 13 "Hydronic Piping."

S. Secure anchors and fittings where piping changes direction, and where elsewhere required by manufacturer's written installation instructions, with concrete thrust blocks.

T. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors.

U. After field quality-control testing is complete, backfill with 150 mm (6-inches) of clean, granular material in accordance with piping system manufacturer's written instructions. If mechanical compaction is required, manually backfill to 300 mm (12-inches) before using mechanical-compaction equipment.

3.4 Joint Construction

A. Join pipe and fittings in accordance with the following requirements and Section 232113 "Hydronic Piping":

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

B. Fusion Joints: Fusion join polypropylene pipe in accordance with ASTM D2657, ASTM F2389, and manufacturer's instructions.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1 or ISO 7-1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Insulation joints made for pre-insulated pipe shall be done in accordance with the insulation manufacturer's instructions.

F. Data loggers shall be used to log each joint made. Data logger shall record at least the date, time of day and person making the joint. Data logger shall also record the required pressure/leak test for Warranty.

3.5 Inspection and Cleaning

A. The pipes shall be flushed with cold water after finishing the installation. Flush the system until the water runs clear of debris and dirt.

B. Inspect and test piping systems following procedures of authorities having jurisdiction and as specified by the piping system manufacturer.

C. Clean and disinfect water distribution piping following procedures of the manufacturer and/or the authority having jurisdiction.

3.6 Identification

A. Install continuous plastic underground warning tapes during backfilling of trenches for underground hydronic piping. Locate tapes 150 to 200 mm (6 to 8 inches) below finished grade, directly over piping.

3.7 Field Quality Control

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Prepare hydronic piping for testing in accordance with ASME B31.9 and as follows:
    a. Leave joints, including welds, uninsulated and exposed for examination during test.
    b. Isolate equipment and instrumentation. Do not subject equipment and instrumentation to test pressure.
    c. Install relief valve set to relieve at pressure no more than one-third higher than test pressure.
    d. Fill system with water. Where there is risk of freezing, perform testing with air or liquid that will not freeze or cause damage to piping system materials.
    e. For hydrostatic testing, install vents at high points to release trapped air while filling system. Remove test liquid at accessible low points.
2. Test hydronic piping as follows:
    a. Comply with manufacturer requirements for pressure testing.

b. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times system design pressure.

c. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.

d. Do not pressurize carrier pipe with air.

e. Maintain test pressure for four hours with no loss of pressure.

3. Test conduit as follows:

a. Seal vents and drains and subject conduit to 103 kPa (15-psig) compressed air for four hours with no loss of pressure. Repair leaks and retest.

4. Flush/Purge Pipe as follows:

a. Ensure piping has been filled with liquid and purged of air and debris, pressure tested, and filled with proper quality water and heat transfer fluid as specified.

b. Flushing, pigging, or other means of cleaning the system to remove dirt and debris that may damage vales, regulators, and so forth is required before connecting to above ground piping systems.

c. Flushing flow rate shall be sufficient to remove air and debris, at a minimum of 0.6 m/s (2 feet per second) but not in excess of maximum flow velocity recommended by the pipe and fitting manufacturer.

C. Piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. When successful testing is complete, flush carrier piping to remove dirt or debris remaining after construction. Drain piping after flushing is complete.

F. Fill underground piping system with permanent system liquid prior to system testing and balancing.

END OF SECTION

Part 1 General

1.1 Related Requirements

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code requirements, the contractor shall notify the Engineer of the conflict in writing. If direction is not provided prior to the submission of the bid, the contractor shall price the more extensive system.

1.2 Summary

A. Section includes services and material required for on-site cleaning and chemical treatment of water and steam systems.

B. Equipment, chemicals, testing, and service shall be provided by one supplier.

C. Chemical treatment agency shall provide equipment, chemicals, and site supervision so as to fully comply with all requirements and their intent contained within this specification section.

D. Perform the cleaning, degreasing operation and initial water treatment and submit written reports on all situations found, actions taken and final results. Reports shall be signed by the commissioning coordinator, and chemical treatment agency. Inform the Consultant and commissioning agency fifteen (15) working days prior to commencing of work.

E. Provide chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency, mechanical contractor and commissioning agency.

F. Chemical treatment agency shall provide directive and assistance to the mechanical contractor in the degreasing, cleaning, and chemical treatment of all piping systems. Use of the permanent mechanical systems for pumping or heating of cleaning and dilution solutions is not permitted. Permanent systems shall be isolated and portable pumps and boilers utilized for the duration of the cleaning process. Permanent equipment shall be flushed, degreased, and chemically treated independent of the piping systems.

G. Confirm chemical treatment products are compatible with piping materials, seals, and gaskets used on this project prior to use.

1.3 References

A. American Society for Testing and Materials International (ASTM)

1. ASTM E202, Standard Test Methods for Analysis for Ethylene Glycols and Propylene Glycols

B. American Society of Mechanical Engineers (ASME)

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

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

1. Material Safety Data Sheets (MSDS)

1.4 Action and Informational Submittals

A. Submit in accordance with Section 01 00 01 – General Requirements.

B. Product Data:

1. Submit manufacturer's instructions, product literature and data sheets for proposed chemicals, quantities, calculations, procedures and equipment to be supplied. Provide written operating instructions and system schematics.

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

D. Report: Submit a written report of actual cleaning activities for each system including:

1. Times.
2. System status.
3. Problems encountered.
4. Actions taken.
5. Composition of cleaning & spent cleaning solutions.
6. Inspection results.
7. Final concentration of corrosion inhibitor in hydronic system.
8. Corrosion rates in hydronic systems.
9. Final suspended solids concentration in system.
10. Final iron concentration in systems.
11. Final copper concentration in systems.
12. Description of site preparatory work required.
13. Proposed cleaning procedure.
14. Material and safety data sheets for all treatment materials.
15. Method of disposal of solutions.

1.5 Closeout Submittals

A. Submit in accordance with Section 01 00 01 – General Requirements.

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

1.6 Quality Assurance

A. Use a qualified water treatment specialist, who has a demonstrated record of expertise in water systems cleaning and chemical treatment, to supply chemicals, equipment, and consulting services to perform cleaning and chemical treatment work specified.

1. For existing system: use the chemical treatment provider currently under service contract with the owner.

B. Provide documentation from an accredited independent laboratory if requested by the Owner or Consultant.

C. Notify Consultant 48 hours prior to chemical cleaning so that work may be verified and reviewed.

1.7 Performance Requirements

A. Closed piping loops, including heating, cooling, heat recovery or condenser loops (glycol or water) shall have the following water quality parameters measures and controlled. Control limits to be as recommended by water treatment vendor qualified chemistry expert and per connected equipment requirements.

Part 2 PRODUCTS

2.1 Manufacturers

A. Owner has a contract with a chemical treatment supplier to maintain proper levels of chemical in building systems. New chemicals and/or treatment delivery hardware are to be supplied by this supplier. Obtain supplier's name during bidding process and obtain required pricing information.

2.2 General

A. Confirm chemical treatment products are compatible with piping and equipment materials, seals, and gaskets used on this project prior to use.

B. Materials which may contact finished areas shall be colourless and non-staining.

C. Chemicals used must comply with environmental and health standards applicable to the usage on this project.

D. Chemicals must be approved by governing authorities for release into municipal sewer system.

2.3 System Cleaner

A. 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.

1. Pace Solutions PURGEX L-724 or equivalent.

B. For Aluminum boilers or heat exchangers: Use a concentrated neutral pH cleaning compound. pH must remain below 8.5 in the system water.

1. Pace Solutions PURGEX L-729 or equivalent.

2.4 Chemicals

A. General:

1. Provide sufficient chemical to treat the system from the time of commissioning to acceptance of the project. In addition, provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months of normal operation.

2. Materials which may contact finished areas must be colourless.

B. Closed System Treatment (Hot Water, Chilled Water): Use a Borated Nitrite-based corrosion inhibitor. Maintain levels at 700 to 1000 ppm. Note: The use of Molybdate or Sulphite only will not be accepted.

1. Pace Solutions BAR COR CWS-555, or equivalent.

C. Closed System Treatment (ALUMINUM boilers or heat exchangers): Use a neutral pH corrosion inhibitor. Maintain pH between 6.0-8.5. Note: system pH above 8.5 is not acceptable.

1. Pace Solutions BAR COR CWS-593, BAR COR CWS-580, or equivalent.

D. Glycol Systems (Where noted): Charge identified systems with solution of inhibited glycol to indicated concentration.

1. Pace Solutions PG-100, or equivalent.

2. NOTE: ethylene glycol is not acceptable.

2.5 Equipment – Closed System (Heating or Cooling)

A. Closed System (Heating or Cooling)

1. Bypass Pot Feeder: All closed hot water, chilled water, dual temperature, and condenser water systems shall have a bypass chemical pot feeder with a 7.6 L (2 Gal) capacity. It shall be constructed of heavy duty cast iron or welded steel, suitable for associated system working pressure, with quick opening cap and complete with 20 mm (3/4 inch) NPT connections. Isolating valves shall be installed on the inlet, outlet and drain.

2. Sidestream Filter: All closed hot water, chilled water, dual temperature, and condenser water systems shall have a sidestream filter housing of steel construction using a 250 mm (10 inch) x 30 micron filter cartridge, with a minimum flow rate of 35 litres per minute (9.25 GPM). A flow indicator shall be installed in conjunction with the sidestream filter. Connections shall be 20 mm (3/4 inch) MxFNPT and all isolating valves shall be installed as per manufacturer's instructions. Include 6 filter cartridges.

3. Totalizing Make-up Water Meter: Cast Bronze body, 20 mm (3/4 inch) NPT connections, thermoplastic rotor and gear train, rated at 1,034 kPa (150 PSI) operating pressure.
4. Chemical Feed Piping:
    a. Scheduled 40 black steel
5. Corrosion Coupon and Holder Assembly:
    a. Mild steel corrosion coupon.
    b. Holder, 20 mm (3/4 inch) or 25 mm (1 inch) NPT male connection.
    c. Provide malleable or cast iron cross, 20 mm (3/4 inch) or 25 mm (1 inch) NPT female connection.

2.6 Test Kits

A. Provide test kits to determine proper system treatment, including but not limited to the following:

1. Closed System Test Kit: To determine proper level of inhibitor in closed system treatment. (Pace Solutions Test Kit PSTK3300-Z, or equivalent.)
2. Glycol System Refractometer Test Kit: To determine freezing point and glycol percent of glycol systems. Displays freeze point/percent of propylene glycol, ethylene glycol and battery acid. Has a metal body with a cushioned eyepiece, a rubber hand grip, and a calibration screen. Includes a calibration screwdriver, a plastic pipette and a carrying case. For ethylene and propylene glycol and battery acid.
3. Total Dissolved Solids Meter: 3 ranges, 0-50 ppm, 0-500 ppm, 0-5000 ppm equivalent to Myron 532T1. For use in controlling dissolved solids and calculations of cycles of concentration and blowdown.
4. Total Dissolved Solids/Conductivity/Salinity/Temperature Meter: Myron Ultrapen PT1 pocket tester pen.
5. pH/Temperature Meter: Myron Ultrapen PT2 pocket tester pen.

Part 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 General

A. New and existing system piping of affects systems shall be chemically cleaned and thoroughly flushed.

B. Submit a proposed treatment plan to the Consultant for review prior to starting the operation and shall submit a report following the completion of the cleaning.

3.3 Installation

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

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

C. Provide isolation, bypass, and drain valves on all pot feeders and side stream filter installations.

D. Pipe all pot feeder and side stream filter drain lines to nearest sanitary floor drain.

E. Install makeup water meters where specified.

F. Install bypass piping or hoses at the supply and return piping connections at heat exchangers, chillers, cooling towers, pumps and coils to prevent debris from being caught or causing damage to equipment which will be connected to the piping system.

G. Mechanical Contractor is responsible for installation of all hardware items in the construction drawings and specifications.

H. Mechanical Contractor shall coordinate cleaning, flushing and treatment to filling and pressure testing system. Once water is added to the system, these processes must begin immediately. At no point should untreated water be circulated in the system outside of these processes.

3.4 Flushing Sequence

A. 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.

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

C. 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.

3.5 Cleaning Sequence

A. Concentration: add cleaner to closed systems at concentration levels recommended by Water Treatment Specialist.

B. Hot Water Heating Systems: apply heat while circulating, raise temperature slowly to 70°C (158°F) and maintain at 70°C (158°F) for minimum 12 hours. Remove heat and circulate at 40°C (104°F) 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 test 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.

C. 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.

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

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

3.6 Chemical Treatment

A. After cleaning and draining, the chemical cleaning agency shall treat the system water with a closed system inhibitor used in the building.

B. All water treatment chemicals used in the system shall be as recommended by the chemical treatment agency and previously used in the building.

C. A letter signed by a principal of the cleaning agency, certifying the cleaning of the system and the final chemical treatment shall be filed with the Consultant for approval. This shall include a chemical analysis of the final system water condition.

3.7 Commissioning

A. Start-up:

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

B. Commissioning:

1. Commissioning Agency: to be water treatment supplier or holder of service contract.
2. Timing:
    a. After start-up deficiencies rectified.
    b. After start-up and before TAB of connected systems.
3. Pre-commissioning Inspections: verify:
    a. Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
    b. Suitability of log book.

c. Required quality of treated water.

4. Commissioning procedures - applicable to Water Treatment Systems:
   a. Establish, adjust as necessary and record automatic controls and chemical feed rates.
   b. Monitor performance continuously during commissioning of connected systems and until acceptance of project.
   c. Establish test intervals, regeneration intervals.
   d. Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
   e. Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
   f. Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
5. Commissioning procedures - Water side of closed circuit coolers, Cooling Tower Systems:
   a. Verify operation of bleed-off system.
   b. Establish bleed-off flow rate.
   c. Establish rate of chemical feed - continual and periodic.
   d. Test system water for chlorides, TDS, suspended solids, algae, slime, inhibitor level, pH, alkalinity, hardness, other impurities and microbiological organisms.
   e. Compare with readings of total dissolved and suspended solids metre.
   f. Read make-up water metre, compare with chiller load summation (ton-hours).
   g. Test make-up water for chlorides, hardness.
   h. Compare test results with readings from TDS metre.
   i. Record quantity of make-up water, compare with summation of chiller load (in ton-hours).
   j. Record types, quantities of chemicals applied.
6. Commissioning procedures - Closed Circuit Hydronic Systems:
   a. Analyze water in system.
   b. Establish rate of chemical feed.
   c. Record types, quantities of chemicals applied.
7. Training:

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

8. Certificates:

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

9. Commissioning Reports:

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

END OF SECTION