



ST. CLAIR CATHOLIC
DISTRICT SCHOOL BOARD
Lighting the Way ~ Rejoicing in Our Journey

BOILER REPLACEMENT TENDER

INSTRUCTIONS TO BIDDERS

Date: MAY 15, 2015

BID PACKAGE #: 626-CP1511

1. BID SUBMISSION

The St. Clair Catholic District School Board (Board) is seeking mechanical contractors to replace the hot water boiler at St. Anne Catholic School, 183 Snow Avenue, Blenheim, ON.

Bids from invited bidders shall be submitted on the Bid Form provided and submitted in an envelope clearly marked:

Bid Package #: 626-CP1511 – Boiler Replacement Tender

The envelope shall be sealed and delivered to: St. Clair Catholic District School Board
420 Creek St.
Wallaceburg, ON
N8A 4C4

Attention: Mr. Tony Prizio, Procurement Specialist

Bids will be accepted at the Board's Catholic Education Centre office not later than **June 3, 2015 @ 2:00:00 p.m.** (No extensions to Bid Closing date are anticipated. Bidders are encouraged to act immediately to prepare their submissions!)

Bids shall be filled out in ink or typed, signed in longhand by a duly authorized company official (having authority to bind) and sealed with a company corporate seal. One original of the fully completed Bid Form must be submitted. **Failure to provide all of the requested information on the Bid Form may result in disqualification of the bid.**

Unsolicited bids will not be accepted.

Bids by telephone, fax or email will **not** be accepted.

After bid closing, sealed envelopes will be opened by the Board's Procurement Specialist (Tony Prizio) and a representative from Corporate Services' department.

2. SCOPE OF WORK

The Instructions to Bidders identifies the work to be performed in the Contract and takes priority if there is a conflict within the Bid Documents. **Refer to Scope of Work in Appendix A for detailed description of work to be carried out by the successful proponent.**

3. BID DOCUMENTS

The following Bid Documents form the basis of this Bid Package and shall be examined by bidders:

3.1 Instructions to Bidders dated May 15, 2015

3.2 Bid Form dated May 15, 2015.

3.3 Prime Contract – Board will issue a purchase order to the successful proponent(s). The Board assumes no responsibility for the bidder's failure to examine **all** of the Bid Documents.



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BID PACKAGE #: 626-CP1511

4. BID ACCEPTANCE

It shall be understood by all bidders, that the bid shall be valid and subject to acceptance by the Board, and that no adjustments shall be made to the Bid amounts for a period of up to and including sixty (60) days from the Bid Closing Date.

The Board reserves the right to determine the successful bidder by any combination of base bid, separate prices, requested alternate prices and voluntary alternate prices submitted with the bid. The Board is not obligated to select the bid with the lowest price and may cancel a bid prior to award without liability to any bidder.

The successful bidder shall be required to enter into a formal contract with the Board, which will include the terms and conditions of the Instructions to Bidders, Bid Form, and all other applicable documents.

5. AWARD

The Board has the right to reject any or all bids. The lowest Bid will not necessarily be accepted. The invitation to bid does not constitute an offer by the Contractor to enter into a contract.

6. PAYMENT

The Board shall pay within forty-five (45) days after receipt of the invoices which are received and approved by the Board.

7. TAXES

Include in Bid all Taxes and all other Customs Duties and Excise Taxes which are in force at Bid date as detailed in General Conditions. Harmonized Sales Tax (H.S.T.) is **not** to be included in the bid. The H.S.T. amount and the Bidder's **H.S.T. Registration Number** are to be indicated on the Bid Form in the spaces provided.

8. ADDENDA

Bidders finding discrepancies, ambiguities or omissions in the bid documents or having doubt as to the meaning or intent thereof, shall immediately notify the Procurement Specialist who may issue instructions and/or clarifications by Addendum to all Bidders. Bidders may also, during the Bidding Period, be advised by Addendum of any additions, deletions or alterations to bid documents. All such Addenda shall become part of the Bid Documents.

All questions to be addressed in writing to: **Mr. Tony Prizio**, Procurement Specialist
St. Clair Catholic District School Board
Fax 519.627.8230 or
E-mail: tony.prizio@st-clair.net
Copy: patsy.mckenzie@st-clair.net
No later than 24 hours prior to bid closing date.



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Date: MAY 15, 2015

BID PACKAGE #: 626-CP1511

9. CHANGE NOTICES, CHANGE ORDERS

The following fee percentage and overhead charges shall be applied to additional work ordered by the Board:

- For work carried out by the Contractor's own forces – 10% Overhead & Profit
- For work involving a subcontractor, the subcontractor may charge a maximum 10% fee. The General Contractor may charge a maximum of 5% in addition to subcontractor's fee.

10. BONDING

On bids exceeding \$ 50,000.00, submit with the Bid an Agreement to Bond for a 50% Performance Bond, and a 50% Labour & Material Payment Bond. Upon request, the successful Bidder will be required to provide the 50% Performance Bond and 50% Labour and Material Payment Bond from a bonding company acceptable to the Board. The cost of the bond is not to be included in the bid sum, the amount of which is to be identified on the Bid Form. – **BONDING NOT REQUIRED FOR THIS PROJECT.**

11. VOLUNTARY ALTERNATE AND SEPARATE PRICES

The bid amounts are to be based on the bid documents. Where there is any conflict within the bid documents, the bid amount shall include the higher cost alternative. Alternative proposals are encouraged and must be identified in the bid. Submit complete information including any impact on schedule to allow a full evaluation of the proposal including, as applicable, any particulars in which the alternate proposal is at variance with or unable to meet the specifications. Note also any impact on other trades if the alternative is accepted. Alternative proposals may be made without limitation, including for items specified as single sourced.

12. EXAMINATION OF SITE & SITE VISIT

In submitting a bid, it will be assumed that the bidders have carefully examined the site and surrounding properties of the work and have informed themselves as to the existing conditions, access, storage areas and limitations, and have included in the bid price the complete cost of the work contemplated by the drawings and specifications and other bid documents.

A site visit has been scheduled for **May 21, 2015 at 1:00 p.m.** Interested parties should meet at the office of **St. Anne Catholic School, 183 Snow Avenue, Blenheim** The contact for this site visit is Paul Lernout (Cell: 519-360-6262).

13. TIMING OF PROJECT

A purchase order will be issued by June 8, 2015. Work must take place during the month of July and August and completed no later than August 21, 2015.

14. PROJECT SPECIFIC REQUIREMENTS

Contractor's employees shall use only those toilet and washroom facilities designated by the Owner or provide their own facilities. In the event that the contractor elects to use Board facility washrooms, the contractor will be responsible for the maintenance, stocking and cleaning of the designated washroom. The designated washroom shall be returned to the Board in the same condition as received by the contractor. Any and all damages to facilities while under the control of the contractor shall be repaired at the contractor's cost.



INSTRUCTIONS TO BIDDERS

Date: MAY 15, 2015

BID PACKAGE #: 626-CP1511

Please be advised that the Owner has a No Smoking Requirement on the Owners' property. Contractors are requested to ensure that employees and suppliers are advised of the Requirement. Contractor shall remove rubbish and debris from the site on a daily basis or as directed by the Board. On completion of the work, all debris shall be removed; the floor shall be thoroughly cleaned and swept; the site shall be left in a tidy condition (construction clean). Do not use the Board's equipment or facilities for cleaning or for any reason.

15. INSURANCE

Contractor must maintain, at the Contractor's expense for the entire term of the Contract or as otherwise required, all insurance as set out below:

- The successful Contractor shall provide the Board with proof of insurance for Comprehensive General Liability and Property Damage with a limit of not less than \$2,000,000.00 (two million dollars) inclusive prior to commencing work.
- The successful Contractor shall provide the Board with proof of insurance for Motor Vehicle Public Liability and Property Insurance on all owned and rented equipment with a limit of not less than **\$2,000,000.00 (two million dollars)** inclusive prior to commencing work.
- The Contractor agrees to indemnify, hold harmless, and defend the Board from and against any and all liability for loss, damage and expense, which the Board may suffer or for which the Board may be held liable by reason of injury (including death) or damage to any property arising out of negligence on the party of the proponent or any of its representatives or employees by way of ownership or operation of an automobile.
- The successful Contractor shall provide the Board with a complete certified copy of all policies.
- The successful Contractor must name the St. Clair Catholic District School Board as additional insured on their insurance policies.

16. WORKPLACE SAFETY INSURANCE BOARD (WSIB)

Contractor must furnish a copy of Workplace Safety and Insurance Board Clearance Certificate of good standing, "Section 748" of the Workplace Safety and Insurance Act with its bid documents.

17. PERMITS

The Board will apply and pay for the building permit. The Contractor shall apply for and include costs for any other permits and approvals required for the completion of their work.

18. MEETINGS

A Post Bid Meeting may be convened and chaired by the Board who will invite Contractor and his major Subcontractors to review the Contract Documents and Bid submitted. This meeting will be prior to the Board issuing a Letter of Intent or Contract. This meeting does not constitute or infer any contract award to the proposed contractor or any other contractor, nor that will the project proceed.

During the course of Work, scheduled progress meetings may be required at the call of the Project Leader.

19. GUARANTEE



INSTRUCTIONS TO BIDDERS

Date: MAY 15, 2015

BID PACKAGE #: 626-CP1511

The guarantee shall be for a period of 1 year from and after completion of the entire job and acceptance thereof by the Board unless a different period of time is specified with the Board's approval. The Contractor's guarantee shall cover all work under the Contract whether or not any portion or trade has been sublet.

The Contractor agrees to correct promptly, at the Contractor's own expense, defects or deficiencies in the Work which appear prior to and during the period of guarantee, or such longer periods as may be specified for certain products or work.

If the Contractor fails to make any replacements or repairs required hereunder, after notice from the Board and reasonable opportunity to do so, the Board may have such work done at Contractor's expense, including all necessary labour costs in connection therewith. Board shall inform Contractor in advance of the approximate cost of such work to be done by the Board.

20. SCHEDULE

The Contractor will be required to perform the work in accordance with the Schedule dates provided in 13. Timing of Project. Ordering of major and long delivery items shall begin immediately upon successful bidder's receipt of contract award. The Contractor will provide a construction schedule within five (5) days of being awarded the project.

Time is of the essence. Bidders are to include adequate manpower, overtime and shift work necessary to meet or improve the schedule, and to make up any time lost to weather or normal delays. Include travel, room and board costs for out of town workers, shop overtime and other premiums to expedite material and equipment, shipping premiums and any incentive costs required to meet the schedule.

21. CONTRACTED SERVICES PROGRAM

Contractors performing work on Board property must complete the Contracted Services Program. This program has three basic components that **must** be met before the bid is awarded. Contractors who cannot meet the minimum requirements of this program will not be awarded this tender. Program information can be found on the Board's web site at www.st-clair.net or through the Board contact identified previously in this document.

22. HEALTH and SAFETY

The Occupational Health and Safety Act describes the responsibilities of an employer. The Board requires Contractors to maintain procedures, training, and enforcement so that the responsibilities are carried out in the workplace. The Contractor shall abide by and strictly adhere to the regulations and conditions set out and laid down by the most current versions of the Occupational Health and Safety Act. All staff employed or hired by the Contractor and working on the Board's premise **MUST** be trained in WHMIS in accordance with Occupational Health and Safety Act and Regulations. They **MUST** adhere to all of the Board's Health and Safety Procedures and Guidelines and to Municipal By-Laws.

Contractor will submit proof of its health and safety program, procedures and training as detailed above upon request by the Board.

The Contractor shall appoint a Competent Person as the Supervisor of this project. The Competent Person shall be as defined in Section 1 of the Occupational Health and Safety Act.

The successful Contractor shall conform to the Ontario "Occupational Health and Safety Act" and all regulations made under said act and assume full responsibility for contraventions of same.



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All workplace injuries or accidents on Board property MUST be reported by the Contractor to the Board's representative within 24 hours.

Any workplace injury that is defined under the Occupational Health and Safety Act as a "Critical Injury" must be reported to the Board's representative IMMEDIATELY.

23. SAFE SCHOOL PROCEDURES

Contractor's staff is required to report to the main office of each school during regular school hours and notify the school office staff of the purpose of the visit. The Contractor is required to adhere to all school specific procedures if applicable.

It is the responsibility of the Contractor's staff to sign in and sign out of the Log Book, which is located in the main office area, while performing their duties.

The following information must be recorded in a legible manner:

- Date
- Company Name
- Employee Name
- Employee Signature
- Reason for Visit
- Time Entering Building
- Time Leaving Building

24. PARKING

Contractors must park within the designated areas and allow for provisions to and from the designated parking area onto the job site.

END OF INSTRUCTIONS TO BIDDERS



BID FORM

Date: **May 15, 2015**

Project #: 626-CP1511

NAME OF BIDDER

ADDRESS

BID PRICE

I/We the undersigned, having carefully examined the Bid Documents, having received, carefully examined and incorporated Addenda No. _____ to No. _____ inclusive, the General Conditions of the contract as amended by the Supplementary General Conditions, having complied with the Instructions to Bidders, having visited and investigated the Place of the Work, and having examined all conditions, circumstances and limitations affecting the Work, offer to enter into a Contract with the Owner to perform the Work required by the Bid Documents for the price of

_____ CANADIAN DOLLARS (\$ _____). The price offered **excludes** all Harmonized Sales Tax (HST) but includes all other eligible taxes.

HST

The HST amount **not** included in the BID PRICE: \$ _____.

ACCEPTANCE

In submitting this bid, we recognize the right of the Owner to accept any bid at the price submitted, to reject any and all bids, or to negotiate contract terms with various bidders, at the Owner's sole

DECLARATIONS

I/We the undersigned declare that:

1. I/We agree to perform the Work in compliance with the Contract Documents and attain Substantial Performance of the Work on or before August 21st, 2015.
2. No person, firm or corporation other than the undersigned has any interest in this bid or in the proposed Contract for which this bid is made.
3. This bid is irrevocable and is open for acceptance by the Owner for a period of sixty (60) days from the date of submission.



ST. CLAIR CATHOLIC
DISTRICT SCHOOL BOARD

Lighting the Way ~ Rejoicing in Our Journey

BOILER REPLACEMENT TENDER
ST. ANNE CATHOLIC SCHOOL BLENHEIM

BID FORM

Date: May 15, 2015

Project #: 626-CP1511

AUTHORIZATION

Corporate Name and Seal

Signature (Signing Officer)

Name (Print)

Date

END OF DOCUMENT

**MECHANICAL
SPECIFICATIONS**

FOR

**ST. CLAIR CATHOLIC DISTRICT SCHOOL
BOARD
ST. ANNE ELEMENTARY SCHOOL
BOILER REPLACEMENT**

ISSUED FOR TENDER

VANDERWESTEN RUTHERFORD MANTECON
Consulting Structural, Mechanical, Electrical & Civil Engineers
7242 Colonel Talbot Road
London, ON N6L 1H8

Date: May 8, 2015

VRM Project No. 15-048

TABLE OF CONTENTS

Pages

Division 22 - Plumbing

Section 22 00 01 - Supplementary Bid Form 2
Section 22 01 01 - General Requirements..... 8
Section 22 01 05 - Demolition and Renovations..... 3
Section 22 05 00 - Common Work Results 10
Section 22 11 13 - Fuel Gas Piping 3
Section 22 11 19 - Plumbing Specialties 3
Section 22 14 13 - Plumbing Piping..... 8

Division 23 - Heating, Ventilating and Air Conditioning (HVAC)

Section 23 00 01 - Supplementary Bid Form 2
Section 23 01 01 - General Requirements..... 8
Section 23 01 05 - Demolition and Renovations..... 4
Section 23 05 00 - Common Work Results 20
Section 23 05 14 - Variable Frequency Drives 5
Section 23 05 30 - Supports and Anchors 4
Section 23 05 48 - Vibration Controls 3
Section 23 05 93 - Testing, Adjusting and Balancing 6
Section 23 07 16 - HVAC Equipment Insulation 7
Section 23 07 19 - Piping Insulation 6
Section 23 21 13 - Hydronic Piping..... 8
Section 23 21 16 - Hydronic Specialties 4
Section 23 21 23 - Hydronic Pumps 3
Section 23 25 13 - HVAC Chemical Treatments 4
Section 23 52 16 - Boilers, Condensing..... 3
Section 23 90 50 - Mechanical-Electrical Equipment Schedule 1

END OF TABLE

1 GENERAL

1.1 SUBMITTAL

- .1 Each bidder for the work of Division 22: Plumbing shall submit this Supplementary Bid Form to the consultant within two (2) hours of tender closing to the Consultant.
- .2 This document, on acceptance by the Consultant, will be included in the Contract Documents and shall govern the work of Division 22: Plumbing.

1.2 SUBCONTRACTORS

- .1 List the trade Subcontractors that have been included in the bid proposal.

TRADE	OWN FORCES	SUBCONTRACTOR
Plumbing	<input type="checkbox"/>	
Welding	<input type="checkbox"/>	
Insulation	<input type="checkbox"/>	

1.3 LABOUR RATES

- .1 Indicate the unit labour rate required for additional work and/or work to be deleted in changes to the Contract under Part 6 of the General Conditions of the Stipulated Price Contract. Rates indicated shall include all allowances for foremen, supervision and office support but shall not include the Division 22 Sub-Contractor's overhead and profit margins and shall be based on regular working hours.
- .2 Labour rates for changes must be negotiated with the Owner prior to acceptance and use in pricing.

TRADE	HOURLY RATE
Plumbing	
Welding	
Insulation	

1.4 PRODUCTS

- .1 Indicate the name of the manufacturer of equipment items included in the Bid Price by submitting a copy of the appended Equipment List marked to indicate choices. Failure to indicate a specific manufacturer will be taken to mean that products of the first manufacturer named in the specifications are included in the Bid Price. This list shall in no way limit the extent of the Contract.
- .2 The Division 22 Bidder may propose the name of an alternative manufacturer for any equipment item in accordance with Section 22 01 01, Part 2, Article 2.3

Section	Product	Specified Product Included in Bid	Proposed Alternative
22 05 00	Adhesives		
	Sealants		
	Paints and Coatings		
	Firestopping Compounds		
	Escutcheons		
	Flashings		
	Penetration Seals		

22 11 13	Natural Gas Piping Hangers and Supports		
	Natural Gas Valves		
	Gas Pressure Reducing Valves		
22 11 19	Floor Drains		
	Trap Seal Primers		
	Cleanouts		
	Backflow Preventers		
	Water Hammer Arrestors		
22 14 13	Plumbing Isolation Valves		
	Plumbing Throttling Valves		
	Plumbing Check Valves		
	Drain Valves		
	Water Pressure Reducing Valves		
	Strainers		
	Pipe Hangers and Supports		

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to:
 - .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended,
 - .2 Division 1 requirements and documents referred to therein.
- .2 Section 22 01 01 applies to and governs the work of all Sections of Division 22.
- .3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..
- .4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
- .5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

1.2 WORK INCLUDED

- .1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
- .2 Cutting and patching of new or existing work
- .3 Identification of equipment, piping, valves and controllers
- .4 Concrete equipment bases, housekeeping pads.
- .5 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.
- .6 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.3 RELATED WORK

- .1 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.
- .2 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.
- .3 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

1.4 SUBMITTALS

- .1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.
- .2 Shop Drawings: Prepare and submit one (1) electronic copy of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
 - .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
 - .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
 - .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of

- approval or certification.
- .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."
- .3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Division 23. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.
- .4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.
- .5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:
- .1 description of the system (description and type),
 - .2 description of the tests conducted and results observed, including re-testing, where necessary,
 - .3 description of any corrective measures undertaken,
 - .4 description of materials used (pipe and fittings),
 - .5 list of witnesses for each test conducted,
 - .6 date system left ready for service,
 - .7 signature of installing Contractor.
- .6 Directories & Schematics
- .1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service, and location of each valve under this Division.
 - .2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.
 - .3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.
- .7 Maintenance Data and Operating Instructions
- .1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.
 - .2 Ensure the binder spines have typewritten lettering as follows:
OPERATION & MAINTENANCE MANUAL
for
Platt's Lane Estates Boiler Plant Replacement
[Insert date of submission]
[Insert Division Title]
 - .3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.
 - .4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.
 - .5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.
 - .6 Ensure operating instructions include the following:
 - .1 General description of each mechanical system.

- .2 Step by step procedure to follow in putting each piece of equipment into service.
- .3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
- .4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
- .5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.
- .7 Ensure maintenance instructions include the following:
 - .1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.
 - .2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
 - .3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
 - .4 Balancing and testing reports.
 - .5 Copy of valve directory.
- .8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to Division 1 for requirements.
- .9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.
- .10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.5 QUALITY ASSURANCE

- .1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.
- .2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
- .3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.
- .4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.
- .5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.
- .6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.

1.6 PRODUCT DELIVERY, HANDLING AND STORAGE

- .1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
- .2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.7 JOB CONDITIONS

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.

- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.8 WARRANTY

- .1 Refer to General Conditions. Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
- .2 Make submissions necessary to register product warranties to the benefit of the Owner.
- .3 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

1.9 DEFINITIONS

- .1 The following are definitions of words found in this specification and on associated drawings under this Division:
 - .1 "Concealed" - locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
 - .2 "Exposed" - mechanical work normally visible to building occupants.
 - .3 "Furnish" - (and its derivatives) has the same meaning as the term "Supply".
 - .4 "Install" - (and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
 - .5 "Provide" - (and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
 - .6 "Supply" - (and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
 - .7 "Wet" - locations exposed to moisture, requiring special materials and arrangement.

1.10 INTERRUPTIONS

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.11 EXTRAS AND CREDITS

- .1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
 - .1 Materials, quantities and unit costs including any applicable contractor's trade discount clearly identified.
 - .2 Labour hours and unit costs.
 - .3 Total materials and labour costs.
 - .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- .1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.
- .2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.
- .3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.
- .4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

- .1 First item named or specified by catalogue number meets specifications regarding performance, quality of material and workmanship, and is acceptable to the Consultant.
- .2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only, if they also meet performance and/or capacities specified and can be accommodated within the space allotted.
- .3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.
- .2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.
- .3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

- .1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.
- .2 Apply, in writing, to Consultant for substitution of any products, indicating the following:
 - .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
 - .2 Reason for substitution.

- .3 Any revisions to the contract price made necessary by substitution.
- .4 Any revisions to the contract time made necessary by substitution.
- .5 Any revisions to layout, arrangement or services made necessary by substitution.
- .3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

- .1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.
- .2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 EXECUTION

3.1 RELATIONSHIP WITH OTHER TRADES

- .1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.
- .2 Provide materials to be built-in, such as sleeves, anchors, and inserts, together with templates and/or measurements, promptly when required by other trades.
- .3 Provide structural supports for equipment to be mounted on or in walls, supported above floors and/or suspended from the structure.

3.2 INSTALLATION REQUIREMENTS

- .1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
- .2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
- .3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
- .4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
- .5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
- .6 Provide suitable shielding and physical protection for devices.
- .7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
- .8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
- .9 Do not use power activated tools without written permission of the Consultant. Use them in accordance with the Owner's health and safety policies.
- .10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.3 CONTRACT DRAWINGS

- .1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
- .2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
- .3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note

that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.

- .5 Provide the equipment as specified and/or shown on the documents of this Division.
- .6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents.

3.4 CONSTRUCTION DRAWINGS

- .1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.
- .2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.
- .3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
- .4 Submit construction drawings to other Divisions. Provide one (1) print copies of construction drawings to the Consultant for record purposes.
- .5 Submit construction drawings prior to commencement of work.

3.5 RECORD DRAWINGS

- .1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
- .2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.
- .3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.
- .4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.
- .5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
- .6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.6 USE OF EQUIPMENT

- .1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.
- .2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over the Owner.

3.7 EXTRAS AND CREDITS

- .1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
 - .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly

- identified.
- .2 Labour hours and unit costs.
- .3 Total materials and labour costs.
- .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

3.8 INSTRUCTION

- .1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.
- .2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
- .3 Ensure each instruction period includes, but is not limited to the following;
 - .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
 - .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
 - .3 demonstration of the proper operating procedures for each item of equipment,
 - .4 explanation of the purpose and function of all safety devices provided,
 - .5 demonstration of all measures required for safe and proper access for operation and maintenance.
- .4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.
- .5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.9 COMMISSIONING

- .1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 WORK INCLUDED

- .1 Identification of existing services and utility connections.
- .2 Installation, protection and maintenance of temporary services as required to support continuing operation of the facility.
- .3 Disconnection and removal of various mechanical equipment in areas to be turned over to the Owner.
- .4 Disconnection and making safe of various mechanical systems and equipment in areas to be demolished and/or renovated.
- .5 Disposal of waste materials in accordance with waste management requirements.
- .6 Re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction including requirements for marking of equipment.

1.3 REGULATORY REQUIREMENTS

- .1 Notify all authorities of intent to demolish and schedule for the work. Obtain required permits from authorities.
- .2 Conform to all codes for demolition work, dust control, products requiring disconnection and re-connection.
- .3 Do not close or obstruct egress width to any building or site exit.
- .4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.
- .5 Conform to procedures applicable when hazardous or contaminated materials are discovered.
- .6 Arrange for re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction. This includes requirements for marking of equipment under rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

1.4 JOB CONDITIONS

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

2 PRODUCTS

Not Applicable

3 EXECUTION

3.1 PREPARATION

- .1 Prior to start of work under this Section, ensure that the General Trades;
 - .1 Provide, erect, and maintain temporary barriers at locations indicated.
 - .2 Erect and maintain weatherproof closures for exterior openings.
 - .3 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.
 - .4 Prevent movement of structure; provide bracing and shoring.
- .2 Install, protect and maintain temporary services as required to support continuing operation of the facility.
- .3 Protect services and equipment which are not to be demolished.
- .4 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
- .5 Notify affected utility companies before starting work and comply with their requirements.
- .6 Mark location and termination of utilities.
- .7 Provide appropriate temporary signage including signage for exit or building egress.

3.2 RELATIONSHIP WITH OTHER TRADES

- .1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.
- .2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.
- .3 Remove and dispose of bases, supports and anchors for piping, equipment and ductwork mounted on or in walls, supported above floors and/or suspended from the structure.

3.3 PROTECTION

- .1 Protect existing and new work to remain free from damage due to execution of work under this Division with tarpaulins and other protective coverings as necessary .
- .2 Repair any and all damage to the building and components resulting from failure to provide sufficient protection, to the satisfaction of the Consultant.
- .3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
- .4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
- .5 Temporary filters shall be removed on completion of the construction works.

3.4 DEMOLITION

- .1 Notify all authorities of intent to demolish and schedule for the work.
- .2 All demolition work shall conform to all codes, regulations, standards and by-laws applicable to the work.
- .3 Isolate and drain systems as required to effect demolition. Disconnect, cap and make safe all mechanical services to the building including, but not limited to; sanitary sewer(s), storm sewer(s), water service, natural gas service, water supply to standpipe and sprinkler systems, fire suppression systems hot water heating systems.
- .4 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.
- .5 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
- .6 Remove and dispose of all redundant mechanical services and equipment within the limits of the demolition site and where demolished systems extend beyond these limits.
- .7 Turn over items identified for recovery by the Owner.
- .8 All demolition work shall conform to Occupational Health & Safety and Environmental regulations.

- Ensure that all parties are familiar with requirements and experienced in the work to be undertaken.
- .9 Waste disposal shall conform to the requirements of Division 1, municipal By-Laws and Ministry of the Environment regulations and standards.
 - .10 All existing air intake and exhaust openings that may be affected by dust and/or debris from the demolition work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from demolition work with new filters.
 - .11 In the event that dust and debris from demolition work does penetrate the building and/or its air distribution systems, this Section shall be responsible for cleaning the affected areas and/or systems.
 - .12 Disconnect remove, cap and identify all utilities within demolition areas.
 - .13 Demolish in an orderly and careful manner. Protect existing supporting structural members.
 - .14 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
 - .15 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.
 - .16 Remove temporary Work.

3.5 RENOVATIONS

- .1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.
- .2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.
- .3 Existing items to be relocated shall be cleaned and repaired or altered as required to suit new location. All damaged or ineffective parts shall be replaced and the item made "as new".
- .4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.
- .5 Make good all surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap all existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.
- .6 Openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction in general must be temporarily sealed with fire barrier materials such as mineral wool or other noncombustible insulation.
- .7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop work in the affected area and immediately notify consultant.

3.6 INSPECTION AND RE-CERTIFICATION

- .1 Where any equipment, machine or apparatus is modified, rebuilt or rewound with any change resulting in its performance or capacity rating and characteristics it shall be inspected and re-certified as required by authorities having jurisdiction.
- .2 A nameplate giving the name of the person or firm making the change and the resulting changes in performance or capacity shall be provided and affixed to the equipment, machine or apparatus adjacent to the original nameplate. Where the original nameplate is removed, the original manufacturer's name and original identifying data, such as serial numbers, shall be added to the nameplate.
- .3 Refer to rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 COMMON WORK RESULTS

- .1 Section 22 05 00 applies to and governs all work of Division 22.

1.3 REFERENCE STANDARDS

- .1 Provide all work in accordance with requirements of Regulatory Agencies and conform to:
 - .1 Local and district by-laws, regulations and published engineering standards.
 - .2 the Ontario Building Code as amended,
 - .3 the Ontario Gas Utilization Code as amended
 - .4 Regulations for Construction Projects under The Occupational Health and Safety Act.
 - .5 Fire Code made under the Fire Marshal's Act.
- .2 Conform to following CSA Standards:
 - .1 CSA B242 Groove and Shoulder Type: Mechanical Pipe Couplings.
 - .2 CSA W48 series Electrodes.
 - .3 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CAN/CSA-W117.2, Safety in Welding, Cutting and Allied Processes
- .3 Conform to following National Research Council Canada publications:
 - .1 National Building Code of Canada and Supplements to National Building Code of Canada
 - .2 National Fire Code of Canada.
 - .3 Canadian Plumbing Code.
 - .4 Model National Energy Code for Buildings
- .4 Conform to following American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) Standards:
 - .1 ANSI/ASME Boiler and Pressure Vessel Code:
 - .1 Section 1: Power Boilers.
 - .2 Section V: Nondestructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
 - .2 ASME A13.1 - Scheme for the Identification of Piping Systems.
 - .3 ASME B40.100 - Pressure Gauges and Gauge Attachments.
- .5 Conform to following American Welding Society (AWS) Standards:
 - .1 AWS C1.1, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1, Welding Inspection.
- .6 Conform to following American Society for Testing and Materials (ASTM) Standards:
 - .1 ASTM E1 - Specification for ASTM Thermometers.
 - .2 ASTM E77 - Inspection and Verification of Thermometers.
- .7 Conform to following Underwriters Laboratories (UL) Standards:
 - .1 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- .8 Conform to AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- .9 Conform to IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- .10 Conform to NEMA MG 1 - Motors and Generators.
- .11 Provide work where indicated in conformance with guide Specification of the Victaulic System for Building Services, G-100.
- .12 The above documents or portions thereof are referenced within the work of Division 23 and shall be considered part of the requirements of this document as though fully repeated herein.

1.4 QUALIFICATIONS

- .1 Firestop Sealant Manufacturer: Company specializing in manufacture of sealants with minimum three years documented product development, testing, and manufacturing experience.
- .2 Firestop components and assemblies shall be ULC listed and tested in accordance with ULC S115

Standard Method of Fire Test for Firestop Systems.

1.5 SUBMITTALS

- .1 Submit shop drawings in accordance with refer to section 22 01 01

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Transport, handle, store, and protect products. refer to Division 1 requirements as well.
- .2 Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WASTE MANAGEMENT & DISPOSAL

- .1 Separate and recycle waste materials in accordance with Owner's Requirements, and with the Contractor's Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

2 PRODUCTS

2.1 PIPING SPECIALTIES

- .1 Cast brass, pressure, copper to copper unions shall be used with seamless copper tubing smaller than 3" (75 mm).
- .2 Cast brass flanges shall be used with seamless copper tubing, type L for tubing 3" (75 mm) and larger.
- .3 Dart type, 125 lb. (860 kPa) black malleable iron unions shall be used with all steel pipe for piping 2-1/2" (65 mm) and smaller.
- .4 Slip-on, 150 lb. (1000 kPa) carbon steel flanges with 1/16" (4 mm) raised face shall be used with all steel pipe for piping larger than 2-1/2" (65 mm).
- .5 Gaskets for joining flanged steel pipe shall be 1/16" (4 mm) Cranite ring type gaskets.
- .6 Piping specialties including backflow preventers, strainers, valves etc. shall be line size unless indicated otherwise on drawings.
- .7 Strainers
 - .1 Manufacturers:
 - .1 Sarco SB
 - .2 S. A. Armstrong
 - .3 Crane
 - .4 Conbraco
 - .5 Colton
 - .2 In copper tubing: Class 250, wye type, bronze, screwed connection, with blind caps, and 1/32" (0.8 mm) perforated stainless steel screen.
 - .3 In Steel Piping: 2" (50mm) and smaller
 - .1 Body and cover: screwed, line size Y type strainer, semi-steel conforming to ASTM A278-85, Class 30, complete with screwed blind cap. Primary service rating of 125 psi @ 350 F (860 kPa @ 178 C). Body shall have side drain connection.
 - .2 Screen: perforated type 304 stainless steel service:
 - .1 Steam 1/16" (0.4 mm)
 - .2 Water 1/32" (0.8 mm)
 - .3 Glycol 1/32" (0.8 mm)
 - .4 Water @ Pump Suction 1/8" (3.2 mm)
 - .5 Light Oil 1/16" (1.6 mm)
 - .6 Compressed Air 1/64" (0.4 mm)
 - .4 In Steel Piping: 2-1/2" (65mm) and larger
 - .1 Body and cover: flanged, line size Y type strainer, cast steel, class 150, complete with flanged blow down cover. Primary service rating of 150 psi @ 500 F (1 MPa @

- 260 C).
- .2 Screen: perforated type 304 stainless steel service:
 - .1 Steam 1/32" (0.8 mm)
 - .2 Water 1/16" (1.6 mm)
 - .3 Glycol 1/16" (1.6 mm)
 - .4 Water @ Pump Suction 1/4" (6.4 mm)
 - .5 Light Oil 1/16" (1.6 mm)
 - .6 Compressed Air 1/32" (0.8 mm)

2.2 ADHESIVES, SEALANTS, PAINTS AND COATINGS

- .1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria:
 - .1 Paint for Mechanical Identification: maximum VOC emission of 250g/L
 - .2 Touch-Up Paint: maximum VOC emission of 250g/L
 - .3 Zinc-Rich Primer: maximum VOC emission of 250g/L
 - .4 Adhesives for Mechanical Identification: maximum VOC emission of 70g/L
 - .5 Sealants for service penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented
 - .6 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented
 - .7 Acrylic Sealant for supports and anchors: maximum VOC emission of 250g/L
 - .8 Insulation Vapour Barrier Lap Adhesive: maximum VOC emission of 80g/L
 - .9 Insulation Joint Sealer: maximum VOC emission of 250g/L
 - .10 Insulation Vapour Barrier Mastic: maximum VOC emission of 400g/L
 - .11 Flame Retardent Adhesive: maximum VOC emission of 650g/L clear and 350 g/L pigmented

2.3 FIRESTOPPING COMPOUNDS

- .1 Manufacturer: 3M products indicated.
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Dow Corning
 - .2 John Manville
 - .3 Hilti Firestop Systems
- .3 Fire Rated Sealants: intumescent material, synthetic elasomers, capable of expanding up to 8 to 10 times when exposed to temperatures of 250°F (121°C) or higher. ULC listed and labelled.

2.4 WELDING ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.

2.5 NAMEPLATES

- .1 Provide laminated plastic plates with black face and white centre of minimum size 3-1/2" x 1-1/2" x 3/32" (90 x 40 x 2 mm) nominal thickness, engraved with 1/4" (6 mm) high lettering. Use 1" (25 mm) lettering for major equipment.
- .2 Fasten nameplates securely in conspicuous place. Where nameplates cannot be mounted on cool surface, provide standoffs.
- .3 Identify equipment type and number and service of areas or zone of building served.
- .4 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-1/2" x 9" (65 x 230 mm), reading: "WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME."

2.6 TAGS

- .1 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background colour. Tag size minimum 1-1/2" (40 mm) diameter. **OR**
- .2 Metal Tags: Brass, aluminum or stainless steel with stamped letters; tag size minimum 1-1/2" (40 mm) diameter with smooth edges.

- .3 Chart: Typewritten letter size list in anodized aluminum frame.

2.7 STENCILS

- .1 Stencils: With clean cut symbols and letters of following size:
 - .1 3/4"-1-1/4" (20-30 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 1/2" (15 mm) high letters.
 - .2 1-1/2"-2" (40-50 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 3/4" (20 mm) high letters.
 - .3 2-1/2"-6" (65-150 mm) Outside Diameter of Insulation or Pipe: 12" (300 mm) long colour field, 1-1/4" (30 mm) high letters.
 - .4 8" - 10" (200-250 mm) Outside Diameter of Insulation or Pipe: 24" (600 mm) long colour field, 2-1/2" (65 mm) high letters.
 - .5 Over 10" (250 mm) Outside Diameter of Insulation or Pipe: 32" (800 mm) long colour field, 3-1/2" (90 mm) high letters.
 - .6 Ductwork and Equipment: 2-1/2" (65 mm) high letters.

2.8 SLEEVES

- .1 Materials: minimum schedule 20 galvanized steel or cast iron.

2.9 ESCUTCHEONS

- .1 Finish: Polished chrome

2.10 FLASHINGS AND COUNTERFLASHINGS

- .1 Thaler or equivalent mechanical/electrical flashings as recommended for specific purpose.
- .2 Stainless steel flashing sleeve, integral deck flange and EPDM seal.

2.11 PENETRATION SEALS

- .1 Manufacturer: Link-Seal
- .2 Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.

3 EXECUTION

3.1 INSPECTION

- .1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.
- .2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.
- .3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 PREPARATION

- .1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.
- .2 Services that are no longer required shall be removed or cut back and capped to the satisfaction of Consultant.
- .3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.
- .4 Where modifications or connections to existing systems require shutdown of the system the Contractor shall submit a request for system shutdown describing the system or part to be shutdown, the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. The request shall be submitted in the format stipulated by the Owner.

- .5 All work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling shall be included in this Bid Price.

3.3 PIPING INSTALLATION - ABOVE GROUND

- .1 Cooperate with other trades whose work affects or is affected by work of this Section, to ensure satisfactory installation and to avoid delays. Provide all materials to be built-in such as sleeves, anchors, etc., together with accurate dimensions or templates, promptly.
- .2 Layout all work accurately, installing piping parallel to lines of building.
- .3 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap uninsulated piping in masonry walls with building paper.
- .4 Install concealed piping close to building structure to minimize furring dimensions.
- .5 Provide adequate space around piping to facilitate application of insulation.
- .6 Use dielectric couplings where piping of dissimilar metals connect.
- .7 Where piping passes through concrete floors, or walls, sleeves shall be sized to permit the pipe to expand freely without binding or crushing pipe insulation.
- .8 Where branch pipes are welded into main without the use of "T" connections, torch cut openings must be cut true, bevelled and filed smooth. Branch pipes must not be allowed to project inside of main pipe. Openings must not be cut large enough to permit entry of welding metal and slag within the pipe.
- .9 Arrange all take-offs from mains to allow for expansion and contraction of pipes. Hot water branches serving downfeed risers must be taken from lower sides or bottom of mains and grade down slightly to risers. Branches which serve units above the mains shall be taken from the top or sides of mains.
- .10 Install automatic control valves and wells supplied under other Sections.

3.4 PIPING JOINTS

- .1 Make joints in piping installed under this Division using persons familiar with the particular materials being used and in accordance with CSA B51 and CSA B52, manufacturer's instructions, and as specified herein.
- .2 Use only welder and/or brazer operators, with a valid identification card, as issued under The Boiler and Pressure Vessels Act, to make joints in Registered Piping Systems, as indicated under Section 22 01 01, and 22 05 00.
- .3 Use 95/5 Sb.Sn (tin-antimony) solder for joining copper drainage tubing smaller than 4" (100 mm), and for joining copper water tubing installed above grade, and smaller than 4" (100 mm).
- .4 Use silver solder or Silfos for joining copper tubing 4" (100 mm) and larger in size.
- .5 Carefully ream joints in threaded pipe and paint with approved graphite type joint sealer on male connections only. Make connections with proper wrench to suit pipe size. Where leaks occur, the joint shall be disassembled and corrected if possible, or replaced. Over-tightening, caulking or peening will not be acceptable.
- .6 Make joints in cast iron pipe with standard M-J joints in accordance with manufacturer's recommendations and CSA B70.
- .7 Install unions or welding flanges at connections to valves, etc. to facilitate removal.
- .8 Use butt welding and/or schedule 40 carbon steel welding fittings to join sections of steel piping with welding ends.

3.5 WELDING

- .1 Welder's Qualifications
 - .1 Welding qualifications to be in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure to be performed from authority having jurisdiction.
 - .3 Furnish welder's qualifications to Consultant and Owner.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
- .2 Inspector's Qualifications: qualified to CSA W178.2
- .3 Welding Procedures
 - .1 Registration of welding procedures in Procedures accordance with CSA B51.
 - .2 Copy of welding procedures to be available for inspection at all times.

- .3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA-W117.2.
- .4 Workmanship: Welding to be in accordance with ANSI/ASME B31.1 and B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, special procedures specified elsewhere in Division 15 applicable requirements of provincial authority having jurisdiction.
- .5 Installation Requirements:
 - .1 Identify each weld with welder's identification symbol.
 - .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
 - .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.
- .6 Inspection and Testing:
 - .1 Hydrostatically test all welds to requirements of ANSI/ASME B31.1.
 - .2 Review all weld quality requirements and defect limits of applicable codes and standards with Consultant before any work is started.
 - .3 Formulate "Inspection and Test Plan" in co-operation with Consultant.
 - .4 Do not conceal welds until they have been inspected, tested and approved by inspector.
 - .5 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Consultant, to ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .6 Visual examinations: include entire circumference of weld externally and wherever possible internally.
 - .7 Failure of visual examinations: on failure of any weld by visual examination, perform additional testing as directed by Consultant of a total of up to 25% of all welds, selected at random by Consultant, by particle tests.
 - .8 Inspect and test all welds in high pressure steam and high pressure condensate piping in accordance with "Inspection and Test Plan" by magnetic particle (hereinafter referred to as "particle") tests.
- .7 Defects Causing Rejection: as described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code, plus;
 - .1 Undercutting greater than 1/32" (0.8 mm) adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 1/32" (0.8 mm) adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 1/32" (0.8 mm) at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 1-1/2" (38 mm) 97% in any 6" (150 mm) length of weld depth of such defects being greater than 1/32" (0.8mm).
 - .5 Repair all cracks and defects in excess of 1/32" (0.8mm) in depth.
 - .6 Repair defects whose depth cannot be determined accurately on the basis of visual examination or particle tests.
- .8 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.6 FLUSHING AND CLEANING

- .1 Thoroughly flush all piping installed by this Division.
- .2 Remove, clean and replace all strainers in systems after flushing.
- .3 Thoroughly clean and lubricate HVAC equipment, and leave all items in perfect order ready for operation.

3.7 PIPING SYSTEMS TESTING AND INSPECTION

- .1 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.
- .2 Test all piping at the completion of roughing-in, before connecting to existing systems, and prior to concealment, insulation or covering of piping.
- .3 Make tests, that are required by any authority having jurisdiction, in the presence of the authority's authorized inspector and shall be certified by him.

- .4 Conduct tests in the presence of:
 - .1 Authorized inspector(s) for authorities having jurisdiction.
 - .2 The Commissioning Agent
 - .3 The Owner's Representative
 - .4 The Consultant
- .5 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.
- .6 Repair all leaks exposed during testing and retest. If defects in pipe or fittings are discovered in the system, they shall be removed and replaced.
- .7 Certify tests not required by authorities having jurisdiction.

3.8 PROTECTION

- .1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.
- .2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such protection.
- .3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
- .4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
- .5 Temporary filters shall be removed on completion of the construction works.

3.9 CUTTING AND PATCHING

- .1 Include cutting and patching as required in execution of work under respective Sections of this Division.
- .2 Holes through the structure will not be permitted without written approval of the Consultant. Any and all openings required through the completed structure must be clearly and accurately shown on a copy of the relevant structural drawing(s). Exact locations, elevations and size of the proposed opening must be identified well in advance of the need for the work.
- .3 All sleeved or formed openings through the structure must be shown on sleeving drawings and must be approved by the Structural Consultant prior to construction.
- .4 The Contractor shall conduct exploratory work including x-ray of the existing structure, shall mark the location of embedded reinforcements, anchors, conduits and piping on exposed surfaces of adjacent floors and/or walls and shall pay all associated costs.
- .5 Reinforcing shall not be cut or modified without prior approval of the Structural Consultant. Should reinforcement be cut without such prior approval, the cost of any additional reinforcement deemed necessary by the Structural Consultant shall be the responsibility of this Contractor.
- .6 Alternative imaging techniques are subject to the approval of the Structural Consultant.
- .7 Ensure that cutting and patching of roofs and reinforced concrete structures is executed by specialists familiar with the materials affected, and is performed in a manner to neither damage nor endanger the work. Coordinate and supervise such cutting and patching.
- .8 Maintain the integrity of fire rated assemblies where they are pierced by ducts and pipes.
- .9 Make good surfaces affected by this work and repair finish to satisfaction of Consultant. Finish painting, where required, will be provided under Division 9.
- .10 Stop work immediately upon discovery of any hazardous material and report discovery to the Owner and Consultant. Obtain instruction prior to proceeding with the work.

3.10 SEALANTS & CAULKING

- .1 Fill voids around pipes:
 - .1 Where sleeves pass through non-fire rated walls or floors, caulk space between pipe and sleeve with fibreglass. Seal space at each end with waterproof, fire retardant, non-hardening

- mastic.
- .2 Ensure no contact between copper tube or pipe and ferrous sleeve.
- .3 Fill future-use sleeves with easily removable filler.
- .4 Coat exposed exterior surfaces or ferrous sleeves with heavy application of zinc rich paint (VOC content not to exceed 250 g/L).
- .2 Temporarily plug all openings during construction.

3.11 FIRESTOPPING

- .1 All openings in fire separations and fire rated assemblies for service penetrations shall be protected with ULC listed service penetration firestop systems (SP).
- .2 The service penetration firestop system shall have F and FT ratings equal to or greater than ratings specified by the Architect for the fire separation (F) and firewall (FT) joint firestop systems (JF).
- .3 All components employed in the service penetration firestop system shall conform to the ULC listing.
- .4 Contractor shall prepare and submit a schedule of service penetration firestop systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation assembly.

3.12 SLEEVES AND CURBS

- .1 Provide pipe sleeves at points where pipes pass through masonry or concrete.
- .2 Provide sleeves of minimum schedule 20 galvanized steel or cast iron.
- .3 Use cast iron or steel pipe sleeves with annular fin continuously welded at midpoint:
 - .1 through foundation walls, with penetration seals.
 - .2 through floors of mechanical rooms and equipment rooms.
- .4 Provide 1/4" (6 mm) clearance all around, between sleeve and pipes or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry and 2" (50 mm) above floors. Not applicable to concrete floors on grade.
- .6 Provide watertight concrete curb 4" (100 mm) high around mechanical services (pipes, ducts, conduits) which rise through mechanical (service) room floors. Provide minimum 4" (100 mm) clearance between openings for services within curbs.
- .7 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction, caulk between sleeve recess and pipe, fasten roof flashing to clamp device, make water-tight durable joint. Co-ordinate with roofing Section.

3.13 FLASHINGS

- .1 Provide all flashing at each point where piping passes through the roof.
- .2 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.14 ESCUTCHEONS AND PLATES

- .1 Provide on pipes passing through finished walls, partitions, floors and ceilings.
- .2 Use chrome or nickel plated brass, solid type with set screws for ceiling or wall mounting.
- .3 Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve.
- .4 Where sleeve extends above finished floor, escutcheon or plates shall clear sleeve extension.
- .5 Secure to pipe or finished surface, but not insulation.

3.15 SUPPORT AND ATTACHMENT

- .1 Support and attach piping, ductwork fixtures and equipment from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes. Roof mounted mechanical equipment and services shall be anchored to the roof structure to resist both lateral and uplift wind forces in accordance with requirements of the Ontario Building Code.

3.16 PAINTING

- .1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.
- .2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

3.17 DISSIMILAR METALS

- .1 Separate dissimilar metals in order to prevent galvanic corrosion.
- .2 Provide gaskets or shims of approved materials to avoid electrolytic action.
- .3 Use dielectric unions and/or flanges where piping of dissimilar metals are connected.

3.18 EQUIPMENT BASES AND CURBS

- .1 Supply and erect structural work required for installation of mechanical equipment.

3.19 ADJUST AND CLEAN

- .1 Clean equipment and fixtures, lubricate mechanical equipment installed under this Division and leave items in perfect order ready for operation.
- .2 Test and adjust control devices, instrumentation, relief valves, dampers, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.
- .3 Remove from the premises upon completion of work of this division, debris, surplus, and waste materials resulting from operations.

3.20 MECHANICAL IDENTIFICATION INSTALLATION

- .1 Degrease and clean surfaces to receive adhesive for identification materials.
- .2 Prepare surfaces for stencil painting.
- .3 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer (VOC content not to exceed 680 g/L).
- .4 Install tags with corrosion resistant chain.
- .5 Comply with standard detail drawing plate, "Detail of Piping Identification".
- .6 Apply stencil markings on all covered piping.
- .7 Install plastic tape pipe markers complete around bare pipe to manufacturer's instructions.
- .8 Label piping that is heat traced or equipped with heating cable "HEAT TRACED" in addition to other identification. Locate such labels adjacent to other identifications.
- .9 Clearly identify abandoned services left in place as "ABANDONED".
- .10 Identify control panels and major control components outside panels with plastic nameplates.
- .11 Identify valves in main and branch piping with tags. Consecutively number valves in each system.
- .12 Identify piping, concealed or exposed, with stencilled painting and plastic tape pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- .13 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-3/8" x 9" (60 x 230 mm), reading: **"WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED. IT MAY START AT ANY TIME."**
- .14 Provide colour coded self-adhesive dots to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.21 MECHANICAL IDENTIFICATION SCHEDULES

- .1 Consult the Owner and identify piping, ductwork and equipment as directed;
 - .1 Conforming to the Owner's existing identification practices, or
 - .2 Conforming to the following Pipe and Valve Identification Table:

SERVICE	COLOURS	LEGEND
---------	---------	--------

	BACKGROUND	LETTERS	
Make-up water	Yellow	Black	MAKE-UP WTR
Gas regulator vents	to Code		

3.22 MANUFACTURER'S NAMEPLATES

- .1 Provide metal nameplates on each piece of equipment, mechanically fastened with raised or recessed letters.
- .2 Include registration plates, Underwriters' Laboratories and CSA approval, as required by respective agency and as specified. Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors, all factory supplied.
- .3 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

- .1 Pipe and pipe fittings.
- .2 Hangers and supports.
- .3 Labelling and identification.
- .4 Valves.
- .5 Accessories.

1.3 REFERENCES

- .1 CSA B149.1 Natural gas and propane installation code, as adopted.
- .2 ANSI B31.1 - Power Piping.
- .3 ASME SEC IX - Welding and Brazing Qualifications.
- .4 ASME B16.3 - Malleable Iron Threaded Fittings.
- .5 ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- .6 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

1.4 SUBMITTALS

- .1 Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- .2 Project Record Documents: Record actual locations of piping system, storage tanks, and system components.
- .3 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- .4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- .5 Contractor's material and test certificates.

1.5 QUALITY ASSURANCE

- .1 Welding Materials and Procedures: Conform to ASME Code.
- .2 Welders Certification: To ASME SEC IX.
- .3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .4 Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.
- .5 Valves: Manufacturer's name and pressure rating marked on valve body.

1.6 REGULATORY REQUIREMENTS

- .1 Conform to CSA B149.1 Natural Gas and Propane installation code
- .2 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND PROTECTION

- .1 Transport, handle, store, and protect products.
- .2 Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain protection in place until installation.

1.8 EXTRA MATERIALS

- .1 Provide two repacking kits for each size valve.

2 PRODUCTS

2.1 ABOVE GROUND PIPING

- .1 Copper Tubing: ASTM B88, Type K, hard drawn.
 - .1 Fittings: ASME B16.18, cast copper alloy or ASTM B16.22 wrought copper and bronze.
 - .2 Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.
- .2 Steel Pipe: ASTM A53/A53M Gr. B, ERW or A106 SMLS, schedule 40.
 - .1 Fittings: ASTM B16.3, malleable iron class 150, screwed or flanged or ASTM A234/A234M, wrought carbon steel and alloy steel welding type.
 - .2 Joints: NFPA 30, threaded, flanged or welded to ANSI B31.1.
 - .1 Screwed fittings: pulverized lead paste.
 - .2 Welded fittings: butt-welding fittings to CSA W47.1.
 - .3 Flange gaskets: nonmetallic flat, to ASME B16.5.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A 47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A 53/A53M.

2.2 PIPE HANGERS AND SUPPORTS

- .1 Hangers for Pipe Sizes 1" - 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
- .2 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
- .3 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- .4 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
- .5 Vertical Support: Steel riser clamp.
- .6 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .7 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.3 ISOLATION VALVES

- .1 2" (50 mm) and smaller: semi-steel lubricated plug valves, screwed, wrench operated. Rockwell "Nordstrum" Fig. 142, Newman-Milliken 170M.
- .2 2-1/2" (65 mm) and 3" (75 mm): semi-steel lubricated plug valves, flanged, wrench operated. Rockwell "Nordstrum" Fig. 143, Newman-Milliken 171M.
- .3 Provide two (2) standard pattern, cast handle wrenches to operate valves.

2.4 PRESSURE REDUCING VALVES

- .1 Gas Pressure Reducing and Relief Valves: Spring loaded regulator with internal relief valve. Cast iron body, aluminum diaphragm case and orifice. For capacities refer to drawings. Fisher Type 133L or 133H, or approved equal as noted on drawings.

3 EXECUTION

3.1 EXAMINATION

- .1 Verify existing conditions before starting work.
- .2 Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- .1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- .2 Remove scale and dirt, on inside and outside, before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- .1 Install to to CSA B149.1 as adopted.
- .2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- .3 Route piping in orderly manner and maintain gradient.
- .4 Install piping to conserve building space and not interfere with use of space.
- .5 Group piping whenever practical at common elevations.
- .6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .7 Provide clearance for installation of insulation and access to valves and fittings.
- .8 Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- .9 Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.
- .10 Identify piping systems including underground piping.
- .11 Install valves with stems upright or horizontal, not inverted.
- .12 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

- .1 Floor drains.
- .2 Cleanouts.
- .3 Backflow preventers.
- .4 Water hammer arrestors.
- .5 Trap Seal Primers.

1.3 REFERENCES

- .1 ASME A112.21.1 - Floor Drains.
- .2 ASME A112.26.1 - Water Hammer Arrestors.
- .3 AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
- .4 PDI WH-201 - Water Hammer Arrestors.

1.4 SUBMITTALS FOR REVIEW

- .1 Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- .2 Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.5 SUBMITTALS FOR INFORMATION

- .1 Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors
- .2 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND PROTECTION

- .1 Accept specialties on site in original factory packaging. Inspect for damage.

2 PRODUCTS

2.1 GENERAL

- .1 Manufacturer: Watts Drainage model indicated or equivalent by;
 - .1 Zurn
 - .2 Jay R. Smith
 - .3 Precision Plumbing Products.

2.2 FLOOR DRAINS

- .1 Floor Drain (FD):
 - .1 Watts Drainage model FD-100-C-5

- .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel-bronze strainer with removable perforated sediment bucket.
- .2 Floor Drain (FFD):
 - .1 Watts Drainage Model FD-100-C-EG
 - .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze elongated funnel.
- .3 Floor Drain (HD):
 - .1 Watts Drainage Model FD-100-C-AS-7-8
 - .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, adjustable nickel-bronze angle strainer, trap primer tapping, and backwater valve.

2.3 TRAP SEAL PRIMERS

- .1 Individual Traps:
 - .1 Watts Drainage model MS-810
 - .2 Automatic cast brass body, renewable disc and seat rings, vacuum breaker and removable cover.

2.4 CLEANOUTS

- .1 Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.
- .2 Line Cleanouts: lacquered cast iron Malcom type with cleanout ferrule, 1/2" (13mm) thick epoxy coated gasketed cover.
- .3 Caulking for cleanouts: VOC content not to exceed 250g/L.

2.5 BACKFLOW PREVENTERS

- .1 Reduced Pressure Backflow Preventers:
 - .1 Manufacturers:
 - .1 Watts Model 909.
 - .2 ITT lawler Model RZ.
 - .3 Baukman Model BF-299.
 - .4 Febco Model 825Y
 - .2 ANSI/ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.6 WATER HAMMER ARRESTORS

- .1 Watts Drainage Series 05
- .2 ANSI A112.26.1; copper construction, piston type sized to PDI WH-201, precharged suitable for operation in temperature range 33°F to 100°F (0.5°C to 82°C) and maximum 150 psi (1000 kPa) working pressure.

3 EXECUTION

3.1 GENERAL

- .1 Install all products in accordance with the plumbing code and with manufacturer's instructions.

3.2 CLEANOUTS

- .1 Cleanouts shall be the same size as the pipe up to 4" (100mm) and not less than 4" (100mm) for larger pipes.
- .2 Provide cleanouts at the end of mains and branches, at changes in direction, in long straight runs and at the base of all soil stacks and rainwater leaders and where required by code.
- .3 Extend cleanouts to finished floor or wall surface.
- .4 Install floor cleanouts at elevation to accommodate finished floor.
- .5 Cleanouts in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.
- .6 Lubricate threaded cleanout plugs with mixture of graphite and linseed oil.
- .7 Ensure clearance at cleanout for rodding of drainage system.

3.3 FLOOR DRAINS

- .1 Provide floor drains where indicated on architectural and plumbing floor plans.
- .2 Inspect locations where floor drains are shown to determine that floor is sloped appropriately. Report concerns to Consultant prior to installation of drains.
- .3 Coordinate installation with general trades.
- .4 Trap and vent all floor drains in accordance with Plumbing Code.
- .5 Provide trap seal priming for each floor drain trap.
- .6 Floor drains in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.
- .7 Floor drains, traps and drain pipes installed in slabs on grade shall be embedded in concrete and made water-tight to prevent water seepage.

3.4 WATER HAMMER ARRESTORS

- .1 Install water hammer arrestors complete with an accessible isolation valve on hot and cold water supply piping to;
 - .1 Downstream of each backflow preventer,
 - .2 HVAC equipment with solenoid valves or other quick closing valves,
 - .3 Owner's equipment and appliances with flush valves, solenoid valves or other quick closing valves,
 - .4 Wherever necessary to prevent water hammer.

3.5 TRAP SEAL PRIMERS

- .1 Condensate drains from cooling units may not be used to prime traps.
- .2 Trap seal primers shall be provided where flush valves and/or drinking fountains are not available.
- .3 Group trap primers shall be provided where specifically shown and where agreed with the Consultant.

3.6 BACKFLOW PREVENTION

- .1 Backflow prevention includes backflow preventers, anti-siphon devices and vacuum breakers.
- .2 Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur;
 - .1 On boiler feed water lines,
 - .2 Where require by codes, regulations and/or standards.
- .3 Pipe relief or drain from backflow prevention device to nearest drain.
- .4 Install a strainer upstream of each backflow preventer.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

- .1 Pipe, pipe fittings, valves, and connections for piping systems.
 - .1 Sanitary Sewer
 - .2 Sanitary Vent
 - .3 Non-Potable Water
- .2 Testing and reporting results.

1.3 REFERENCES

- .1 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .3 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- .4 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.
- .5 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- .6 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Solvent Drainage Systems.
- .7 ASTM A74 - Cast Iron Soil Pipe and Fittings.
- .8 ASTM B32 - Solder Metal.
- .9 ASTM B42 - Seamless Copper Pipe, Standard Sizes.
- .10 ASTM B68 - Seamless Copper Tube, Bright Annealed.
- .11 ASTM B75 - Seamless Copper Tube.
- .12 ASTM B88 - Seamless Copper Water Tube.
- .13 ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
- .14 ASTM B302 - Threadless Copper Pipe, Standard Sizes.
- .15 ASTM B306 - Copper Drainage Tube (DWV).
- .16 ASTM C1053 - Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
- .17 ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings.
- .18 ASTM D2239 - Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
- .19 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- .20 ASTM D2447 - Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
- .21 ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- .22 ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
- .23 ASTM D2661 - Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
- .24 ASTM D2665 - Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- .25 ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .26 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer, Pipe, and Fittings.
- .27 ASTM D2846 - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems.
- .28 ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- .29 ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .30 ASTM E814 - Fire Tests of Through-Penetration Fire Stops.
- .31 ASTM F679 - Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- .32 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- .33 AWWA C110 - Ductile - Iron and Gray - Iron Fittings, 3" - 48" (76 mm - 1219 mm), for Water.
- .34 AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .35 AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
- .36 AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe (and Fabricated Fittings), 4" - 12" (100 mm - 300 mm), for Water Distribution.
- .37 AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2" - 3" (13 mm - 76 mm) for Water Service.
- .38 AWWA C902 - Polybutylene (PB) Pressure Pipe and Tubing, 1/2" - 3" (13 mm - 76 mm) for Water.

- .39 AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14" - 48" (350 mm - 1200mm).
- .40 CISPI 301 - Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
- .41 CISPI 310 - Joints with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- .42 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- .43 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- .44 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SUBMITTALS FOR REVIEW

- .1 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Project Record Documents: Record actual locations of valves.

1.6 QUALITY ASSURANCE

- .1 Perform Work to Province of Ontario standards. Maintain one copy on site.
- .2 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.7 REGULATORY REQUIREMENTS

- .1 Perform Work to Province of Ontario plumbing code.
- .2 Conform to applicable code for installation of backflow prevention devices.
- .3 Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.8 DELIVERY, STORAGE, AND PROTECTION

- .1 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- .2 Provide temporary protective coating on cast iron and steel valves.
- .3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

- .1 Do not install underground piping when bedding is wet or frozen.

1.10 EXTRA MATERIALS

- .1 Provide two repacking kits for each size valve.

2 PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING

- .1 Cast Iron Pipe: ASTM A74 extra heavy weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- .2 Cast Iron Pipe: CISPI 301, hubless.
 - .1 Fittings: Cast iron.
 - .2 Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

- .3 Copper Tube: ASTM B306, DWV.
 - .1 Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
 - .2 Joints: ASTM B32, solder, Grade 50B.
- .4 ABS Pipe: ASTM D2751 or ASTM F628.
 - .1 Fittings: ABS.
 - .2 Joints: ASTM D2235, solvent weld.
- .5 ABS Pipe: ASTM D2661 or ASTM D2751.
 - .1 Fittings: ABS.
 - .2 Joints: ASTM D2235, solvent weld.
- .6 PVC Pipe: ASTM D2665 or ASTM D3034.
 - .1 Fittings: PVC.
 - .2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- .7 PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679.
 - .1 Fittings: PVC.
 - .2 Joints: ASTM F477, elastomeric gaskets.

2.2 SANITARY SEWER PIPING, ABOVE GRADE

- .1 Cast Iron Pipe: ASTM A74, service weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: ASTM C564, neoprene gasket system
- .2 Cast Iron Pipe: CISPI 301, hubless, service weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- .3 Copper Tube: ASTM B306, DWV.
 - .1 Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper, or ASME B16.32, solvent.
 - .2 Joints: ASTM B32, solder, Grade 50B.

2.3 WATER PIPING, ABOVE GRADE

- .1 Copper Tubing: ASTM B88M, Type L, hard drawn.
 - .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - .2 Joints: ASTM B32, solder, Grade 95TA.
- .2 Copper Tubing: ASTM B88M, Type L, hard drawn.
- .3 Ductile Iron Pipe: AWWA C151.
 - .1 Fittings: Ductile iron, standard thickness.
 - .2 Lining: cement
 - .3 Joints: AWWA C111, rubber gasket with 3/4" (19 mm) diameter rods.

2.4 FLANGES, UNIONS, AND COUPLINGS

- .1 Pipe Size 3-1/4" (80 mm) and Under:
 - .1 Ferrous pipe: Class 150 malleable iron threaded unions.
 - .2 Copper tube and pipe: Class 150 bronze unions with soldered joints.
- .2 Pipe Size Over 1" (25 mm):
 - .1 Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - .2 Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- .3 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.5 PIPE HANGERS AND SUPPORTS

- .1 Plumbing Piping - Drain, Waste, and Vent:
 - .1 Conform to ASME B31.9.
 - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.

- .3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
- .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- .5 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
- .6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
- .7 Vertical Support: Steel riser clamp.
- .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .2 Plumbing Piping - Water:
 - .1 Conform to ASME B31.9.
 - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
 - .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
 - .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
 - .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
 - .6 Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
 - .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
 - .8 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
 - .9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 - .10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
 - .11 Vertical Support: Steel riser clamp.
 - .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - .13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
 - .14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
 - .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.6 VALVES - GENERAL

- .1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
- .2 Provide valves of the same manufacturer where possible.
- .3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
- .4 Valid CRN (Canadian Registration Number) issued by Province of Ontario required for each valve.
- .5 Materials:
 - .1 Bronze: ASTM B62 or B61 as applicable
 - .2 Brass: ASTM B283 C3770
 - .3 Cast Iron: ASTM A126 Class B
- .6 End Connections:
 - .1 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
 - .2 Face-to-face dimensions: ANSI B16.10
- .7 Design and Testing:
 - .1 Bronze Gate & Check valves: MSS-SP-80
 - .2 Ball Valves: MSS-SP-110
 - .3 Cast Iron Gate Valves: MSS-SP-70
 - .4 Cast Iron Globe Valves: MSS-SP-85
 - .5 Cast Iron Check: MSS-SP-71
 - .6 Butterfly Valves: MSS-SP-67
- .8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products listed on spread sheet attached.

2.7 ISOLATION VALVES

- .1 Up To and including 2" (50mm) - Ball type
 - .1 Manufacturer: Kitz #69AMLL
 - .2 Construction: MSS SP-110, Class 150, 600 psi (4140 kPa) CWP, forged brass, two piece body, stainless steel ball and stem, full port, virgin PTFE seats and stem packing, blow-out proof stem, lever handle with balancing stops, stem extensions for insulated piping, solder ends.
- .2 2-1/2" (65 mm) and Larger - Butterfly type:
 - .1 Manufacturer: Kitz 6122EL
 - .2 Construction: MSS-SP-67, MSS-SP-25 and API-609; lug type having bi-directional "Dead End Service" pressure rating of 1380 kPa (200 psi) with the downstream flange removed; stainless steel stem with top and bottom bushings of dissimilar materials and with positive stem retention mechanism, aluminum bronze disc and molded or bonded style EPDM seat; suitable for both chilled water and hot water operation; supplied with 10 position locking lever handle 2" extended neck to allow for insulation. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 8-Ft (2400 mm) above floor.

2.8 THROTTLING VALVES

- .1 Up To and including 2" (50 mm) - Globe type:
 - .1 Manufacturer: Kitz 10.
 - .2 Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, rising stem, union bonnet, inside screw, PTFE disk, solder ends.
- .2 2-1/2" (65 mm) and Larger - Globe type: (NOT READY)
 - .1 Manufacturer: Kitz 76 (Globe)
 - .2 Construction: Cast iron body globe

2.9 CHECK VALVES

- .1 Up To and Including 3" (75 mm):
 - .1 Manufacturers: Kitz 23
 - .2 Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, bronze trim, solder ends

2.10 DRAIN VALVES

- .1 Up to 150 psig - Ball type:
 - .1 Manufacturers: Kitz 68C
 - .2 Construction: 150 psig (1034 kPa), 600 WOG, brass body to ASTM C37700, two piece body, full port, PTFE seats and stem packing or double "O" ring, blow-out proof stem, Chrome Plated ball, lever handle with cap and chain, (3/4") 20 mm hose connection.

2.11 STRAINERS

- .1 Up to 125 psig:
 - .1 Size 2" (50 mm) and Under:
 - .1 Manufacturers: Mueller Steam 351M
 - .2 Construction : 860 kPa (125 psig) 200 WOG Rating, Bronze body, Screwed Cap, Y Pattern, 304 stainless steel screen with 20 Mesh perforation, Threaded Ends.

3 EXECUTION

3.1 PREPARATION

- .1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- .2 Remove scale and dirt, on inside and outside, before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- .3 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- .4 Install piping to maintain headroom, conserve space, and not interfere with use of space.
- .5 Group piping whenever practical at common elevations.
- .6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- .8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with general trades.
- .9 Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- .10 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (maximum VOC content of 80 g/L) to welding.
- .11 Provide support for utility meters to requirements of utility companies.
- .12 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting where required. Coordinate with general trades.
- .13 Install bell and spigot pipe with bell end upstream.
- .14 Install valves with stems upright or horizontal, not inverted.
- .15 Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- .16 Sleeve pipes passing through partitions, walls and floors.
- .17 Inserts:
 - .1 Provide inserts for placement in concrete formwork.
 - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
 - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- .18 Pipe Hangers and Supports:
 - .1 Install to OBC (Plumbing Code)
 - .2 Support horizontal piping as scheduled.
 - .3 Install hangers to provide minimum 1/2" (15 mm) space between finished covering and adjacent work.
 - .4 Place hangers within 12" (300 mm) of each horizontal elbow.
 - .5 Use hangers with 1-1/2" (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - .6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - .8 Provide copper plated hangers and supports for copper piping.
 - .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - .10 Provide hangers adjacent to motor driven equipment with vibration isolation.
 - .11 Support cast iron drainage piping at every joint.

3.3 UNDERGROUND SEWER LINES

- .1 Arrange for and coordinate the installation of the storm and sanitary sewer connections with the municipal authority.
- .2 Provide qualified personnel to properly layout and establish all lines and grades necessary for construction. Accurately verify location and inverts of all existing services before any sewer work is started to ensure that connection of new sewers to existing can be made. Construct and maintain

- adequate batter boards, alignment markers and secondary bench marks as may be required for proper execution of work.
- .3 Batter boards or sight lines shall be set not more than 25 ft. (7.5 m) apart. A minimum of three (3) batter boards shall be in place at all times during laying operation.
 - .4 Notify Consultant of any layout work to be carried out, Consultant shall have right to check Contractor's layout at any time, but checking layout or failure to do so on part of Consultant in no way relieves Contractor of full responsibility for construction to exact alignment and grade.
 - .5 Verify all existing invert elevations before setting out drainage work.
 - .6 Sewer lines, connections shall be built to exact lines and grades as shown on drawings. No deviation from these lines and grades will be permitted unless approved in writing by Consultant.
 - .7 Where pipes enter or leave manhole or other structure, support them on compacted crushed stone bed or concrete cradle through the backfill area. The pipe support shall extend laterally from undisturbed soil to the face of wall through which the pipes pass.
 - .8 Install precast manholes and catch basins or cast-in-place concrete manholes and catch basins, as indicated where required.
 - .9 Form concrete benching in sanitary manholes to provide a smooth unobstructed flow channel in the bottom of manhole with slopes of 1" per foot (100 mm/m). Storm manholes shall have 24" (600 mm) sumps unless instructed otherwise by the Consultant or local authority.
 - .10 Completely surround plastic piping by at least 4" (100 mm) of non-cohesive ballast material of which at least 50% will pass a 1/4" (6.35 mm) sieve and 100% will pass a 1/2" (12.7 mm) sieve, and that is sufficiently consolidated so that the intended earth loading will not produce further compaction.
 - .11 Install Big "O" BOSS 2000 storm sewer system in accordance with BOSS 2000 Gravity Sewer Installation Guide and ASTM D2321. Perform all bedding, haunching and backfilling as required.

3.4 APPLICATION

- .1 Use grooved mechanical couplings and fasteners only in accessible locations.
- .2 Install unions downstream of valves and at equipment or apparatus connections.
- .3 Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- .4 Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- .5 Install globe valves for throttling, bypass, or manual flow control services.
- .6 Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- .7 Provide plug valves in natural gas systems for shut-off service.

3.5 SCHEDULES

- .1 Pipe Hanger Schedule:
 - .1 Metal Piping:
 - .1 Pipe size: 1/2" to 1-1/4" (15 to 32 mm):
 - .1 Maximum hanger spacing: 6.5' (2 m).
 - .2 Hanger rod diameter: 3/8" (9 mm).
 - .2 Pipe size: 1-1/2" to 2" (40 to 50 mm):
 - .1 Maximum hanger spacing: 10' (3 m).
 - .2 Hanger rod diameter: 3/8" (9 mm).
 - .3 Pipe size: 2-1/2" to 3" (65 to 75 mm):
 - .1 Maximum hanger spacing: 10' (3 m).
 - .2 Hanger rod diameter: 1/2" (13 mm).
 - .4 Pipe size: 4" to 6" (100 to 150 mm):
 - .1 Maximum hanger spacing: 10' (3 m).
 - .2 Hanger rod diameter: 1/2" (15 mm).
 - .5 Pipe size: 8" to 12" (200 to 300 mm):
 - .1 Maximum hanger spacing: 14' (4.25 m).
 - .2 Hanger rod diameter: 3/4" (22 mm).
 - .6 Pipe size: 14" (350 mm) and Over:
 - .1 Maximum hanger spacing: 20' (6 m).
 - .2 Hanger rod diameter: 1" (25 mm).

END OF SECTION

1 GENERAL

1.1 SUBMITTAL

- .1 Each bidder for the work of Division 23: Heating, Ventilating and Air Conditioning (HVAC) shall submit this Supplementary Bid Form to the consultant within two (2) hours of tender closing to the Consultant.
- .2 This document, on acceptance by the Consultant, will be included in the Contract Documents and shall govern the work of Division 23: HVAC.

1.2 SUBCONTRACTORS

- .1 List the trade Subcontractors that have been included in the bid proposal.

TRADE	OWN FORCES	SUBCONTRACTOR
Gas Fitting	<input type="checkbox"/>	
Hydronic Piping	<input type="checkbox"/>	
Welding	<input type="checkbox"/>	
Insulation	<input type="checkbox"/>	
Testing, Adjusting & Balancing	<input type="checkbox"/>	

1.3 LABOUR RATES

- .1 Indicate the unit labour rate required for additional work and/or work to be deleted in changes to the Contract under Part 6 of the General Conditions of the Stipulated Price Contract. Rates indicated shall include all allowances for foremen, supervision and office support but shall not include the Division 23 Sub-Contractor's overhead and profit margins and shall be based on regular working hours.
- .2 Labour rates for changes must be negotiated with the Owner prior to acceptance and use in pricing.

TRADE	HOURLY RATE
Gas Fitting	
Hydronic Piping	
Welding	
Insulation	
Testing, Adjusting & Balancing	

1.4 PRODUCTS

- .1 Indicate the name of the manufacturer of equipment items included in the Bid Price by submitting a copy of the appended Equipment List marked to indicate choices. Failure to indicate a specific manufacturer will be taken to mean that products of the first manufacturer named in the specifications are included in the Bid Price. This list shall in no way limit the extent of the Contract.
- .2 The Division 23 Bidder may propose the name of an alternative manufacturer for any equipment item in accordance with Section 23 01 01, Part 2, Article 2.3.

Section	Product	Specified Product Included in Bid	Proposed Alternative
23 05 00	Adhesives		
	Sealants		

	Paints and Coatings		
	Pressure Gauges		
	Thermometers		
	Test Plugs		
	Access Doors		
	Firestopping Compounds		
	Escutcheons		
	Flashings		
	Penetration Seals		
23 05 14	Variable Frequency Drive		
23 05 30	Pipe Hangers and Supports		
23 07 16	HVAC Equipment Insulation		
23 07 19	Pipe Insulation		
	Canvas Jackets		
	PVC Jacket		
	Aluminum Jacket		
23 07 19	Insulation Accessories		
	Hydronic Valves		
23 21 16	Expansion Tanks		
	Air Vents		
	Air Separators		
	Strainers		
	Combination Pump Discharge Valves		
	Pump Suction Fittings		
23 21 23	Relief Valves		
	In-Line Circulators		
	Vertical In-Line Pumps		
23 25 13	Side Stream Filtration System		
	HVAC Chemical Treatments		
23 52 16	Boilers - Condensing		
25 10 00	Digital Controllers		
	Sensors		
	Thermostats		
	Humidistats		
	Electric Actuators		
	Valves		
	Dampers		

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to:
 - .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended,
 - .2 Division 1 requirements and documents referred to therein.
- .2 Section 23 01 01 applies to and governs the work of all Sections of Division 23.
- .3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work.
- .4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
- .5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

1.2 WORK INCLUDED

- .1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
- .2 Cutting and patching of new or existing work
- .3 Identification of equipment, piping, and valves and controllers
- .4 Concrete equipment bases, housekeeping pads.
- .5 Motors required for equipment supplied under this Division.
- .6 Variable frequency drives for motors and equipment supplied under this Division.
- .7 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.
- .8 Disconnect switches for exhaust fans located on the roof complete with;
 - .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,
 - .2 EEMAC 3 enclosure if exposed to weather
- .9 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.
- .10 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.
- .11 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.3 RELATED WORK

- .1 Power wiring, conduit and connections for motors under this Division will be by Division 26.
- .2 Power wiring, conduit and connections to variable frequency drives for motors under this Division will be by Division 26. Wiring and connections from VFD to motors under this Division will be by Division 26.
- .3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.
- .4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

1.4 SUBMITTALS

- .1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to

- commencement of work under this Division.
- .2 Shop Drawings: Prepare and submit one (1) electronic copy of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
 - .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
 - .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
 - .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
 - .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:

"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."
 - .3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Division 23. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.
 - .4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.
 - .5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:
 - .1 description of the system (description and type),
 - .2 description of the tests conducted and results observed, including re-testing, where necessary,
 - .3 description of any corrective measures undertaken,
 - .4 description of materials used (pipe and fittings),
 - .5 list of witnesses for each test conducted,
 - .6 date system left ready for service,
 - .7 signature of installing Contractor.
 - .6 Directories & Schematics
 - .1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service, and location of each valve under this Division.
 - .2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.
 - .3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.
 - .7 Maintenance Data and Operating Instructions
 - .1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.
 - .2 Ensure the binder spines have typewritten lettering as follows:

OPERATION & MAINTENANCE MANUAL

- for
[Insert name of project]
[Insert date of submission]
[Insert Division Title]
- .3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.
 - .4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.
 - .5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.
 - .6 Ensure operating instructions include the following:
 - .1 General description of each mechanical system.
 - .2 Step by step procedure to follow in putting each piece of equipment into service.
 - .3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
 - .4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
 - .5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.
 - .7 Ensure maintenance instructions include the following:
 - .1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.
 - .2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
 - .3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
 - .4 Balancing and testing reports.
 - .5 Copy of valve directory.
 - .8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract.
 - .9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available.
 - .10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.5 QUALITY ASSURANCE

- .1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.
- .2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
- .3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.
- .4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.
- .5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.
- .6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.

1.6 PRODUCT DELIVERY, HANDLING AND STORAGE

- .1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
- .2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.7 JOB CONDITIONS

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.8 WARRANTY

- .1 Refer to General Conditions. Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
- .2 Make submissions necessary to register product warranties to the benefit of the Owner.
- .3 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

1.9 DEFINITIONS

- .1 The following are definitions of words found in this specification and on associated drawings under this Division:
 - .1 "Concealed" - locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
 - .2 "Exposed" - mechanical work normally visible to building occupants.
 - .3 "Furnish" - (and its derivatives) has the same meaning as the term "Supply".
 - .4 "Install" - (and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
 - .5 "Provide" - (and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
 - .6 "Supply" - (and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
 - .7 "Wet" - locations exposed to moisture, requiring special materials and arrangement.

1.10 INTERRUPTIONS

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- .1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.
- .2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.
- .3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.
- .4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

- .1 First item named or specified by catalogue number meets specifications regarding performance, quality of material and workmanship, and is acceptable to the Consultant.
- .2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only, if they also meet performance and/or capacities specified and can be accommodated within the space allotted.
- .3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.
- .2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, and space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.
- .3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

- .1 If during the progress of work, specified products are not obtainable, equivalent or similar products by

- other manufacturers may be permitted by Consultant.
- .2 Apply, in writing, to Consultant for substitution of any products, indicating the following:
 - .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
 - .2 Reason for substitution.
 - .3 Any revisions to the contract price made necessary by substitution.
 - .4 Any revisions to the contract time made necessary by substitution.
 - .5 Any revisions to layout, arrangement or services made necessary by substitution.
 - .3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

- .1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.
- .2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 EXECUTION

3.1 RELATIONSHIP WITH OTHER TRADES

- .1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.
- .2 Provide materials to be built-in, such as sleeves, anchors, and inserts, together with templates and/or measurements, promptly when required by other trades.
- .3 Provide structural supports for equipment to be mounted on or in walls, supported above floors and/or suspended from the structure.

3.2 INSTALLATION REQUIREMENTS

- .1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
- .2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
- .3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
- .4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
- .5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
- .6 Provide suitable shielding and physical protection for devices.
- .7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
- .8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
- .9 Do not use power activated tools without written permission of the Consultant. Use them in accordance with the Owner's health and safety policies.
- .10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.3 CONTRACT DRAWINGS

- .1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
- .2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement.

- Location and elevation of services are approximate. Verify them before construction is undertaken.
- .3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
 - .4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.
 - .5 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents.

3.4 CONSTRUCTION DRAWINGS

- .1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.
- .2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.
- .3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
- .4 Submit construction drawings to other Divisions.
- .5 Submit construction drawings prior to commencement of work.

3.5 RECORD DRAWINGS

- .1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
- .2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.
- .3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.
- .4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.
- .5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
- .6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.6 USE OF EQUIPMENT

- .1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.
- .2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over the Owner.

3.7 SPECIAL TOOLS AND SPARE PARTS

- .1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.
- .2 On completion of the project furnish spare parts to the Owner as follows:
 - .1 One set of mechanical seals for each pump.
 - .2 One casing joint gasket for each pump.
 - .3 One glass for each gauge glass installed.
 - .4 One set of v-belts for each piece of machinery.
- .3 Identify spare parts containers as to contents and replacement parts number.
- .4 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.8 EXTRAS AND CREDITS

- .1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
 - .1 Materials, quantities and unit costs including any applicable contractors' trade discount clearly identified.
 - .2 Labour hours and unit costs.
 - .3 Total materials and labour costs.
 - .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

3.9 INSTRUCTION

- .1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.
- .2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
- .3 Ensure each instruction period includes, but is not limited to the following;
 - .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
 - .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
 - .3 demonstration of the proper operating procedures for each item of equipment,
 - .4 explanation of the purpose and function of all safety devices provided,
 - .5 demonstration of all measures required for safe and proper access for operation and maintenance.
- .4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.
- .5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.10 COMMISSIONING

- .1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 WORK INCLUDED

- .1 Identification of existing services and utility connections.
- .2 Installation, protection and maintenance of temporary services as required to support continuing operation of the facility.
- .3 Disconnection and removal of various mechanical equipment in areas to be turned over to the Owner.
- .4 Disconnection and making safe of various mechanical systems and equipment in areas to be demolished and/or renovated.
- .5 Disposal of waste materials in accordance with waste management requirements.
- .6 Re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction including requirements for marking of equipment.

1.3 REGULATORY REQUIREMENTS

- .1 Notify all authorities of intent to demolish and schedule for the work. Obtain required permits from authorities.
- .2 Conform to all codes for demolition work, dust control, products requiring disconnection and re-connection.
- .3 Do not close or obstruct egress width to any building or site exit.
- .4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.
- .5 Conform to procedures applicable when hazardous or contaminated materials are discovered.
- .6 Arrange for re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction. This includes requirements for marking of equipment under rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

1.4 JOB CONDITIONS

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

2 PRODUCTS

Not Applicable

3 EXECUTION

3.1 PREPARATION

- .1 Prior to start of work under this Section, ensure that the General Trades;
 - .1 Provide, erect, and maintain temporary barriers at locations indicated.
 - .2 Erect and maintain weatherproof closures for exterior openings.
 - .3 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.
 - .4 Prevent movement of structure; provide bracing and shoring.
- .2 Install, protect and maintain temporary services as required to support continuing operation of the facility.
- .3 Protect services and equipment which are not to be demolished.
- .4 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
- .5 Notify affected utility companies before starting work and comply with their requirements.
- .6 Mark location and termination of utilities.
- .7 Provide appropriate temporary signage including signage for exit or building egress.

3.2 RELATIONSHIP WITH OTHER TRADES

- .1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.
- .2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.
- .3 Remove and dispose of bases, supports and anchors for piping, equipment and ductwork mounted on or in walls, supported above floors and/or suspended from the structure.

3.3 PROTECTION

- .1 Protect existing and new work to remain free from damage due to execution of work under this Division with tarpaulins and other protective coverings as necessary.
- .2 Repair any and all damage to the building and components resulting from failure to provide sufficient protection, to the satisfaction of the Consultant.
- .3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
- .4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
- .5 Temporary filters shall be removed on completion of the construction works.

3.4 DEMOLITION

- .1 Notify all authorities of intent to demolish and schedule for the work.
- .2 All demolition work shall conform to all codes, regulations, standards and by-laws applicable to the work.
- .3 Isolate and drain systems as required to effect demolition. Disconnect, cap and make safe all mechanical services to the building including, but not limited to; sanitary sewer(s), storm sewer(s), water service, natural gas service.
- .4 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.
- .5 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
- .6 Remove and dispose of all redundant mechanical services and equipment within the limits of the demolition site and where demolished systems extend beyond these limits.
- .7 Turn over items identified for recovery by the Owner.

- .8 All demolition work shall conform to Occupational Health & Safety and Environmental regulations. Ensure that all parties are familiar with requirements and experienced in the work to be undertaken.
- .9 Waste disposal shall conform to the requirements of, municipal By-Laws and Ministry of the Environment regulations and standards.
- .10 All existing air intake and exhaust openings that may be affected by dust and/or debris from the demolition work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from demolition work with new filters.
- .11 In the event that dust and debris from demolition work does penetrate the building and/or its air distribution systems, this Section shall be responsible for cleaning the affected areas and/or systems.
- .12 Disconnect remove, cap and identify all utilities within demolition areas.
- .13 Demolish in an orderly and careful manner. Protect existing supporting structural members.
- .14 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
- .15 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.
- .16 Remove temporary Work.

3.5 RENOVATIONS

- .1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.
- .2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.
- .3 Existing items to be relocated shall be cleaned and repaired or altered as required to suit new location. All damaged or ineffective parts shall be replaced and the item made "as new".
- .4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.
- .5 Make good all surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap all existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.
- .6 Openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction in general must be temporarily sealed with fire barrier materials such as mineral wool or other noncombustible insulation.
- .7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop work in the affected area and immediately notify consultant.
- .8 Existing refrigerant indicated to be removed shall not be discharged to the atmosphere, but shall be salvaged and reclaimed or disposed of following the guidelines of the authority having jurisdiction.
- .9 All existing air intake and exhaust openings that may be affected by dust and/or debris from the renovation work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from renovation work with new filters.
- .10 In the event that dust and debris from renovation work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
- .11 Temporary filters shall be removed on completion of the renovation work.

3.6 INSPECTION AND RE-CERTIFICATION

- .1 Where any equipment, machine or apparatus is modified, rebuilt or rewound with any change resulting in its performance or capacity rating and characteristics it shall be inspected and re-certified as

- required by authorities having jurisdiction.
- .2 A nameplate giving the name of the person or firm making the change and the resulting changes in performance or capacity shall be provided and affixed to the equipment, machine or apparatus adjacent to the original nameplate. Where the original nameplate is removed, the original manufacturer's name and original identifying data, such as serial numbers, shall be added to the nameplate.
 - .3 Refer to rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 COMMON WORK RESULTS

- .1 Section 23 05 00 applies to and governs all work of Division 23.

1.3 REFERENCE STANDARDS

- .1 Provide all work in accordance with requirements of Regulatory Agencies and conform to:
 - .1 Local and district by-laws, regulations and published engineering standards.
 - .2 the Ontario Building Code as amended,
 - .3 the Ontario Gas Utilization Code as amended
 - .4 Regulations for Construction Projects under The Occupational Health and Safety Act.
 - .5 Fire Code made under the Fire Marshal's Act.
- .2 Conform to following CSA Standards:
 - .1 CSA B242 Groove and Shoulder Type: Mechanical Pipe Couplings.
 - .2 CSA W48 series Electrodes.
 - .3 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CAN/CSA-W117.2, Safety in Welding, Cutting and Allied Processes
- .3 Conform to following National Research Council Canada publications:
 - .1 National Building Code of Canada and Supplements to National Building Code of Canada
 - .2 National Fire Code of Canada.
 - .3 Canadian Plumbing Code.
 - .4 Model National Energy Code for Buildings
- .4 Conform to following American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) Standards:
 - .1 ANSI/ASME Boiler and Pressure Vessel Code:
 - .1 Section 1: Power Boilers.
 - .2 Section V: Nondestructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
 - .2 ASME A13.1 - Scheme for the Identification of Piping Systems.
 - .3 ASME B40.100 - Pressure Gauges and Gauge Attachments.
- .5 Conform to following American Welding Society (AWS) Standards:
 - .1 AWS C1.1, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1, Welding Inspection.
- .6 Conform to following American Society for Testing and Materials (ASTM) Standards:
 - .1 ASTM E1 - Specification for ASTM Thermometers.
 - .2 ASTM E77 - Inspection and Verification of Thermometers.
- .7 Conform to following Underwriters Laboratories (UL) Standards:
 - .1 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- .8 Conform to AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- .9 Conform to IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- .10 Conform to NEMA MG 1 - Motors and Generators.
- .11 The above documents or portions thereof are referenced within the work of Division 23 and shall be considered part of the requirements of this document as though fully repeated herein.

1.4 QUALIFICATIONS

- .1 Motor manufacturer: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
- .2 Firestop Sealant Manufacturer: Company specializing in manufacture of sealants with minimum three years documented product development, testing, and manufacturing experience.

- .3 Firestop components and assemblies shall be ULC listed and tested in accordance with ULC S115 Standard Method of Fire Test for Firestop Systems.

1.5 SUBMITTALS

- .1 Submit shop drawings in accordance with section 23 01 01.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Transport, handle, store, and protect products.
- .2 Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WASTE MANAGEMENT & DISPOSAL

- .1 Separate and recycle waste materials in accordance with Owner's Waste Management and Disposal, and with the Contractor's Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

2 PRODUCTS

2.1 PIPING SPECIALTIES

- .1 Cast brass, pressure, copper to copper unions shall be used with seamless copper tubing smaller than 3" (75 mm).
- .2 Cast brass flanges shall be used with seamless copper tubing, type L for tubing 3" (75 mm) and larger.
- .3 Dart type, 125 lb. (860 kPa) black malleable iron unions shall be used with all steel pipe for piping 2-1/2" (65 mm) and smaller.
- .4 Slip-on, 150 lb. (1000 kPa) carbon steel flanges with 1/16" (4 mm) raised face shall be used with all steel pipe for piping larger than 2-1/2" (65 mm).
- .5 Gaskets for joining flanged steel pipe shall be 1/16" (4 mm) Cranite ring type gaskets.
- .6 Piping specialties including backflow preventers, strainers, valves etc. shall be line size unless indicated otherwise on drawings.
- .7 Strainers
 - .1 Manufacturers:
 - .1 Sarco SB
 - .2 S. A. Armstrong
 - .3 Crane
 - .4 Conbraco
 - .5 Colton
 - .2 In copper tubing: Class 250, wye type, bronze, screwed connection, with blind caps, and 1/32" (0.8 mm) perforated stainless steel screen.
 - .3 In Steel Piping: 2" (50mm) and smaller
 - .1 Body and cover: screwed, line size Y type strainer, semi-steel conforming to ASTM A278-85, Class 30, complete with screwed blind cap. Primary service rating of 125 psi @ 350 F (860 kPa @ 178 C). Body shall have side drain connection.
 - .2 Screen: perforated type 304 stainless steel service:
 - .1 Steam 1/16" (0.4 mm)
 - .2 Water 1/32" (0.8 mm)
 - .3 Glycol 1/32" (0.8 mm)
 - .4 Water @ Pump Suction 1/8" (3.2 mm)
 - .5 Light Oil 1/16" (1.6 mm)
 - .6 Compressed Air 1/64" (0.4 mm)
 - .4 In Steel Piping: 2-1/2" (65mm) and larger
 - .1 Body and cover: flanged, line size Y type strainer, cast steel, class 150, complete

with flanged blow down cover. Primary service rating of 150 psi @ 500 F (1 MPa @ 260 C).

- .2 Screen: perforated type 304 stainless steel service:
 - .1 Steam 1/32" (0.8 mm)
 - .2 Water 1/16" (1.6 mm)
 - .3 Glycol 1/16" (1.6 mm)
 - .4 Water @ Pump Suction 1/4" (6.4 mm)
 - .5 Light Oil 1/16" (1.6 mm)
 - .6 Compressed Air 1/32" (0.8 mm)

2.2 ADHESIVES, SEALANTS, PAINTS AND COATINGS

- .1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria;
 - .1 Paint for Mechanical Identification: maximum VOC emission of 250g/L
 - .2 Touch-Up Paint: maximum VOC emission of 250g/L
 - .3 Zinc-Rich Primer: maximum VOC emission of 250g/L
 - .4 Adhesives for Mechanical Identification: maximum VOC emission of 70g/L
 - .5 Sealants for service penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented
 - .6 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented
 - .7 Acrylic Sealant for supports and anchors: maximum VOC emission of 250g/L
 - .8 Insulation Vapour Barrier Lap Adhesive: maximum VOC emission of 80g/L
 - .9 Insulation Joint Sealer: maximum VOC emission of 250g/L
 - .10 Insulation Vapour Barrier Mastic: maximum VOC emission of 400g/L
 - .11 Flame Retardant Adhesive: maximum VOC emission of 650g/L clear and 350 g/L pigmented

2.3 WELDING ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.

2.4 FIRESTOPPING COMPOUNDS

- .1 Manufacturer: 3M products indicated.
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Dow Corning
 - .2 John Manville
 - .3 Hilti Firestop Systems
- .3 Fire Rated Sealants: intumescent material, synthetic elastomers, capable of expanding up to 8 to 10 times when exposed to temperatures of 250°F (121°C) or higher. ULC listed and labeled.

2.5 NAMEPLATES

- .1 Provide laminated plastic plates with black face and white centre of minimum size 3-1/2" x 1-1/2" x 3/32" (90 x 40 x 2 mm) nominal thickness, engraved with 1/4" (6 mm) high lettering. Use 1" (25 mm) lettering for major equipment.
- .2 Fasten nameplates securely in conspicuous place. Where nameplates cannot be mounted on cool surface, provide standoffs.
- .3 Identify equipment type and number and service of areas or zone of building served.
- .4 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-1/2" x 9" (65 x 230 mm), reading: "WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME."

2.6 TAGS

- .1 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background colour. Tag size minimum 1-1/2" (40 mm) diameter. **OR**
- .2 Metal Tags: Brass, aluminum or stainless steel with stamped letters; tag size minimum 1-1/2" (40 mm)

- diameter with smooth edges.
- .3 Chart: Typewritten letter size list in anodized aluminum frame.

2.7 STENCILS

- .1 Stencils: With clean cut symbols and letters of following size:
 - .1 3/4"-1-1/4" (20-30 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 1/2" (15 mm) high letters.
 - .2 1-1/2"-2" (40-50 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 3/4" (20 mm) high letters.
 - .3 2-1/2"-6" (65-150 mm) Outside Diameter of Insulation or Pipe: 12" (300 mm) long colour field, 1-1/4" (30 mm) high letters.
 - .4 8" - 10" (200-250 mm) Outside Diameter of Insulation or Pipe: 24" (600 mm) long colour field, 2-1/2" (65 mm) high letters.
 - .5 Over 10" (250 mm) Outside Diameter of Insulation or Pipe: 32" (800 mm) long colour field, 3-1/2" (90 mm) high letters.
 - .6 Ductwork and Equipment: 2-1/2" (65 mm) high letters.

2.8 PRESSURE GAUGES

- .1 Manufacturer: Trerice Model 600C.
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Weiss
 - .2 Winter
 - .3 Morrisson
 - .4 Taylor
- .3 Gauge: 4-1/2" (115mm) diameter black cast aluminum, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background, mid-scale accuracy: 1%, scale: psi and kPa.
- .4 Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa).
- .5 Needle Valve: Brass, 1/4" (6 mm) NPT for minimum 150 psi (1034 kPa).
- .6 Pulsation Damper: Pressure snubber, brass with 1/4" (6 mm) connections.
- .7 Syphon: Steel, Schedule 40, 1/4" (6 mm) angle or straight pattern.

2.9 STEM TYPE THERMOMETERS

- .1 Manufacturer: Trerice Model BX91403-1/2.
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Weiss Model 9VS3-1/2.
 - .2 Winter
 - .3 Morrison
 - .4 Taylor
- .3 Thermometer: 9" (230mm) scale, red appearing thermal fluid with black figures on white scale, calibrated in both degrees F and degrees C, accuracy to ASTM E77 of 2%, clear glass lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device, 3/4" (20mm) NPT brass stem.
- .4 All thermometers to include a separable well.
- .5 Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- .6 Flange: 3" (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.10 DIAL THERMOMETERS

- .1 Manufacturer: Trerice
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Weiss.
 - .2 Winter.

- .3 Morrisson.
- .4 Taylor
- .3 Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - .1 Size: 2" (50 mm) diameter dial.
 - .2 Lens: Clear glass.
 - .3 Accuracy: 1 percent.
 - .4 Calibration: Degrees C Both degrees F and degrees C.
- OR**
- .4 Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - .1 Size: 3" (75 mm) diameters dial.
 - .2 Lens: Clear glass.
 - .3 Accuracy: 1 percent.
 - .4 Calibration: Degrees F.
- OR**
- .5 Thermometer: ASTM E1, stainless steel case, vapour or liquid actuated with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer glass lens.
 - .1 Size: 2-3/8" (60 mm) diameters dial.
 - .2 Lens: Clear glass.
 - .3 Length of Capillary: Minimum 60" (1500 mm).
 - .4 Accuracy: 2 percent.
 - .5 Calibration: Degrees C Both degrees F and degrees C.
- .6 Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- .7 Flange: 3" (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.11 TEST PLUGS

- .1 Manufacturer: Pete's Plug.
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Watts TP.
- .3 Test Plug: 1/4" or 1/2" (6 mm or 15 mm) brass fitting and cap for receiving 1/8" (3 mm) outside diameter pressure or temperature probe with neoprene core for temperatures up to 93°C (200°F).
- .4 Test Kit: Carrying case, internally padded and fitted containing one diameter pressure gauges, one gauge adapters with 1/8" (3 mm) probes, two 1" (25 mm) dial thermometers.

2.12 STATIC PRESSURE GAUGES

- .1 Manufacturer: Trerice
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Weiss.
 - .2 Winter.
 - .3 Taylor.
 - .4 Substitutions: Refer to Section 23 01 01.
- .3 3-1/2" (90 mm) diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- .4 Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- .5 Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4" (6 mm) diameter tubing.

2.13 ACCESS DOORS

- .1 Standard Universal Flush
 - .1 Material: Up to 16" x 16" (400x400) 16 Gauge mounting frame, over 16" x 16" (400x400) 14

- gauge door, 16 gauge mounting frame.
- .2 Hinge: Continuous, concealed.
- .3 Latch: Stainless steel screwdriver operated cam latch
- .4 Finish: Steel: 5-stage iron phosphate preparation with prime coat of white, Alkyd Baking Enamel or stainless steel type 304, No. 4 satin polish.
- .5 Manufacturers:
 - .1 Acudoor UF-500
 - .2 CEB
 - .3 MIFAB
 - .4 Cendrex Contour
- .2 Recessed Access Door
 - .1 Material: Steel or stainless steel, 22 gauge door, 22 gauge mounting frame. Door -recessed 5/8"
 - .2 Hinge: Continuous, concealed.
 - .3 Latch: Stainless steel screwdriver operated cam latch
 - .4 Finish: Satin coat steel
 - .5 Manufacturers:
 - .1 Acudoor UF-5015
 - .2 CEB
 - .3 MIFAB
 - .4 Cendrex Contour
- .3 Fire Rated
 - .1 Access doors in fire separations or fire rated assemblies: ULC labelled. Refer to Architectural drawings for ratings of fire separations and assemblies. Minimum 12 gauge.
 - .2 Hinge: Continuous, concealed.
 - .3 Latch: Stainless steel screwdriver operated cam latch
 - .4 Finish: Steel: 5-stage iron phosphate preparation with prime coat of white, Alkyd Baking Enamel or stainless steel type 304, No. 4 satin polish.
 - .5 Manufacturers:
 - .1 Acudoor
 - .2 CEB
 - .3 MIFAB
 - .4 Cendrex Contour

2.14 MOTOR CONSTRUCTION AND GENERAL REQUIREMENTS

- .1 Motors less than 0.33 HP (250 W), for intermittent service may be equipment manufacturer's standard and need not conform to these specifications.
- .2 Electrical Service:
 - .1 Motors 0.35 HP (0.38 kW) and Smaller: 115 volts, single phase, 60 Hz.
 - .2 Motors Larger than 0.35 HP (0.38 kW): 208 volts, three phase, 60 Hz.
- .3 Type:
 - .1 Open drip-proof except where noted otherwise.
 - .2 Design for continuous operation in 104°F (40°C) environment.
 - .3 Design for temperature rise to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - .4 Motors with frame sizes 254T and larger: NEMA premium efficiency.
- .4 Motors smaller than 0.5 HP (372 W): Provide continuously rated squirrel cage induction type with capacitor start, EEMAC `N' starting characteristics and a minimum of Class `A' insulation.
- .5 Motors 0.5 HP (372 W) and over: Provide continuously rated squirrel cage induction type with EMAC `B' starting characteristics and a minimum of Class `B' insulation.
- .6 Provide drip-proof type motors with a 1.15 service factor, unless specified or required otherwise by the motor location.
- .7 Provide fan cooled totally enclosed motors having a 1.0 service factor.
- .8 Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

- .9 Wiring Terminations:
 - .1 Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code, threaded for conduit.
 - .2 For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- .10 Provide motors within the 1-500 horsepower range of the "high efficiency" or "premium efficiency" as required under provincial regulations. Ensure this is indicated on the motor nameplate. Provide "T" frame (NEMA Specifications) motors approved under the Ontario Electrical Safety Code. If delivery of specified motor will delay delivery of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not occur until the specified motor is installed.
- .11 Coordinate with Division 26 the sizing of electrical protective devices supplying new and relocated mechanical equipment that contain integral motor starters and contactors.
- .12 Motor ratings rated in watts refer to output watts.
- .13 Provide constant speed motors with reduced voltage starters where specified.
- .14 Motors for use with variable frequency drives shall be rated for inverter duty. Motors for pumps and fans shall be rated for inverter duty whether or not VFD are included at this time.
- .15 Design BHP shall not exceed 80% of nominal motor HP.

2.15 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- .1 Starting Torque: Less than 150 percent of full load torque.
- .2 Starting Current: Up to seven times full load current.
- .3 Breakdown Torque: Approximately 200 percent of full load torque.
- .4 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- .5 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.16 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- .1 Starting Torque: Exceeding one fourth of full load torque.
- .2 Starting Current: Up to six times full load current.
- .3 Multiple Speed: Through tapped windings.
- .4 Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.17 SINGLE PHASE POWER - CAPACITOR START MOTORS

- .1 Starting Torque: Three times full load torque.
- .2 Starting Current: Less than five times full load current.
- .3 Pull-up Torque: Up to 350 percent of full load torque.
- .4 Breakdown Torque: Approximately 250 percent of full load torque.
- .5 Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- .6 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- .7 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.18 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- .1 Starting Torque: Between 1 and 1-1/2 times full load torque.
- .2 Starting Current: Six times full load current.
- .3 Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- .4 Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- .5 Insulation System: NEMA Class B or better.
- .6 Testing Procedure: To IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

- .7 Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- .8 Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.
- .9 Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt centre line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- .10 Sound Power Levels: To NEMA MG 1.
- .11 Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
- .12 Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- .13 Nominal Efficiency: As scheduled at full load and rated voltage when tested to IEEE 112.
- .14 Nominal Power Factor: As scheduled at full load and rated voltage when tested to IEEE 112.

2.19 SLEEVES

- .1 Materials: minimum schedule 20 galvanized steel or cast iron.

2.20 ESCUTCHEONS

- .1 Finish: Polished chrome

2.21 FLASHINGS AND COUNTERFLASHINGS

- .1 Thaler or equivalent mechanical/electrical flashings as recommended for specific purpose.
- .2 Stainless steel flashing sleeve, integral deck flange and EPDM seal.

2.22 PENETRATION SEALS

- .1 Manufacturer: Link-Seal
- .2 Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.

3 EXECUTION

3.1 INSPECTION

- .1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.
- .2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.
- .3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 PREPARATION

- .1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.
- .2 Services that are no longer required shall be removed or cut back and capped to the satisfaction of Consultant.
- .3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.
- .4 Where modifications or connections to existing systems require shutdown of the system the Contractor shall submit a request for system shutdown describing the system or part to be shutdown,

the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. The request shall be submitted in the format stipulated by the Owner.

- .5 All work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling shall be included in this Bid Price.

3.3 PIPING INSTALLATION - ABOVE GROUND

- .1 Cooperate with other trades whose work affects or is affected by work of this Section, to ensure satisfactory installation and to avoid delays. Provide all materials to be built-in such as sleeves, anchors, etc., together with accurate dimensions or templates, promptly.
- .2 Layout all work accurately, installing piping parallel to lines of building.
- .3 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap uninsulated piping in masonry walls with building paper.
- .4 Install concealed piping close to building structure to minimize furring dimensions.
- .5 Provide adequate space around piping to facilitate application of insulation.
- .6 Use dielectric couplings where piping of dissimilar metals connect.
- .7 Where piping passes through concrete floors, or walls, sleeves shall be sized to permit the pipe to expand freely without binding or crushing pipe insulation.
- .8 Where branch pipes are welded into main without the use of "T" connections, torch cut openings must be cut true, beveled and filed smooth. Branch pipes must not be allowed to project inside of main pipe. Openings must not be cut large enough to permit entry of welding metal and slag within the pipe.
- .9 Arrange all take-offs from mains to allow for expansion and contraction of pipes. Hot water branches serving downfeed risers must be taken from lower sides or bottom of mains and grade down slightly to risers. Branches which serve units above the mains shall be taken from the top or sides of mains.
- .10 Install automatic control valves and wells supplied under other Sections.

3.4 PIPING JOINTS

- .1 Make joints in piping installed under this Division using persons familiar with the particular materials being used and in accordance with CSA B51 and CSA B52, manufacturer's instructions, and as specified herein.
- .2 Use only welder and/or brazer operators, with a valid identification card, as issued under The Boiler and Pressure Vessels Act, to make joints in Registered Piping Systems, as indicated under Section 23 01 01, and 23 05 00.
- .3 Use 95/5 Sb.Sn (tin-antimony) solder for joining copper drainage tubing smaller than 4" (100 mm), and for joining copper water tubing installed above grade, and smaller than 4" (100 mm).
- .4 Use silver solder or Silfos for joining copper tubing 4" (100 mm) and larger in size.
- .5 Carefully ream joints in threaded pipe and paint with approved graphite type joint sealer on male connections only. Make connections with proper wrench to suit pipe size. Where leaks occur, the joint shall be disassembled and corrected if possible, or replaced. Over-tightening, caulking or peening will not be acceptable.
- .6 Make joints in cast iron pipe with standard M-J joints in accordance with manufacturer's recommendations and CSA B70.
- .7 Install unions or welding flanges at connections to valves, etc. to facilitate removal.
- .8 Use butt welding and/or schedule 40 carbon steel welding fittings to join sections of steel piping with welding ends.

3.5 WELDING

- .1 Welder's Qualifications
 - .1 Welding qualifications to be in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure to be performed from authority having jurisdiction.
 - .3 Furnish welder's qualifications to Consultant and Owner.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
- .2 Inspector's Qualifications: qualified to CSA W178.2
- .3 Welding Procedures
 - .1 Registration of welding procedures in Procedures accordance with CSA B51.

- .2 Copy of welding procedures to be available for inspection at all times.
- .3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA-W117.2.
- .4 Workmanship: Welding to be in accordance with ANSI/ASME B31.1 and B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, special procedures specified elsewhere in Division 15 applicable requirements of provincial authority having jurisdiction.
- .5 Installation Requirements:
 - .1 Identify each weld with welder's identification symbol.
 - .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
 - .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.
- .6 Inspection and Testing:
 - .1 Hydrostatically test all welds to requirements of ANSI/ASME B31.1.
 - .2 Review all weld quality requirements and defect limits of applicable codes and standards with Consultant before any work is started.
 - .3 Formulate "Inspection and Test Plan" in co-operation with Consultant.
 - .4 Do not conceal welds until they have been inspected, tested and approved by inspector.
 - .5 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Consultant, to ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .6 Visual examinations: include entire circumference of weld externally and wherever possible internally.
 - .7 Failure of visual examinations: on failure of any weld by visual examination, perform additional testing as directed by Consultant of a total of up to 25% of all welds, selected at random by Consultant, by particle tests.
 - .8 Inspect and test all welds in high pressure steam and high pressure condensate piping in accordance with "Inspection and Test Plan" by magnetic particle (hereinafter referred to as "particle") tests.
- .7 Defects Causing Rejection: as described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code, plus;
 - .1 Undercutting greater than 1/32" (0.8 mm) adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 1/32" (0.8 mm) adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 1/32" (0.8 mm) at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 1-1/2" (38 mm) 97% in any 6" (150 mm) length of weld depth of such defects being greater than 1/32" (0.8mm).
 - .5 Repair all cracks and defects in excess of 1/32" (0.8mm) in depth.
 - .6 Repair defects whose depth cannot be determined accurately on the basis of visual examination or particle tests.
- .8 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.6 FLUSHING AND CLEANING

- .1 Thoroughly flush all piping installed by this Division.
- .2 Remove, clean and replace all strainers in systems after flushing.
- .3 Thoroughly clean and lubricate HVAC equipment, and leave all items in perfect order ready for operation.

3.7 PIPING SYSTEMS TESTING AND INSPECTION

- .1 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.
- .2 Test all piping at the completion of roughing-in, before connecting to existing systems, and prior to concealment, insulation or covering of piping.
- .3 Make tests, that are required by any authority having jurisdiction, in the presence of the authority's

- authorized inspector and shall be certified by him.
- .4 Conduct tests in the presence of:
 - .1 Authorized inspector(s) for authorities having jurisdiction.
 - .2 The Commissioning Agent
 - .3 The Owner's Representative
 - .4 The Consultant
- .5 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.
- .6 Repair all leaks exposed during testing and retest. If defects in pipe or fittings are discovered in the system, they shall be removed and replaced.
- .7 Certify tests not required by authorities having jurisdiction.

3.8 EQUIPMENT TESTING AND INSPECTION

- .1 Test operation of equipment installed under this Division according to instructions in appropriate articles of this Division. Make any required adjustments or replacements to ensure equipment is operating as intended. Retest equipment requiring adjustment or replacement.
- .2 Pay all fuel consumption charges for equipment under testing and during commissioning.
- .3 Conduct tests before application of external insulation and before concealment of piping or ductwork.
- .4 Arrange and pay for inspections by authorities as required by code and complete any changes or alterations required by such inspections.
- .5 Conduct tests in the presence of:
 - .1 Authorized inspector(s) for authorities having jurisdiction.
 - .2 The Commissioning Agent.
 - .3 The Consultant.
 - .4 The Owner's Representative.
- .6 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

3.9 TESTING AND BALANCING

- .1 Allow sufficient time for testing and verification prior to substantial completion. Notify Testing and Balancing Agency on completion of adjusting and balancing of systems.
- .2 Adjust systems and components (drives, sheaves, belts, etc.) as required by Testing and Balancing Agency.
- .3 Maintain systems in full operation during testing and verification.
- .4 Make adjustments to control systems as required to facilitate verification. Maintain all safety controls in operation.
- .5 Check and correct alignment of V-belts, drive shaft coupling drives, etc. as required by Testing and Balancing Agency.
- .6 Provide pitot tube test fittings at all main branches of sheet metal work and at intake and discharge locations of air handling systems as required by Testing and Balancing Agency.

3.10 ELECTRICAL COMPONENTS AND WIRING

- .1 Conform to requirements of Division 26 for all wiring included in Division 23. Includes pre-wired equipment provided by Sections under Division 23.
- .2 Ensure that all pre-wired electrical equipment is CSA approved. Arrange and pay for special approval where this is not possible.
- .3 Coordinate all wiring requirements with other Divisions. Line voltage wiring from power distribution panels to starters and from starters to motors will be provided under Division 26. All the field wiring for equipment shall be included under Division 23, unless specifically called for under Division 25.

3.11 PROTECTION

- .1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.
- .2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such

- protection.
- .3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
 - .4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
 - .5 Temporary filters shall be removed on completion of the construction works.

3.12 CUTTING AND PATCHING

- .1 Include cutting and patching as required in execution of work under respective Sections of this Division.
- .2 Holes through the structure will not be permitted without written approval of the Consultant. Any and all openings required through the completed structure must be clearly and accurately shown on a copy of the relevant structural drawing(s). Exact locations, elevations and size of the proposed opening must be identified well in advance of the need for the work.
- .3 All sleeved or formed openings through the structure must be shown on sleeving drawings and must be approved by the Structural Consultant prior to construction.
- .4 The Contractor shall conduct exploratory work including x-ray of the existing structure, shall mark the location of embedded reinforcements, anchors, conduits and piping on exposed surfaces of adjacent floors and/or walls and shall pay all associated costs.
- .5 Reinforcing shall not be cut or modified without prior approval of the Structural Consultant. Should reinforcement be cut without such prior approval, the cost of any additional reinforcement deemed necessary by the Structural Consultant shall be the responsibility of this Contractor.
- .6 Alternative imaging techniques are subject to the approval of the Structural Consultant.
- .7 Ensure that cutting and patching of roofs and reinforced concrete structures is executed by specialists familiar with the materials affected, and is performed in a manner to neither damage nor endanger the work. Coordinate and supervise such cutting and patching.
- .8 Maintain the integrity of fire rated assemblies where they are pierced by ducts and pipes.
- .9 Make good surfaces affected by this work and repair finish to satisfaction of Consultant. Finish painting, where required, will be provided under Division 9.
- .10 Stop work immediately upon discovery of any hazardous material and report discovery to the Owner and Consultant. Obtain instruction prior to proceeding with the work.

3.13 SEALANTS & CAULKING

- .1 Fill voids around pipes:
 - .1 Where sleeves pass through non-fire rated walls or floors, caulk space between pipe and sleeve with fibreglass. Seal space at each end with waterproof, fire retardant, non-hardening mastic.
 - .2 Ensure no contact between copper tube or pipe and ferrous sleeve.
 - .3 Fill future-use sleeves with easily removable filler.
 - .4 Coat exposed exterior surfaces or ferrous sleeves with heavy application of zinc rich paint (VOC content not to exceed 250 g/L).
- .2 Temporarily plug all openings during construction.

3.14 FIRESTOPPING

- .1 All openings in fire separations and fire rated assemblies for service penetrations shall be protected with ULC listed service penetration firestop systems (SP).
- .2 The service penetration firestop system shall have F and FT ratings equal to or greater than ratings specified by the Architect for the fire separation (F) and firewall (FT) joint firestop systems (JF).
- .3 All components employed in the service penetration firestop system shall conform to the ULC listing.
- .4 Contractor shall prepare and submit a schedule of service penetration firestop systems to be employed indicating the ULC listing designation, services involved, location of opening through fire

- separation and the components of the fire separation assembly.
.5 Refer to architectural drawings for ratings of fire separations and assemblies.

3.15 SLEEVES AND CURBS

- .1 Provide pipe sleeves at points where pipes pass through masonry or concrete.
- .2 Provide sleeves of minimum schedule 20 galvanized steel or cast iron.
- .3 Use cast iron or steel pipe sleeves with annular fin continuously welded at midpoint:
 - .1 through foundation walls, with penetration seals.
 - .2 through floors of mechanical rooms and equipment rooms.
- .4 Provide 1/4" (6 mm) clearance all around, between sleeve and pipes or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry and 2" (50 mm) above floors. Not applicable to concrete floors on grade.
- .6 Provide watertight concrete curb 4" (100 mm) high around mechanical services (pipes, ducts, conduits) which rise through mechanical (service) room floors. Provide minimum 4" (100 mm) clearance between openings for services within curbs.
- .7 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction, caulk between sleeve recess and pipe, fasten roof flashing to clamp device, make water-tight durable joint. Co-ordinate with roofing Section.

3.16 FLASHINGS

- .1 Provide all flashing at each point where piping passes through the roof.
- .2 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.17 ESCUTCHEONS AND PLATES

- .1 Provide on pipes passing through finished walls, partitions, floors and ceilings.
- .2 Use chrome or nickel plated brass, solid type with set screws for ceiling or wall mounting.
- .3 Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve.
- .4 Where sleeve extends above finished floor, escutcheon or plates shall clear sleeve extension.
- .5 Secure to pipe or finished surface, but not insulation.

3.18 SUPPORT AND ATTACHMENT

- .1 Support and attach piping, ductwork fixtures and equipment from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes. Roof mounted mechanical equipment and services shall be anchored to the roof structure to resist both lateral and uplift wind forces in accordance with requirements of the Ontario Building Code.

3.19 PAINTING

- .1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.
- .2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

3.20 DISSIMILAR METALS

- .1 Separate dissimilar metals in order to prevent galvanic corrosion.
- .2 Provide gaskets or shims of approved materials to avoid electrolytic action.
- .3 Use dielectric unions and/or flanges where piping of dissimilar metals are connected.

3.21 EQUIPMENT BASES AND CURBS

- .1 Supply and erect structural work required for installation of mechanical equipment.

- .2 Build concrete bases 6" (150 mm) high, providing all necessary inserts, anchor bolts and other fasteners required, for floor mounted tanks, heaters, pumps, air handlers, boilers, etc. Make concrete bases 2" (50 mm) larger all around than the base of the supported equipment and trowel finish to a neat smooth finish. Anchor equipment to pads using 8" (200 mm) cast-in-place anchor bolts. Ensure concrete supplied under this Division is 2500 psi (17 MPa) compressive strength after 28 days.
- .3 Build 4" (100 mm) high concrete curbs around all openings through floors for ductwork. Make allowances for installation of ductwork and fire dampers where required. Ensure joint between curb and floor is watertight and maintains integrity of floor membrane where applicable.

3.22 BELT DRIVES AND SHEAVES

- .1 Provide belt driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate horsepower rating and in accordance with manufacturer's recommendations for type of service intended. Ensure belt drives are at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque of driver. Do not use single belt drives only for motors larger than two horsepower.
- .2 Provide motor sheaves for one and two belt drives of variable pitch type, with Dodge key adjustments. Supply two sets of fixed drive sheaves for drives with three or more belts. Install first set of fixed motor sheaves to obtain the originally specified rpm. After initial test and preliminary adjustment, supply and install the second set of fixed sheaves if necessary, to provide the design flow quantities as established on the job. Obtain correct total flow rate for fans through speed changes and not by throttling.
- .3 Provide adjustable sheaves on motor sizes up to 2 HP (1492 w) and fixed sheaves on larger motors.

3.23 GUARDS

- .1 Provide OSHA compliant guards for exposed drives as follows;
 - .1 Expanded metal screen (both sides) welded to 1" (25 mm) steel angle frame.
 - .2 18 ga. 1" (25 mm) thick galvanized sheet metal tops and bottoms.
 - .3 Removable sides for servicing.
 - .4 1-1/2" (40 mm) dia. holes on both shaft centers for insertion of tachometer.
- .2 Provide means to permit lubrication and use of test instruments with guards in place.
- .3 Install belt guards to permit movement of motors for adjusting belt tension.
- .4 For flexible couplings, provide removable, "U" shaped, 12 ga. 1/10" (2.7 mm) thick galvanized frame and 18 ga. 1/25" (1.2 mm) thick expanded mesh face.
- .5 Provide 3/4" (20 mm) galvanized mesh wire screen on inlet or outlet of exposed fan blades such that net free area to openings is not less than 1.25 of original openings.

3.24 FIELD QUALITY CONTROL

- .1 Systems Verification:
 - .1 Verify the correct installation and proper operation of equipment and systems installed. Adjust and balance each system as necessary to achieve optimum operation of each system.
 - .2 Co-operate with the TAB agency as follows:
 - .1 Provide assistance when and as requested,
 - .2 Co-ordinate completion of work systematically to permit orderly verification and adherence to schedules,
 - .3 Provide additional necessary flow balancing devices as directed by agency,
 - .4 Notify TAB Agency of tests being conducted.

3.25 ADJUST AND CLEAN

- .1 Clean equipment and fixtures, lubricate mechanical equipment installed under this Division and leave items in perfect order ready for operation.
- .2 Test and adjust control devices, instrumentation, relief valves, dampers, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.
- .3 Remove from the premises upon completion of work of this division, debris, surplus, and waste materials resulting from operations.

3.26 MECHANICAL IDENTIFICATION INSTALLATION

- .1 Degrease and clean surfaces to receive adhesive for identification materials.
- .2 Prepare surfaces for stencil painting.
- .3 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer (VOC content not to exceed 680 g/L).
- .4 Install tags with corrosion resistant chain.
- .5 Comply with standard detail drawing plate, "Detail of Piping Identification".
- .6 Apply stencil markings on all covered piping.
- .7 Install plastic tape pipe markers complete around bare pipe to manufacturer's instructions.
- .8 Label piping that is heat traced or equipped with heating cable "HEAT TRACED" in addition to other identification. Locate such labels adjacent to other identifications.
- .9 Clearly identify abandoned services left in place as "ABANDONED".
- .10 Identify pumps, water heating equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- .11 Identify control panels and major control components outside panels with plastic nameplates.
- .12 Identify valves in main and branch piping with tags. Consecutively number valves in each system.
- .13 Identify piping, concealed or exposed, with stenciled painting and plastic tape pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- .14 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-3/8" x 9" (60 x 230 mm), reading: **"WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED. IT MAY START AT ANY TIME."**
- .15 Provide colour coded self-adhesive dots to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.27 MECHANICAL IDENTIFICATION SCHEDULES

- .1 Consult the Owner and identify piping, ductwork and equipment as directed;
 - .1 Conforming to the Owner's existing identification practices, or
 - .2 Conforming to the following Pipe and Valve Identification Table:

SERVICE	COLOURS		LEGEND
	BACKGROUND	LETTERS	
Hot water heating supply	Yellow	Black	HEATING SUPPLY
Hot water heating return	Yellow	Black	HEATING RETURN
Make-up water	Yellow	Black	MAKE-UP WTR
Gas regulator vents	to Code		

3.28 MANUFACTURER'S NAMEPLATES

- .1 Provide metal nameplates on each piece of equipment, mechanically fastened with raised or recessed letters.
- .2 Include registration plates, Underwriters' Laboratories and CSA approval, as required by respective agency and as specified. Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors, all factory supplied.
- .3 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

3.29 FLOW DIAGRAMS AND DIRECTORIES

- .1 Provide Consultant with six identification flow diagrams of approved size for each system. Include tag

schedule, designating number, service, function, and location of each tagged item and normal operating position of valves.

- .2 Install where agreed with the Owner one copy of each flow diagram and valve schedule mounted in glazed frame. Provide one copy of each in Operation and Maintenance Manual.

3.30 INSTALLATION OF GAUGES AND THERMOMETERS

- .1 Install to manufacturer's instructions.
- .2 Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
- .3 Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- .4 Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide syphon on gauges in steam systems. Extend nipples and syphons to allow clearance from insulation.
- .5 Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-3/8" (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- .6 Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- .7 Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- .8 Locate test plugs adjacent thermometers and thermometer sockets.

3.31 INSTALLATION OF ACCESS DOORS

- .1 Supply access doors for access to equipment requiring service, lubrication or adjustment and all concealed valves, control and volume dampers, and other such equipment.
- .2 Turn over access doors to the appropriate general trade for installation under other Sections.
- .3 Refer to architectural drawings for ratings of fire separations and assemblies. install fire rated access doors in fire rated partitions, walls, and ceilings.
- .4 Access doors in ceilings shall be minimum 24" x 24" (600mm x 600mm), unless otherwise approved by the Consultant.
- .5 Provide concealed access doors in GWB ceilings and coordinate in-fill with general trades.

3.32 MOTOR APPLICATIONS

- .1 Single phase motors for shaft mounted fans: Split phase type.
- .2 Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
- .3 Single phase motors for fans: Capacitor start type.
- .4 Single phase motors for fans: Capacitor start, capacitor run type.
- .5 Motors located in exterior locations: Totally enclosed type.
- .6 Motors located in outdoors: Totally enclosed weatherproof epoxy-treated type.
- .7 Motors located in outdoors: Totally enclosed weatherproof epoxy-sealed type.

3.33 INSTALLATION OF MOTORS

- .1 Install motors to manufacturer's instructions.
- .2 Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- .3 Check line voltage and phase and ensure agreement with nameplate.

3.34 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	kW	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6 - 1/3	0.12-0.25	1.35	1.35	1.35	1.35
1/2	0.38	1.25	1.25	1.25	1.15
3/4	0.5	1.25	1.25	1.15	1.15
1	0.75	1.25	1.15	1.15	1.15

1/6 - 150	0.1-111	1.15	1.15	1.15	1.15
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3.35 PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, OPEN DRIP-PROOF

3 PHASE, ODP					
HP	KW	RPM(Syn)	NEMA Frame	Minimum Efficiency %	Minimum Power Factor %
1	0.75	1200	145T	81	72
1-1/2	1.1	1200	182T	83	73
2	1.5	1200	184T	85	75
3	2.25	1200	213T	86	60
5	3.7	1200	215T	87	65
7-1/2	5.6	1200	254T	89	73
10	7.5	1200	256T	89	74
15	11	1200	284T	90	77
20	15	1200	286T	90	78
25	18	1200	324T	91	74
30	22.5	1200	326T	91	78
40	30	1200	364T	93	77
50	37	1200	365T	93	79
60	45	1200	404T	93	82
75	56	1200	405T	93	80
100	75	1200	444T	93	80
125	93	1200	444T	93	84

3 PHASE, ODP					
HP	KW	RPM(Syn)	NEMA Frame	Minimum Efficiency %	Minimum Power Factor %
1	0.75	1800	143T	82	84
1-1/2	1.1	1800	145T	84	85
2	1.5	1800	145T	84	85
3	2.25	1800	182T	86	86
5	3.7	1800	184T	87	87
7-1/2	5.6	1800	213T	88	86
10	7.5	1800	215T	89	85

15	11	1800	256T	91	85
20	15	1800	256T	91	86
25	18	1800	284T	91	85
30	22.5	1800	286T	92	88
40	30	1800	324T	92	83
50	37	1800	326T	93	85
60	45	1800	364T	93	88
75	56	1800	365T	93	88
100	75	1800	404T	93	83
125	93	1800	405T	93	86
150	112	1800	444T	93	85
200	150	1800	445T	94	85

3 PHASE, ODP					
HP	KW	RPM(Syn)	NEMA Frame	Minimum Efficiency %	Minimum Power Factor %
1-1/2	1.1	3600	143T	82	85
2	1.5	3600	145T	82	87
3	2.25	3600	145T	84	85
5	3.7	3600	182T	85	86
7-1/2	5.6	3600	184T	86	88
10	7.5	3600	213T	87	86
15	11	3600	215T	89	89
20	15	3600	254T	90	89
25	18	3600	256T	90	92
30	22.5	3600	284T	91	91
40	30	3600	286T	92	92
50	37	3600	324T	93	89
60	45	3600	326T	93	91
75	56	3600	364T	93	88
100	75	3600	365T	92	88

3.36 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

3 PHASE, TEFC					
HP	KW	RPM(Syn)	NEMA Frame	Minimum Efficiency %	Minimum Power Factor %
1	0.75	1200	145T	81	72
1-1/2	1.1	1200	182T	83	73
2	1.5	1200	184T	85	75
3	2.25	1200	213T	86	60
5	3.7	1200	215T	87	65
7-1/2	5.6	1200	254T	89	73
10	7.5	1200	256T	89	74
15	11	1200	284T	90	77
20	15	1200	286T	90	78
25	18	1200	324T	91	74
30	22.5	1200	326T	91	78
40	30	1200	364T	93	77
50	37	1200	365T	93	79
60	45	1200	404T	93	82
75	56	1200	405T	93	80
100	75	1200	444T	93	80
125	93	1200	444T	93	84

3 PHASE, TEFC					
HP	KW	RPM(Syn)	NEMA Frame	Minimum Efficiency %	Minimum Power Factor %
1	0.75	1800	143T	82	84
1-1/2	1.1	1800	145T	84	85
2	1.5	1800	145T	84	85
3	2.25	1800	182T	86	86
5	3.7	1800	184T	87	87
7-1/2	5.6	1800	213T	88	86
10	7.5	1800	215T	89	85
15	11	1800	256T	91	85
20	15	1800	256T	91	86

25	18	1800	284T	91	85
30	22.5	1800	286T	92	88
40	30	1800	324T	92	83
50	37	1800	326T	93	85
60	45	1800	364T	93	88
75	56	1800	365T	93	88
100	75	1800	404T	93	83
125	93	1800	405T	93	86
150	112	1800	444T	93	85
200	150	1800	445T	94	85

3 PHASE, TEFC					
HP	KW	RPM(Syn)	NEMA Frame	Minimum Efficiency %	Minimum Power Factor %
1-1/2	1.1	3600	143T	82	85
2	1.5	3600	145T	82	87
3	2.25	3600	145T	84	85
5	3.7	3600	182T	85	86
7-1/2	5.6	3600	184T	86	88
10	7.5	3600	213T	87	86
15	11	3600	215T	89	89
20	15	3600	254T	90	89
25	18	3600	256T	90	92
30	22.5	3600	284T	91	91
40	30	3600	286T	92	92
50	37	3600	324T	93	89
60	45	3600	326T	93	91
75	56	3600	364T	93	88
100	75	3600	365T	92	88

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Variable Frequency Drives.

1.3 SUBMITTALS

- .1 Section 23 01 01: Procedures for submittals.
- .2 Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- .3 Manufacturer's Installation Instructions: indicate setting, mechanical connections, lubrication, and wiring instructions.
- .4 Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.
- .5 The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
- .6 Harmonic filtering. The seller shall, with the aid of the buyer's electrical power single line diagram, providing the data required by IEEE-519, perform an analysis to initially demonstrate the supplied equipment will meet the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.
- .7 Operating and Maintenance manuals: Include instructions for safe operating procedures and maintenance requirements. Include complete assembly and wiring drawings.

1.4 QUALITY ASSURANCE

- .1 Manufacturer: Company specializing in manufacture of variable frequency drives for HVAC use, and their accessories, with minimum ten (10) years documented product development, testing, and manufacturing experience.
- .2 To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.
- .3 All optional features shall be functionally tested at the factory for proper operation.

1.5 REGULATORY REQUIREMENTS

- .1 Conform to Ontario Electrical Safety Code.
- .2 Provide certificate of compliance from authority having jurisdiction indicating approval of variable frequency drives.
- .3 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Transport, handle, store, and protect products.
- .2 Protect variable frequency drives stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering.

1.7 WARRANTY

- .1 Refer to Division 1 and Section 15010.
- .2 Provide extended coverage five year warranty for variable frequency drives.

2 PRODUCTS

2.1 MANUFACTURERS

- .1 Provide Danfoss VLT FC102 Variable Frequency Drives as per the specifications below and the schedules shown.
- .2 Acceptable alternates;
 - .1 ABB, ACH550
 - .2 Allan Bradley.
 - .3 Eaton Cutler Hammon
 - .4 Toshiba
 - .5 Emmerson
 - .6 Hitachi

2.2 VARIABLE FREQUENCY DRIVES

- .1 Furnish complete variable frequency VFDs as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure, The VFD's UL listing shall allow mounting in plenum or other air handling compartments.
- .2 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor de-rating.
- .3 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
- .4 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- .5 The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate CSA or C-UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel. Both VFD and option panel shall be manufactured in ISO 9001 certified facilities.
- .6 The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.
- .7 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- .8 The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without de-rating.
- .9 An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.
- .10 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.
- .11 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor

- from the load to run the test.
- .12 Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.
 - .13 VFD power components to be designed for 575VAC. Components designed for 480VAC are not acceptable.
 - .14 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
 - .15 VFD's operating motors not designed to meet Nema MG1 Part 31 should include Output Load reactors.

2.3 PROTECTIVE FEATURES

- .1 A minimum of Class 20 I2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.
- .2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over-voltage, under-voltage, VFD over-temperature and motor over-temperature. The VFD shall display all faults in plain English. Codes are not acceptable.
- .3 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal.
- .4 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
- .5 To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Motors shall have inverter rated insulation (1600V).
- .6 VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
- .7 VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
- .8 VFD shall catch a rotating motor operating forward or reverse up to full speed.
- .9 VFD shall be rated for 100,000 amp interrupting capacity (AIC).
- .10 VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
- .11 VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt VFDs, 539 V AC on 460 volt VFDs, and 701V AC on 575 volt VFDs.

2.4 INTERFACE FEATURES

- .1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.
- .2 The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.
- .3 The VFD shall provide digital manual speed control. Potentiometers are not acceptable.
- .4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet (3 m) away using standard 9-pin cable.
- .5 The keypads for all sizes of VFDs shall be identical and interchangeable.
- .6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
- .7 Display shall be programmable to display in 9 languages including English, Spanish and French.
- .8 The display shall have four lines, with 20 characters on three lines and eight large characters on one line.
- .9 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

- .10 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.
- .11 The VFD shall include a standard RS-485 communications port and capabilities to be connected at a future date to a Johnson Controls N2, Siemens FLN, or Lonworks. The connection shall be software selectable by the user.
- .12 As a minimum, the following points shall be controlled and/or accessible:
 - .1 VFD Start/Stop, Speed reference, Fault diagnostics, and Meter points as follows;
 - .2 Motor power in HP, Motor power in kW, Motor kW-hr, Motor current, Motor voltage, Hours run, Feedback signal #1, Feedback signal #2, DC link voltage, Thermal load on motor, and Thermal load on VFD, Heatsink temperature.
- .13 Four additional Form C 230 volt programmable relays shall be available for factory or field installation within the VFD.
- .14 Two set-point control interface (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
- .15 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- .16 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.
- .17 Sleep mode shall be provided to automatically stop the VFD when its speed drops below set "sleep" level for a specified time. The VFD shall automatically restart when the speed command exceeds the set "wake" level.
- .18 The sleep mode shall be functional in both follower mode and PID mode.
- .19 Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
- .20 The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and Motor Speed in engineering units per application (in GPM, CFM, etc.). VFD will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
- .21 The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application, and temperature (°F) for a cooling tower application.
- .22 VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
- .23 If the temperature of the VFD's heat sink rises to 176 °F (80 °C), the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
- .24 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
- .25 The VFD shall store in memory the last 10 faults and related operational data.
- .26 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- .27 Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
- .28 Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
- .29 Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24 V DC status indication.
- .30 Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.

2.5 ADJUSTMENTS

- .1 VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.
- .2 Sixteen preset speeds shall be provided.
- .3 Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.
- .4 Four current limit settings shall be provided.
- .5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit and inverter overload.
- .6 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
- .7 An automatic "on delay" may be selected from 0 to 120 seconds.

2.6 SERVICE CONDITIONS

- .1 Ambient temperature, 14° to 104°F (-10° to 40°C).
- .2 0 to 95% relative humidity, non-condensing.
- .3 Elevation to 3,300 feet (1006 m) without de-rating.
- .4 AC line voltage variation, -10 to +10% of nominal with full output.
- .5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

3 EXECUTION

3.1 START-UP SERVICE

- .1 The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.
- .2 Adjust and record minimum and maximum speeds to accommodate required design flows and flow variations.
- .3 Record internal overload settings on start-up form.

3.2 WARRANTY

- .1 The VFD shall be warranted by the manufacturer for a period of 5 years from date of Substantial Performance.
- .2 The warranty shall include parts, labour, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service.

3.3 EXAMINATION

- .1 Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.
- .2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Pipe and equipment hangers and supports.
- .2 Equipment bases and supports.
- .3 Sleeves and seals.
- .4 Flashing and sealing equipment and pipe stacks.

1.3 REFERENCES

- .1 ASME B31.1 - Power Piping.
- .2 ASME B31.2 - Fuel Gas Piping.
- .3 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- .4 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- .5 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- .6 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SUBMITTALS

- .1 Section 23 01 01: Procedures for submittals.
- .2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- .3 Product Data: Provide manufacturers catalogue data including load capacity.
- .4 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- .5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

- .1 Conform to CSA B-51 for support of piping.

2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- .1 Manufacturers:
 - .1 Anvil
 - .2 Myat
 - .3 Copper B-Line
 - .4 Unistrut
 - .5 Erico
- .2 Hydronic Piping:
 - .1 Conform to CSA B-51 and ASME B31.9.
 - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
 - .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
 - .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
 - .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
 - .6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
 - .8 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.
 - .9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 - .10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought

- steel clamp with adjustable steel yoke and cast iron roll.
- .11 Vertical Support: Steel riser clamp.
- .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

- .1 Hanger Rods: galvanized, carbon steel continuous threaded.
- .2 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 EQUIPMENT ROOF CURBS

- .1 Fabrication: Welded 0.05" (1.2 mm) galvanized steel shell and base, mitred 3" (75 mm) cant, variable step to match roof insulation, factory installed wood nailer.

3 EXECUTION

3.1 INSTALLATION

- .1 Install to manufacturer's instructions and best trade practises.

3.2 INSERTS

- .1 Provide inserts for placement in concrete formwork.
- .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
- .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.3 PIPE HANGERS AND SUPPORTS

- .1 Support horizontal piping as scheduled.
- .2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
- .3 Place hangers within 12" (300 mm) of each horizontal elbow.
- .4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.
- .5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
- .6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .7 Support riser piping independently of connected horizontal piping.
- .8 Provide copper plated hangers and supports for copper piping.
- .9 Design hangers for pipe movement without disengagement of supported pipe.
- .10 Prime coat exposed steel hangers and supports. Refer to Section 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

- .1 Provide housekeeping pads of concrete, minimum 4" (100 mm) thick and extending 6" (150 mm) beyond supported equipment. Refer to Section 03.

- .2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- .3 Construct supports of steel members. Steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- .4 Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 FLASHING

- .1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- .2 Flash vent and soil pipes projecting 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
- .3 Flash floor drains in floors with topping over finished areas with lead, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.
- .4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.
- .5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.
- .6 Provide curbs for mechanical roof installations 14" (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- .7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 SLEEVES

- .1 Set sleeves in position in formwork. Provide reinforcing around sleeves.
- .2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- .3 Extend sleeves through floors 1" (25 mm) above finished floor level. Caulk sleeves.
- .4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- .5 Install chrome plated steel escutcheons at finished surfaces.

3.7 SCHEDULES

- .1 Imperial Measure (IP)

Pipe Size (in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
3/4	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10
4	5/8	14	12

.2 Metric Measure (SI)

Pipe Size (mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe	Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3
100	16	4.2	3.6

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Vibration control of piping, ductwork and equipment.
- .2 Inertia bases.
- .3 Coordination with Section 23 05 30 Supports and Anchors

1.3 REFERENCES

- .1 Ontario Building Code.
- .2 SMACNA "HVAC Duct Construction Standards"

1.4 PERFORMANCE REQUIREMENTS

- .1 Provide vibration isolation on motor driven equipment over (1/2 HP), plus connected piping and ductwork.
- .2 Provide minimum static deflection of isolators for equipment as indicated.
 - .1 Basement, Under 15 kW
 - .1 Under 400 rpm: RIS
 - .2 400 - 600 rpm: 1" (25 mm)
 - .3 600 - 800 rpm: 1/2" (12 mm)
 - .4 800 - 900 rpm: 1/4" (5 mm)
 - .5 1100 - 1500 rpm: 1/8" (4 mm)
 - .6 Over 1500 rpm: 1/8" (3 mm)

1.5 SUBMITTALS

- .1 Shop Drawings: Indicate and locate vibration isolators, with static and dynamic load on each.
- .2 Product Data: Provide schedule of vibration isolator type with location and load on each.
- .3 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
- .4 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

2 PRODUCTS

2.1 MANUFACTURERS

- .1 Manufacturer shall be a member of VISCMA.
- .2 Coordinate selection of Manufacturer with Section.
- .3 Acceptable manufacturers;
 - .1 Kinetics Vibron
 - .2 Vibro Acoustics
 - .3 The VMC Group (Korfund-Masdom)

2.2 VIBRATION ISOLATORS

- .1 Isolators and bases shall be as tabulated on the equipment schedule.
- .2 Type 1 Isolators: Model KIP Precompressed Molded Fiberglass Noise and Vibration Isolation Pads, individually coated with a flexible moisture-impervious elastomeric membrane. Pads shall be fine (0.00027"/6.9 micron diameter) bonded annealed glass fibers which have been stabilized during manufacture by compressing the material ten times. Pads shall have a constant natural frequency over the operating load range, and the stiffness shall increase proportionately with load applied. Pads shall be no taller than the shortest horizontal dimension. Where the equipment base does not provide a uniform load surface, steel plates shall be bonded to the top of the pads. Alternatively, Model RD

Neoprene Mounts, incorporating completely enclosed metal inserts to permit bolting to the supported unit, may be used.

- .3 Piping: All piping 1 in. (25 mm) diameter and over in the mechanical equipment room, and all piping three supports away from other mechanical equipment shall be isolated from the structure by means of vibration and noise control isolators. Suspended piping shall be isolated with Type 2 Hangers as described above. Floor-mounted piping shall be isolated with Type 2 Spring Isolators as described above.

3 EXECUTION

3.1 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Install isolation for motor driven equipment.
- .3 Install spring hangers without binding.
- .4 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- .5 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- .6 Support piping connections to isolated equipment resiliently as follows:
 - .1 Up to 4" (100 mm) Diameter: First three points of support.
 - .2 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.
- .7 Connect wiring to isolated equipment with flexible hanging loop.

3.2 VIBRATION ISOLATOR SELECTIONS

- .1 Based on Kinetics Selection Guide. Copied with permission.
- .2 Notes to Selection Guide
 - .1 Provide Type 5 or 6 base if required to support equipment properly.
 - .2 Isolator natural frequency to be 40% of the lowest equipment operating speed.
- .3 Kinetics Products Meeting Selection Guide
 - .1 Type 1
 - Fiberglass Isolation Pad, Model KIP
 - Fiberglass Isolation Mount, Model AC
 - Elastomer Isolation Pad, Model NG
 - Machinery Mount, Model KLM
 - Vibration Isolation Mount, Model RD
 - Isolation Hanger, Model RH
 - .2 Type 4
 - No Base Required
 - .3 Type 5
 - Structural Rail Base, Model SBB
 - .4 Type 6
 - Integral Structural Beam Base, Model SFB

EQUIPMENT ITEM				GRADE SUPPORTED SLAB			
Taken from Kinetics Selection Guide		Horsepower and Other (Shaft Power, kW and Other)	RPM	BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	REFERENCE NOTES
PUMPS	Close Coupled	up to 7.5 (5.6)	All	5/6*	1	0.25 (6)	5, 7
BOILERS	All	All	All	4	1	0.25 (6)	1, 3

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Testing, adjustment, and balancing of equipment.

1.3 REFERENCES

- .1 Ontario Building Code.
- .2 AABC - National Standards for Total System Balance.
- .3 SMACNA - HVAC Systems Testing, Adjusting, and Balancing.
- .4 SMACNA HVAC Systems Commissioning Manual,

1.4 SUBMITTALS

- .1 Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- .2 Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- .3 Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
- .4 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Consultant and for inclusion in operating and maintenance manuals.
- .5 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side.
- .6 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
- .7 Test Reports: Indicate data on AABC National Standards for Total System Balance forms. Submit data based on Project designation IP imperial/SI Metric Units.
- .8 All reports shall be prepared in electronic (computer) format using MS Word software and all tabulations shall be prepared in electronic (computer) format using MS Excel spreadsheet software. Submittals shall include three (3) copies each of hard copy printout and two (2) copies with text in ".pdf" and tabulations in ".xls" or ".xlsx" formats on CD, DVD, or USB flash drive.

1.5 PROJECT RECORD DOCUMENTS

- .1 Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- .2 Record actual locations of flow measuring stations.

1.6 QUALITY ASSURANCE

- .1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance.
- .2 Maintain one copy of each document on site.

1.7 INDEPENDENT AGENCY

- .1 All work of Mechanical Testing, Adjusting and Balancing shall be undertaken by a single agency, employed under Division 23. Other agencies may be proposed as an Alternate only, in accordance with Section 23 01 01, paragraph
- .2 The work of the agency consists of the furnishing of all labour, materials, equipment and accessories necessary in the testing, verification and documentation of the operational performance of all equipment and systems installed under the Sections of Division 23: Mechanical.

1.8 QUALIFICATIONS

- .1 Agency: Company specializing in the testing, adjusting, and balancing of systems under this Section with minimum five years documented experience certified by AABC or prequalified as listed below.
- .2 Work shall be performed under the supervision of an AABC certified Test and Balance Engineer, an NEBB Certified Testing, Adjusting and Balancing Supervisor or a registered Professional Engineer experienced in the performance of this work and licenced at the place where the Project is located.
- .3 Prequalified agencies include;
 - .1 (GTA, Hamilton & Niagara)
 - .1 National Air Balancing
 - .2 Clark Balancing Ltd.
 - .3 Dynamic Flow Balancing
 - .2 (Ottawa)
 - .1 Kanata Air Balancing Services Ltd.
 - .2 Arro Dynamics Inspecting
 - .3 (London)
 - .1 C.J. Zettler & Associates Ltd.
 - .2 D.J. Troupe & Associates
 - .3 Caltab
 - .4 (Kitchener - Waterloo)
 - .1 C.J. Zettler & Associates Ltd.
 - .2 Air Audit
 - .3 National Air Balancing
 - .4 Clark Balancing Ltd.
 - .5 (Windsor)
 - .1 Accu Air (Not recommended by Andy Pears)

1.9 PRE-BALANCING CONFERENCE

- .1 Convene one week prior to commencing work of this Section.

1.10 SEQUENCING

- .1 Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.11 SCHEDULING

- .1 Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

1.12 CO-OPERATION

- .1 Co-operate with installing Contractor(s) in advising them of specific scheduling requirements for systems verification.
- .2 Provide advice to installing Contractors regarding the location and installation of devices required to permit system balancing and measurements, prior to start of the installation work.
- .3 Coordinate verification of smoke control and automatic sprinkler systems with verification of fire alarm system under Division 26.

2 PRODUCTS

2.1 REFERENCE STANDARDS

- .1 All equipment required for the verification of equipment and systems shall be furnished by the agency employed to conduct the Mechanical Systems Verification.
- .2 Testing and measuring equipment used in the verification of the mechanical systems shall be calibrated to give true readings within the accuracy specifications of the equipment used. A certificate of calibration from an independent testing laboratory may be required by the Consultant if there is any reason to suspect that the equipment used is giving erroneous readings. In such an event the verification agency shall reconduct its verifications.

- .3 All equipment used by the agency in its verification of mechanical systems remains the property/responsibility of the agency and is not included in the supply to the project.

3 EXECUTION

3.1 EXAMINATION

- .1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - .1 Systems are started and operating in a safe and normal condition.
 - .2 Temperature control systems are installed complete and operable.
 - .3 Proper thermal overload protection is in place for electrical equipment.
 - .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - .5 Duct systems are clean of debris.
 - .6 Fans are rotating correctly.
 - .7 Fire and volume dampers are in place and open.
 - .8 Air coil fins are cleaned and combed.
 - .9 Access doors are closed and duct end caps are in place.
 - .10 Air outlets are installed and connected.
 - .11 Duct system leakage is minimized.
 - .12 Hydronic systems are flushed, filled, and vented.
 - .13 Pumps are rotating correctly.
 - .14 Proper strainer baskets are clean and in place.
 - .15 Service and balance valves are open.
- .2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- .3 Beginning of work represents acceptance of existing conditions in the areas served.

3.2 PREPARATION

- .1 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.
- .2 Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

- .1 Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- .2 Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.
- .3 Hydronic Systems: Adjust to within plus or minus 10 percent of design.
- .4 Room Pressurization: Adjust to within plus 20 percent and minus 0 percent of design for rooms under positive pressure and within plus 0 percent and minus 20 percent of design for rooms under negative pressure.

3.4 ADJUSTING

- .1 Ensure recorded data represents actual measured or observed conditions.
- .2 Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- .3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- .4 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- .5 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- .6 Check and adjust systems approximately six months after final acceptance and submit report.

3.5 WATER SYSTEM PROCEDURE

- .1 Adjust water systems to provide required or design quantities.
- .2 Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- .3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- .4 Effect system balance with automatic control valves fully open to heat transfer elements.
- .5 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- .6 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.6 SCHEDULES

- .1 Equipment requiring testing, adjusting and balancing:
 - .1 Plumbing Pumps
- .2 Report Forms
 - .1 Title Page:
 - .1 Name of Testing, Adjusting, and Balancing Agency
 - .2 Address of Testing, Adjusting, and Balancing Agency
 - .3 Telephone number of Testing, Adjusting, and Balancing Agency
 - .4 Project name
 - .5 Project location
 - .6 Project Architect
 - .7 Project Engineer
 - .8 Project Contractor
 - .9 Project altitude
 - .10 Report date
 - .2 Summary Comments:
 - .1 Design versus final performance
 - .2 Notable characteristics of system
 - .3 Description of systems operation sequence
 - .4 Summary of outdoor and exhaust flows to indicate amount of building pressurization
 - .5 Nomenclature used throughout report
 - .6 Test conditions
 - .3 Instrument List:
 - .1 Instrument
 - .2 Manufacturer
 - .3 Model number
 - .4 Serial number
 - .5 Range
 - .6 Calibration date
 - .4 Electric Motors:
 - .1 Manufacturer
 - .2 Model/Frame
 - .3 HP/BHP
 - .4 Phase, voltage, amperage; nameplate, actual, no load
 - .5 RPM
 - .6 Service factor
 - .7 Starter size, rating, heater elements
 - .8 Sheave Make/Size/Bore
 - .5 V-Belt Drive:
 - .1 Identification/location
 - .2 Required driven RPM

- .3 Driven sheave, diameter and RPM
- .4 Belt, size and quantity
- .5 Motor sheave diameter and RPM
- .6 Centre to centre distance, maximum, minimum, and actual
- .6 Pump Data:
 - .1 Identification/number
 - .2 Manufacturer
 - .3 Size/model
 - .4 Impeller
 - .5 Service
 - .6 Design flow rate, pressure drop, BHP
 - .7 Actual flow rate, pressure drop, BHP
 - .8 Discharge pressure
 - .9 Suction pressure
 - .10 Total operating head pressure
 - .11 Shut off, discharge and suction pressures
 - .12 Shut off, total head pressure

3.7 EQUIPMENT VERIFICATION

- .1 Test the operation of all equipment installed under Division 23 according to instructions in appropriate articles of this Division. Advise installing contractor of any required adjustments or replacements to ensure that equipment is operating as intended. Retest equipment after adjustment or replacement.
- .2 Ensure that the Contractor has given proper advance notification to all persons required to be present as tests are conducted.
- .3 Instrumentation: verify installation of air filter gauges, pumps, thermometers, thermometer wells, pitot traverse stations, and flow-measuring devices ensuring that:
 - .1 Location of points for readings is appropriate to measure what it is intended to measure;
 - .2 The scale range is appropriate to place the normal reading near mid-range of the scale;
 - .3 Proper positioning of instrumentation to allow reading from a convenient location, and for easy access.
- .4 Pre-start-up Inspection:
 - .1 Verify proper equipment mounting and setting.
 - .2 Verify that control, interlock, and power wiring are complete.
 - .3 Verify proper alignment of motors and drives.
 - .4 Verify proper piping connections and accessories.
 - .5 Verify that lubrication is complete.
- .5 First Run Observation:
 - .1 Verify direction of rotation.
 - .2 Verify setting of safety controls.
 - .3 Monitor heat build-up in bearings.
 - .4 Check motor loads against nameplate ratings.
- .6 Equipment Checkout:
 - .1 Verify the proper overload heater sizes.
 - .2 Verify function of safety and operating controls.
 - .3 Verify proper operation of equipment.
 - .4 Report on inspection, observation, and checkout procedures.
- .7 Stuffing Boxes and Packing Glands: verify adjustment of boxes on pump shafts and packing glands on valve stems.
- .8 Motor Rotation: visually inspect and verify the direction of motor rotation. It is possible for motor rotation to have been checked by the electrician when power connections were made on temporary electric power, then when final connections were made to the permanent transformer bank, crossed phasing may reverse the rotation of all three-phase motors on the system.
- .9 Overload Heaters: verify supply voltage to each equipment. If the applied voltage is different from the motor nameplate, determine whether the applied voltage is within the range allowed under the motor guarantee. If not, take the necessary action to have the Contractor change the motor or the applied voltage. When the voltage is off the nameplate value, but within the allowable range, compute the

equivalent amperage at nameplate voltage and compare to the overload heater amperage rating range. Then, consider whether the ambient temperature of the starter is above, below, or the same as the ambient temperature are not the same. Advise the Contractor to use overload heaters of higher range for "hot area" starters or ones of lower range for "cold area" starters to compensate the heater trip point for heat gains or losses with the environment.

- .10 Alignment of Drives: verify the alignment of drives, belt and direct coupled, and the adjustment of belt tension.
- .11 Control Diagrams and Sequences: provide for coordination with work under the automatic control systems to have the control diagrams and sequences of operation corrected to "as installed", reflecting changes brought about in response to contract modifications and to the more pragmatic changes in diagrams and sequences to make the installed system control the building systems as intended by the designer.
- .12 Safety and Operating Control Setpoints: systematically verify the safety and operating controls of equipment, including an operational check of associated control sequences.
- .13 Verify that manufacturer's start-up procedures have been performed and that equipment is installed in accordance with the manufacturer's written installation recommendations.
- .14 Where work is noted to be done in stages a complete air balance and verification report will be required at the end of each stage.

3.8 MODIFICATIONS TO EXISTING SYSTEMS

- .1 Where an existing air/water system is shown to be modified in any way, no work shall be done on it until the air/water flows in that system are measured and a report submitted to the Engineer. On completion of the modifications, the balancing report shall show the unaffected air/water flows in that system have been rebalanced to the original quantities. "Water" systems include glycol-water systems.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Equipment insulation.
- .2 Covering.

1.3 REFERENCES

- .1 ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- .2 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- .4 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
- .5 ASTM C240 - Testing Cellular Glass Insulation Block.
- .6 ASTM C449/C449M - Mineral Fibre Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .7 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
- .8 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- .9 ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- .10 ASTM C552 - Cellular Glass Thermal Insulation.
- .11 ASTM C553 - Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
- .12 ASTM C592 - Mineral Fibre Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- .13 ASTM C612 - Mineral Fibre Block and Board Thermal Insulation.
- .14 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- .15 ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- .16 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- .17 ASTM E96 - Water Vapour Transmission of Materials.
- .18 NAIMA National Insulation Standards.
- .19 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- .20 UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
- .21 CAN/CG5B-51.11 Mineral Fiber Thermal Insulation Blanket.
- .22 CAN/CG5B-51-GP-52 Ma Vapor Barrier, Jacket & Facing Material For Pipe Duct & Equipment Thermal Insulation.
- .23 CAN/CG5B-51-GP-53 M Jacketing, Polyvinyl Chloride Sheet for Insulating Pipes, Vessels of Round Ducts.

1.4 SUBMITTALS

- .1 Refer to Section 01 33 00 & 23 01 01.
- .2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.
- .3 Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Applicator Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

1.6 REGULATORY REQUIREMENTS

- .1 Materials: Flame spread/smoke developed rating of 25/50 to the requirements of the Ontario Building Code.

1.7 DELIVERY, STORAGE, AND PROTECTION

- .1 Transport, handle, store, and protect products.
- .2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- .3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- .2 Maintain temperature during and after installation for minimum period of 24 hours.

2 PRODUCTS

2.1 GLASS FIBRE, FLEXIBLE

- .1 Manufacturer: Owens Corning Fiberglas
- .2 Other acceptable manufacturers offering equivalent products:
 - .1 Manson
 - .2 Knauf Fiber Glass
 - .3 Johns Manville
- .3 Insulation: ASTM C553; flexible, noncombustible.
 - .1 'ksi' Value: ASTM C177 or ASTM C518, 0.035 at 75.2 °F (24 °C).
 - .2 Maximum Service Temperature: 250 °F (121 °C).
 - .3 Maximum Moisture Absorption: 0.2 percent by volume.
 - .4 Density: 2.4 lb/ft³ (38 kg/cu m).
- .4 Vapour Barrier Jacket:
 - .1 ASTM C921
 - .2 Moisture vapour transmission: ASTM E96; 0.02 perm.
 - .3 Secure with self-sealing longitudinal laps and butt strips.
 - .4 Secure with outward clinch expanding staples and vapour barrier mastic.
- .5 Tie Wire: 3/64" (1.22 mm) stainless steel with twisted ends on maximum 12" (300 mm) centres.
- .6 Vapour Barrier Lap Adhesive: Compatible with insulation, maximum VOC content of 80 g/L
- .7 Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool, maximum VOC content of 80 g/L.
- .8 Tape shall be of aluminum, self adhesive with minimum 2" (50 mm) width.

2.2 GLASS FIBRE, RIGID

- .1 Manufacturer: Owens Corning Fiberglas AF545
- .2 Other acceptable manufacturers offering equivalent products:
 - .1 Manson
 - .2 Knauf Fiber Glass
 - .3 Johns Manville
- .3 Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 - .1 'ksi' Value: ASTM C177 or ASTM C518, 0.035 at 75.2 °F (24 °C).
 - .2 Maximum Service Temperature: 450 °F (232 °C).
 - .3 Maximum Moisture Absorption: 0.1 percent by volume.
 - .4 Density: 16 kg/cu m.
- .4 Vapour Barrier Jacket:
 - .1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film.

- .2 Moisture vapour transmission: ASTM E96; 0.02 perm.
- .3 Secure with self-sealing longitudinal laps and butt strips.
- .4 Secure with outward clinch expanding staples and vapour barrier mastic.
- .5 Facing: 1" (25 mm) galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .6 Vapour Barrier Lap Adhesive: Compatible with insulation, maximum VOC content of 80 g/L.
- .7 Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool, maximum VOC content of 80 g/L.

2.3 PHENOLIC INSULATION

- .1 Manufacturers:
 - .1 Manufacturer: Resolco International by "Insul-Phen"
 - .2 Other Manufacturers: in accordance with 23 01 01.
- .2 Insulation: ASTM C-1126 Phenolic Foam Thermal Insulation, CFC and HCFC free, rigid moulded, noncombustible insulation fabricated in required shapes by Resolco International approved fabricators to ASTM C-450 and C-585.
 - .1 Density: 40-kg/m³ [2.5-lb/ft³]
 - .2 Temperature range: -290°F to +250°F (-129°C to +107°C)
 - .3 Closed cell content: 92%
 - .4 Compressive strength: 2 bar [29 psi]
 - .5 Thermal conductivity: 0.13 BTU-in/hr-ft²-°F (18.72 W-mm/m²-°C)
 - .6 Fire resistance rating: flame spread less than 25 and smoke developed less than 50 to ULC S102 and ASTM E84 on plain and faced product up to 3" (75 mm) thick
- .3 Joint Sealer:
 - .1 vapour barrier type, moisture and water resistant, 97% solids by weight, non-hardening, flexible in temperature range from -5°F to +200°F (-20.5°C to +93.3°C), Daxcel 161D, Fosters 30-45, Childers CP-76.
- .4 Vapour Barrier Mastic / Reinforcing:
 - .1 Vimasco Vapor-Block, Fosters 30-80, #749 or Childers' Chil-Perm #SP-35, or approved equal with the following minimum requirements:
 - .1 Wet Fammability: No flash to boiling
 - .2 Water Vapor Permeance: Maximum 0.08 US perms
 - .3 Average Non Volatile: 58% by volume
 - .4 Service Temperature Range: -20°F to +190°F (-29°C to 88°C)
 - .5 Application: Two Coats
 - .2 The membrane for reinforcement of vapor retardant mastic shall be 6 X 6 or 10 X 10 glass fiber reinforcing mesh, Chil Glas #5 made by Chilers or PC-79 Fabric, 5 X 6 mesh, by Pittsburgh Corning, or approved equal.
- .5 Vapour Barrier (Indoor Service)
 - .1 Vapor barrier for indoor service shall be ASJ All Service Jacket as manufactured by Compac Corp or Lamtec Corp as per the Resolco UL E84 test reports, constructed from 0.00035 inch thick aluminum foil laminated to 30lb. Kraft paper by flame retardant adhesive. The complete laminated product shall be reinforced with tri directional fiberglass yarn with yarn spacing of 5 per inch.
 - .2 Venture 1555U factory applied zero perm jacket system shall be used in areas of high humidity or where there is a risk of mould/mildew growth.
 - .3 In areas of heavy mechanical abuse or high pressure wash down areas use product for Outdoor Service.
- .6 Fabrication Adhesive
 - .1 Fabrication adhesive for Insul-Phen shall be H.B. Fuller's SC-1454, a contact adhesive or H.B. Fuller's HL-2278, hot melt adhesive, or approved equal.
- .7 Pipe and Hanger Supports
 - .1 Pipe support load bearing insulation shall be fabricated by a Resolco approved fabricator from Resolco CFC & HCFC free heavy density Insul-Phen in 3.75lb/ft³ density in accordance with the table in attachment 1. The upper 1870° section of the support can be fabricated from standard 2.5lb./ft³ density Insul-Phen and 2.5lb./ft³ can be used at the support point up to a certain pipe diameters (contact your local Resolco fabricator or technical rep) with a 12" (300

- mm) long saddle.
- .2 The pipe support insulation shall be supported by a saddle. Stainless steel saddles shall be used where edible food or open product is exposed. For all other applications it is acceptable to use painted, galvanized or carbon steel.
- .8 PVC Cladding (Indoor Use only)
- .1 The jacketing to provide protection to insulation and vapor barrier shall be 0.030 inch thick Ceel-Co 300 Series UVR PVC Jacketing or Proto LoSmoke 25/50 UVR PVC. Jacketing shall be tough all purpose, UV resistant capable of enduring frequent washing with hot water or other cleaning agents. All joints of PVC jacket shall be solvent welded with Ceeltite or Proto PVC Adhesive. As an alternative a high density (3.75lb) phenolic along with 0.020 PVC jacket can be used.
 - .2 Ceel-Co 300 Series or Proto LoSmoke UVR PVC Jacket .040 inch, or a double wrap of .030 inch thick shall be used where protection from mechanical abuse or high pressure washing is required.
 - .3 A stainless steel diamond-mesh expanded metal lath cage shall be installed with spacers a minimum of 1" (25 mm) away from and over top of the pipe and insulation sealed with PVC Jacket in areas where it is possible for knives, etc. to damage jacket system.
 - .4 In food preparation/hygenic areas cladding must withstand scalding water washdowns; wherever a higher temperature material is required: Proto EXOD (R), a CPVC material, light grey and is rated to +225°F (107.2°C). EXOD (R) shall be ordered "cut and precurled" for pipe insulation jacket.
- .9 Fastening Accessories
- .1 Tape for fastening plain pipe covering insulation shall be 3/4 inch Fiberglass reinforced strapping tape made by National Tape Co. or approved equal.
 - .2 Stainless steel type T304/T316 or .020 aluminum strapping for fastening aluminum jacketing outdoors and outer layer of vessel and/or large diameter (above 16 inches O.D.) pipe insulation shall be 1/2 inch X .020 inch thick with stainless steel or aluminum wing seals made by RPR Products, Childers Products or approved equal. RPR no. 7 or breather spring 4 inches long made from stainless steel type T305 shall be used for securing large diameter vessels metal jacketing.
 - .3 Polypropylene 1/2" (15 mm) wide, 1/2" (15 mm) thick banding and clips, Q-Band/Q-Clip made by Band-It Inc. shall be used for securing PVC jacketing indoors. The banding shall not be used in food processing areas where bacterial growth is anticipated. Banding may be used for temporary securement until PVC joint adhesive cures. The PVC Jacketing must be complete sealed at all joints to prevent entry of water or moisture. In non food processing areas PVC jacketing should be glued using manufacturers adhesive.
- .10 Inspection Plugs
- .1 NDT Inspection plugs made from EPDM and aluminum metal cap as manufactured by Parker Special Products shall be installed on pipe and equipment requiring frequent inspections. Use 1-1/2" (40 mm) NDT plug for pipe and equipment insulation jacket OD of less than 9" (225 mm). Use 2-1/2" (65 mm) and 3" (75 mm) NDT plug for pipe and equipment between 9" (225 mm) and 24" (600 mm) insulation jacket OD. Use 5" (125 mm) NDT plug for pipe and equipment insulation jacket OD above 24" (600 mm).
- .11 Expansion/Contraction Joints
- .1 Expansion/contraction joint material shall be 1lb/ft³ density fiberglass blanket.

2.4 ELASTOMERIC INSULATION

- .1 Acceptable Manufacturers:
 - .1 Armacell APArmaflex, APArmaflex W, APArmaflex SS, or APArmaflex SA.
- .2 Insulation material shall be a flexible, closed-cell elastomeric insulation in tubular or sheet form to ASTM C 534, "Specification for preformed elastomeric cellular thermal insulation in sheet and tubular form."
- .3 Insulation materials shall have a closed-cell structure to prevent moisture from wicking.
- .4 Insulation material shall be manufactured without the use of CFC's, HFC's or HCFC's, formaldehyde free, low VOC's, fiber free, dust free and shall resist mold and mildew.
- .5 Materials shall have a flame spread index of less than 25 and a smoke-developed index of less than

50 when tested in accordance with ULC S102, ASTM E 84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.

- .6 Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft²- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
- .7 Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A, latest revision.
- .8 The material shall be manufactured under an independent third party supervision testing program covering the properties of fire performance, thermal conductivity and water vapor transmission.
- .9 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 23 05 00 Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.

2.5 CELLULAR GLASS

- .1 Manufacturer: Pittsburgh Corning FOAMGLAS.
- .2 Insulation: ASTM C552 "Standard Specification for Cellular Glass Thermal Insulation",
 - .1 'k' Value: 0.039 at 24 degrees C.
 - .2 Maximum Service Temperature: 482 degrees C.
 - .3 Maximum Water Vapour Transmission: 0.1 perm.
 - .4 Maximum Moisture Absorption: ASTM C240, 0.2% by volume.
 - .5 Density: 128 kg/cu m.
- .3 FOAMGLAS® pipe insulation shall be fabricated according to the requirements of ASTM C1639 "Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation".

2.6 HYDROUS CALCIUM SILICATE

- .1 Manufacturers:
 - .1 Industrial Insulation Group Model Thermo-12
- .2 Insulation: ASTM C533, Type 1; rigid, moulded, white, asbestos free, corrosion inhibiting.
 - .1 Thermal conductivity (k) value: ASTM C177, C335 and C518;

Mean Temperature °F	200	300	400	500	600	700
BTU-in/(Hr-Ft ² -F°)	0.41	0.45	0.5	0.55	0.6	0.65
Mean Temperature °C	93	149	204	260	316	371
W/(m-C°)	0.059	0.065	0.072	0.079	0.086	0.094

- .2 Maximum Service Temperature: 1200°F (649°C).
- .3 Density: 14.5 lb/ft³ (232 kg/m³) to ASTM C302
- .4 Flexural strength: 65 psi (448 kPa)
- .5 Compressive strength: >100 psi (690 kPa), 5% compression, to ASTM C165
- .6 Mould Growth: Does not support (ASTM C1338)
- .7 Surface burning characteristics: Flame spread:0, Smoke developed: 0. (ULC)
- .3 Tie Wire: stainless steel with twisted ends on 12" (300mm) centres maximum.
- .4 Insulating Cement: to ASTM C449 and Section 15100.2.2.

2.7 JACKETS

- .1 Canvas Jacket: UL listed.
 - .1 Fabric: ASTM C921, 220 g/sq m, plain weave cotton treated with dilute fire retardant lagging adhesive.
 - .2 Lagging Adhesive:
 - .1 Compatible with insulation.
- .2 PVC Jacket (Indoor):
 - .1 Jacket: ASTM C921, One piece sheet material.

- .1 Minimum Service Temperature: -31 °F (-35 °C).
- .2 Maximum Service Temperature: 150 °F (66 °C).
- .3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
- .4 Maximum Flame Spread: ASTM E84; 25 or less.
- .5 Maximum Smoke Developed: ASTM E84; 50 or less.
- .6 Thickness: 20 mil (0.4 mm) minimum.
- .2 Colour: standard off-white
- .3 Covering Adhesive Mastic
 - .1 Compatible with insulation, low VOC.
- .4 Manufacturer;
 - .1 Ceel-Co 300 series
 - .2 Speedline *Smoke Safe*

2.8 REMOVABLE / REUSABLE INSULATION COVERS

- .1 Material: Teflon coated, woven fibreglass fabric
- .2 Weight: 16.5 oz/sq.yd. (± 10%)
- .3 Thickness: 0.015" (± 10%)
- .4 Colour: Gray
- .5 Tensile Strength: 400 x 330 lb. (W x F)
- .6 Tarp Tear strength: 60 x 40 lb. (W x F)
- .7 Mullen Burst Pressure: 650 psi
- .8 Insulation thickness: Match connecting piping
- .9 Temperature Range: -67°F to 500°F
- .10 Lacing Hooks: Stainless Steel
- .11 Tie Wire: 16-ga stainless steel

2.9 ACCESSORIES

- .1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 23 05 00 Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.
- .2 Vapor retarder lap adhesive shall be water based, fire retardant
- .3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.
- .4 Tie wire shall be of 1/16" (1.5 mm) Ø stainless steel.
- .5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.
- .6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.
- .7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

3 EXECUTION

3.1 EXAMINATION

- .1 Verify that equipment has been tested before applying insulation materials.
- .2 Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- .1 Install equipment insulations to TIAC National Installation Standards.
- .2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
- .3 Do not insulate factory insulated equipment.
- .4 Exposed Equipment: Locate insulation and cover seams in least visible locations.
- .5 Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- .6 Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold

- equipment, use vapour barrier cement.
- .7 For hot equipment containing fluids 140°F (60°C) or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- .8 For hot equipment containing fluids over 140°F (60°C), insulate flanges and unions with removable sections and jackets.
- .9 Fibre glass insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapour barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- .10 Inserts and Shields:
 - .1 Application: Equipment 1-1/2 " (40 mm) diameter or larger.
 - .2 Shields: Galvanized steel between hangers and inserts.
 - .3 Insert location: Between support shield and equipment and under the finish jacket.
 - .4 Insert configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - .5 Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- .11 Finish insulation at supports, protrusions, and interruptions.
- .12 Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket.
- .13 Cover glass fibre insulation with metal mesh and finish with heavy coat of insulating cement.
- .14 Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- .15 Provide removable / reusable insulation covers for equipment, devices and fittings requiring access for maintenance, repair, or cleaning.

3.3 EQUIPMENT INSULATION

- .1 Insulate new or altered equipment and re-insulate existing equipment where insulation has been removed or damaged as follows:

Mineral Fiber Blanket - Hot Surfaces 68°F - 750°F	
Item	Thickness
Heating Glycol Pumps including Fittings & Accessories	2"
Expansion Tanks, Air Separators	2"
Heat Exchangers	2"
Any Other Equipment Operating at High Temp.	2"

Mineral Fiber Blanket - Hot Surfaces 20°C - 400°C	
Item	Thickness
Heating Glycol Pumps including Fittings & Accessories	50 mm
Expansion Tanks, Air Separators	50 mm
Heat Exchangers	50 mm
Any Other Equipment Operating at High Temp.	50 mm

- .2 Phenolic insulation may be used in place of rigid fibreglass equipment insulation, thickness to provide equivalent thermal resistance.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Piping insulation.
- .2 Jackets and accessories.

1.3 REFERENCES

- .1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- .3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
- .4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
- .5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.
- .6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
- .7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- .8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- .9 ASTM C547 - Mineral Fibre Pipe Insulation.
- .10 ASTM C552 - Cellular Glass Thermal Insulation.
- .11 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
- .12 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- .13 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.
- .14 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.
- .15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- .16 ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
- .17 ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
- .18 ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
- .19 ASTM E84 - Surface Burning Characteristics of Building Materials.
- .20 ASTM E96 - Water Vapour Transmission of Materials.
- .21 NFPA 255 - Surface Burning Characteristics of Building Materials.
- .22 UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- .1 Product Data: Provide product description, list of materials and thickness for each service, and locations.
- .2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- .1 Materials: Flame spread/smoke developed rating of 25/50 or less to ULC S102 and ASTM E84.

1.6 QUALIFICATIONS

- .1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Transport, handle, store, and protect products.

- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- .3 Store insulation in original wrapping and protect from weather and construction traffic.
- .4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- .2 Maintain temperature during and after installation for minimum period of 24 hours.

2 PRODUCTS

2.1 GLASS FIBRE

- .1 Manufacturers:
 - .1 Manufacturer: Owens Corning Fiberglas
- .2 Other acceptable manufacturers offering equivalent products:
 - .1 Manson
 - .2 Knauf Fiber Glass
 - .3 Johns Manville
- .3 Insulation: ASTM C547; rigid moulded, noncombustible.
 - .1 'ksi' value : ASTM C335, 0.035 at 75°F (24°C).
 - .2 Minimum Service Temperature: -20°F (-28.9°C).
 - .3 Maximum Service Temperature: 302°F (150°C).
 - .4 Maximum Moisture Absorption: 0.2 percent by volume.
- .4 Vapour Barrier Jacket
 - .1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.
 - .2 Moisture Vapour Transmission: ASTM E96; 0.02 perm.
 - .3 Secure with self sealing longitudinal laps and butt strips.
 - .4 Secure with outward clinch expanding staples and vapour barrier mastic.
- .5 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.
- .6 Vapour Barrier Lap Adhesive
 - .1 Compatible with insulation.
- .7 Insulating Cement/Mastic
 - .1 ASTM C195; hydraulic setting on mineral wool, VOC content not to exceed 80 g/L.
- .8 Fibrous Glass Fabric
 - .1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 - .2 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
- .9 Indoor Vapour Barrier Finish
 - .1 Vinyl emulsion type acrylic, compatible with insulation, white colour, VOC content not to exceed 250 g/L.
- .10 Insulating Cement
 - .1 ASTM C449, VOC content not to exceed 80 g/L.

2.2 PHENOLIC INSULATION

- .1 Manufacturers:
 - .1 Manufacturer: Resolco International by "Insul-Phen"
 - .2 Other Manufacturers: in accordance with 15010.2.3
- .2 Insulation: ASTM C-1126 Phenolic Foam Thermal Insulation, CFC and HCFC free, rigid moulded, noncombustible insulation fabricated in required shapes by Resolco International approved fabricators to ASTM C-450 and C-585.
 - .1 Density: 2.5-lb/ft³ (40-kg/m³)
 - .2 Temperature range: -290°F to +250°F (-129°C to +107°C)
 - .3 Closed cell content: 92%
 - .4 Compressive strength: 29 psi (2 bar)
 - .5 Thermal conductivity: 0.13 BTU-in/hr-ft²-°F (18.72 W-mm/m²-°C)

- .6 Fire resistance rating: 25/50 to ASTM E84 on plain and faced product up to 3" (75mm) thick
- .3 Joint Sealer:
 - .1 vapour barrier type, moisture and water resistant, 97% solids by weight, non-hardening, flexible in temperature range from -5°F to +200°F (-20.5°C to +93.3°C), Daxcel 161D, Fosters 30-45, Childers CP-76.

2.3 ELASTOMERIC INSULATION

- .1 Acceptable Manufacturers:
 - .1 Armacell APArmaflex, APArmaflex W, APArmaflex SS, or APArmaflex SA.
- .2 Insulation material shall be a flexible, closed-cell elastomeric insulation in tubular or sheet form to ASTM C 534, "Specification for preformed elastomeric cellular thermal insulation in sheet and tubular form."
- .3 Insulation materials shall have a closed-cell structure to prevent moisture from wicking.
- .4 Insulation material shall be manufactured without the use of CFC's, HFC's or HCFC's, formaldehyde free, low VOC's, fiber free, dust free and shall resist mold and mildew.
- .5 Materials shall have a flame spread index of less than 25 and a smoke-developed index of less than 50 when tested in accordance with ULC S102, ASTM E 84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.
- .6 Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft²- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
- .7 Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A, latest revision.
- .8 The material shall be manufactured under an independent third party supervision testing program covering the properties of fire performance, thermal conductivity and water vapor transmission.
- .9 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 23 05 00. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.

2.4 HYDROUS CALCIUM SILICATE

- .1 Manufacturers:
 - .1 Industrial Insulation Group Model Thermo-12
- .2 Insulation: ASTM C533, Type 1; rigid, moulded, white, asbestos free, corrosion inhibiting.
 - .1 Thermal conductivity (k) value: ASTM C177, C335 and C518;

Mean Temperature	°F	200	300	400	500	600	700
BTU-in/(Hr-Ft ² -F°)		0.41	0.45	0.5	0.55	0.6	0.65
Mean Temperature	°C	93	149	204	260	316	371
W/(m-C°)		0.059	0.065	0.072	0.079	0.086	0.094

- .2 Maximum Service Temperature: 1200°F (649°C).
- .3 Density: 14.5 lb/ft³ (232 kg/m³) to ASTM C302
- .4 Flexural strength: 65 psi (448 kPa)
- .5 Compressive strength: >100 psi (690 kPa), 5% compression, to ASTM C165
- .6 Mould Growth: Does not support (ASTM C1338)
- .7 Surface burning characteristics: Flame spread: 0, Smoke developed: 0. (ULC S102)
- .3 Tie Wire: stainless steel with twisted ends on 12" (300mm) centres maximum.
- .4 Insulating Cement: to ASTM C449.

2.5 JACKETS

- .1 PVC Plastic
 - .1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.

- .1 Minimum Service Temperature: -31°F (-35°C).
- .2 Maximum Service Temperature: 151°F (66°C).
- .3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
- .4 Maximum Flame Spread: ASTM E84; 25 or less.
- .5 Maximum Smoke Developed: ASTM E84; 50 or less.
- .6 Thickness: 20 mil (0.4 mm) minimum.
- .2 Colour: standard off-white OR coloured to suit pipe identification.
- .3 Covering Adhesive Mastic
 - .1 Compatible with insulation, maximum VOC content of 50 g/L.
- .4 Manufacturer;
 - .1 Ceel-Co 300 series
 - .2 Speedline Smoke Safe
- .2 Aluminum Jacket: ASTM B209.
 - .1 Thickness: 0.02" (0.40 mm) sheet.
 - .2 Finish: Smooth.
 - .3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
 - .4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.
 - .5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

2.6 REMOVABLE / REUSABLE INSULATION COVERS

- .1 Material: Teflon coated, woven fibreglass fabric
- .2 Weight: 16.5 oz/sq.yd. (± 10%)
- .3 Thickness: 0.015" (± 10%)
- .4 Colour: Gray
- .5 Tensile Strength: 400 x 330 lb. (W x F)
- .6 Tarp Tear strength: 60 x 40 lb. (W x F)
- .7 Mullen Burst Pressure: 650 psi
- .8 Insulation thickness: Match connecting piping
- .9 Temperature Range: -67°F to 500°F
- .10 Lacing Hooks: Stainless Steel
- .11 Tie Wire: 16-ga stainless steel

2.7 ACCESSORIES

- .1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 23 05 00. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.
- .2 Vapor retarder lap adhesive shall be water based, fire retardant
- .3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.
- .4 Tie wire shall be of 1/16" (1.5 mm) Ø stainless steel.
- .5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.
- .6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.
- .7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation

3 EXECUTION

3.1 EXAMINATION

- .1 Verify that piping has been tested before applying insulation materials.
- .2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- .1 Install piping insulations to TIAC National Installation Standards.
- .2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written

- instructions and as specified.
- .3 On exposed piping locate insulation and cover seams in least visible locations.
 - .4 For insulated pipes conveying fluids above ambient temperature:
 - .1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
 - .2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
 - .3 Finish with glass cloth and adhesive.
 - .4 PVC fitting covers may be used.
 - .5 For hot piping conveying fluids 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
 - .6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.
 - .5 Inserts and Shields:
 - .1 Application: Piping 1-1/2" (40 mm) diameter or larger.
 - .2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - .3 Insert Location: Between support shield and piping and under the finish jacket.
 - .4 Insert Configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - .5 Insert Material: hydrous calcium silicate insulation.
 - .6 Finish insulation at supports, protrusions, and interruptions.
 - .7 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement.
 - .8 Provide integral vapour barrier jacket on insulation on pipe and fittings for exterior applications.
 - .9 Provide PVC jacket and fitting covers for pipe in mechanical equipment rooms and where exposed in finished spaces.
 - .10 Provide aluminum jacket and fitting covers with seams located on bottom side of horizontal piping for exterior applications, in boiler rooms and where subject to temperatures > 200°F (93°C).
 - .11 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
 - .12 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 PIPE INSULATION

- .1 Insulate new or altered piping with rigid pipe insulation and re-insulate existing piping where insulation has been removed or damaged as follows:

RIGID PIPE INSULATION (I-P)			
Service	Operating Temperature Range °F	Pipe Diameter in.	Insulation Thickness in.
Hydronic heating (hot water & glycol/water)	105 to 140	4 and smaller	1
		5 and larger	1-1/2
	141 to 200	All sizes	1-1/2
FLEXIBLE INSULATION			
Service			Insulation Thickness
Horizontal storm and sanitary drainage			1"

RIGID PIPE INSULATION (SI)			
Service	Operating Temperature Range °C	Pipe Diameter (mm)	Insulation Thickness (mm)
Hydronic heating (hot water & glycol/water)	41 to 60	100 and smaller	25
		125 and larger	40
	61 to 93	All sizes	40
FLEXIBLE INSULATION			
Service			Insulation Thickness
Horizontal storm and sanitary drainage			25mm

- .2 Phenolic insulation may be used in place of rigid fibreglass pipe insulation, thickness to provide equivalent thermal resistance.
- .3 Insulate valves, flanges and pipe connections with removable / reusable insulation covers.
- .4 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.
- .5 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.
- .6 Insulate all fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.
- .7 Continue insulation through sleeves including specified finish.
- .8 Cut back covering on strainers and finish off to expose removable head insulation.
- .9 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.
- .10 Protect insulation with protection saddles where insulated pipe is supported by rollers.
- .11 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapourproof sealant.
- .12 Extend pipe insulation and covering through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. Protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.
- .13 Pack annular space between pipe sleeves and piping or pipe covering with glass fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or other ULC listed materials. Seal exposed insulation with mastic.
- .14 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers instructions.

3.4 REFRIGERATION PIPE INSULATION

- .1 Insulate all refrigerant suction and hot gas piping and fittings with flexible foamed plastic pipe insulation. Insulation shall fit pipe. Thickness shall be as follows: 1/2" (13 mm) thick for pipe 1" (25 mm) O.D. and smaller; 3/4" (20 mm) thick for pipe 1-1/8" (28 mm) to 2" (50 mm) O.D.; 1" (25 mm) thick for pipes 2-1/8" (54 mm) O.D. and larger.
- .2 Slip insulation on to tubing before tubing sections and fittings are assembled. Keep slitting of insulation to a very minimum. Seal all joints in the insulation with Armaflex 520 BLV. Insulate flexible pipe connectors.
- .3 On insulation exposed outside the building, place "slit" joint seams on bottom of pipe and provide two coats of grey Armaflex finish. Extend insulation through pipe support clamps. Provide a 6" (150 mm) long, 20 gauge (1.1 mm) galvanized steel sleeve around pipe insulation at each support.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Pipe and pipe fittings for:
 - .1 Heating water piping system.
 - .2 Glycol/water piping system.
 - .3 Equipment drains and overflows.
- .2 Valves:
 - .1 Gate valves.
 - .2 Globe or angle valves.
 - .3 Ball valves.
 - .4 Butterfly valves.
 - .5 Check valves.
 - .6 Circuit balancing valves
 - .7 Drain valves.

1.3 REFERENCES

- .1 ASME - Welding and Brazing Qualifications.
- .2 ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- .3 ASME B16.5 Pipe Flanges & Fittings.
- .4 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .5 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .6 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
- .7 ASME B31.1 - Code for Power Piping.
- .8 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .9 A183 Carbon Steel Track Bolts and Nuts.
- .10 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .11 ASTM B32 - Solder Metal.
- .12 ASTM B88 - Seamless Copper Water Tube.
- .13 ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- .14 ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- .15 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
- .16 ASTM D2310 - Machine-Made Fibreglass' (Glass Fibre-Reinforced Thermosetting Resin) Pipe.
- .17 ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- .18 ASTM D2467 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- .19 ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
- .20 ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- .21 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- .22 ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
- .23 ASTM D3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
- .24 ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- .25 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- .26 ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
- .27 ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.
- .28 AWS A5.8 - Filler Metals for Brazing and Braze Welding.
- .29 AWS D1.1 - Structural Welding Code - Steel.
- .30 AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
- .31 AWWA C110 - Ductile - Iron and Grey -Iron Fittings 3 inch - 48 inch (76 mm - 1219 mm), for Water and Other Liquids.

- .32 AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Pressure Pipe and Fittings.
- .33 AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
- .34 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
- .35 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- .36 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SUBMITTALS

- .1 Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- .2 Welders Certificate: Include welder's certification of compliance with ASME SEC 9.
- .3 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- .4 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.5 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.
- .3 Welders: Certify to ASME SEC 9.

1.6 REGULATORY REQUIREMENTS

- .1 Conform to ASME B31.1 code for installation of piping system.
- .2 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.
- .3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- .2 Provide temporary protective coating on cast iron and steel valves.
- .3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 EXTRA MATERIALS

- .1 Provide two repacking kits for each size and valve type.

2 PRODUCTS

2.1 VALVES - GENERAL

- .1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
- .2 Provide valves of the same manufacturer where possible.
- .3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
- .4 Valid CRN (Canadian Registration Number) required for each valve.
- .5 Materials:
 - .1 Bronze: ASTM B62 or B61 as applicable
 - .2 Brass: ASTM B283 C3770
 - .3 Cast Iron: ASTM A126 Class B
- .6 End Connections:
 - .1 Threaded ends: ANSI B1.20.1
 - .2 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
 - .3 Face-to-face dimensions: ANSI B16.10
- .7 Design and Testing:

- .1 Bronze Gate & Check valves: MSS-SP-80
- .2 Ball Valves: MSS-SP-110
- .3 Cast Iron Gate Valves: MSS-SP-70
- .4 Cast Iron Globe Valves: MSS-SP-85
- .5 Cast Iron Check: MSS-SP-71
- .6 Butterfly Valves: MSS-SP-67
- .8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products include:
 - .1 Kitz.
 - .2 Crane
 - .3 Conbraco.
 - .4 Nibco
 - .5 Jenkins

2.2 HYDRONIC SYSTEMS TO 150 PSIG, ABOVE GROUND

- .1 Nominal Operating Pressure 125 psig
- .2 Design Pressure 150 psig
- .3 Test Pressure 225 psig
- .4 Design Temperature 350°F
- .5 Corrosion Allowance 0.0625 in.
- .6 Steel Pipe ASTM A53 Gr.B ERW or ASTM A106 Gr.B SMLS, sch 40,
- .7 Joints, 2" and smaller screwed
- .8 Screwed Fittings 150 Lb. malleable iron
- .9 Unions Cl.150, ASTM A-47 malleable iron, ASTM A-153 galvanized, ANSI B2.1 threads.
- .10 Joints, 2-1/2" and larger welded, with flanges at connections to equipment
- .11 Butt weld fittings ASTM A234 Gr. WFB
- .12 Flanges ASTM A105, Class 150, raised face, weld neck or slip on
- .13 Bolts ASTM A307 C.S. bolts, sq. head; ASTM A563 nuts, hex head
- .14 Gaskets 1/16" (1.6 mm) thick preformed non-asbestos graphite fibre.
- .15 Copper Tubing, 2" and Smaller ASTM B88, Type L, hard drawn.
- .16 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220°C to 280°C.
- .17 Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper
- .18 Dielectric Unions Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- .19 Valves, 2" and smaller
 - Gate Valves (Isolating) ASTM A105
300 psig non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25
 - Globe Valves (Throttling) 300 psig non-shock WOG, ASTM B62 bronze body, composition (Teflon) disc, rising stem, bronze trim, threaded ends, Kitz #09
 - Check Valves (Backflow) 300 psig non-shock WOG, ASTM B62 bronze body, Y-pattern horizontal, swing type disc, threaded ends, Kitz #29
 - Ball Valves (Drain) 600 psig non-shock WOG, forged brass, 2-piece, chrome ball and stem, full port, blow-out proof PTFE seats & stem, lever handle, threaded ends, Kitz #68AC.
- .20 Valves, 2-1/2" and larger
 - Gate Valves (Isolating) ASTM A216 WCB
200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, solid wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #72.
 - Globe Valves (Throttling) 200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, bevelled wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #76.
 - Check (Backflow) 200 psig non-shock WOG, ASTM 126 Class B cast iron body, bolted cover, bronze mounted, swing type disc, flanged ends, Kitz #78

- .21 Provide stem extensions for insulated piping.
- .22 Provide gear operator and chain on valves installed above 10-ft AFF.
- .23 Strainers, 2" and smaller Class 250, 400 psig WOG, cast iron body, Y-pattern, screwed cap and ends, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 11M.
- .24 Strainers, 2-1/2" and larger Class 250 psig non-shock WOG, cast iron, Y-pattern, bolted flange cover, blow-out plug, A167 304 stainless steel screen with 1/32" perforations, flanged ends, Mueller Steam 752 .

2.3 EQUIPMENT DRAINS AND OVERFLOWS

- .1 Copper Tubing: ASTM B88, Type M and DWV, hard drawn.
 - .1 Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - .2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 4428°F to 536°F (220°C to 280°C).

2.4 CIRCUIT BALANCING VALVES

- .1 Circuit Balancing Valves; 2" (50 mm) and smaller
 - .1 Screwed connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy. Each valve shall be such that when installed in any direction, it will not affect flow measurement.
 - .2 Valves shall provide the following functions:
 - .1 Precise flow measurement.
 - .2 Precision flow balancing.
 - .3 Positive shut off with no drip seat and teflon disc.
 - .4 Drain connection with protective cap.
 - .3 Valves shall have four 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
 - .4 Valves shall be shipped in a 4.5 R factor polyurethane container that shall be used as insulation after valve in installed.
 - .5 Provide valves suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (121°C).
 - .6 Acceptable Products: S.A. Armstrong CRV I indicated or Tour & Anderson STA-D or Newman Hattersley.
- .2 Circuit Balancing Valves 2 1/2" (65 mm) and larger
 - .1 Flanged, line size connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy.
 - .2 Valves, shall provide the following functions:
 - .1 Precise flow measurement.
 - .2 Precision flow balancing.
 - .3 Positive shut off with no drip seat and teflon disc.
 - .3 Valves shall have twelve 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
 - .4 Valves shall be suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (120°C).
 - .5 Acceptable Products: S.A. Armstrong CBV II indicated or Tour & Anderson STA-F or Newman Hattersley.

3 EXECUTION

3.1 PREPARATION

- .1 Ream pipe and tube ends, remove burrs and bevel plain end ferrous pipe.
- .2 Remove scale and dirt on inside and outside before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

- .4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- .5 After completion, fill, clean, and treat systems.

3.2 APPLICATIONS

- .1 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, union, and couplings for servicing are consistently provided.
- .2 Install unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- .3 Provide non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- .4 Provide pipe hangers and supports to CSA B51 unless indicated otherwise.
- .5 Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- .6 Use globe valves for throttling, bypass, manual flow control services, for balancing & in bypass around control valves.
- .7 Use spring loaded check valves on discharge of condenser water pumps.
- .8 Use wafer check valves where required to suit space and or weight limitations
- .9 Use 3/4 inch (20 mm) gate or ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
- .10 Use lug end butterfly valves to isolate equipment.
- .11 Butterfly valves may be used isolation and throttling duty for large pipe sizes 2-1/2" (65 mm) and above.
- .12 Gasket material shall be Grade 'E' EPDM compound conforming of ASTM D2-2000 and suitable for an operating temperature range of -34°C to 110°C.
- .13 Small runouts, size 3/4" (20 mm) and less for extension of domestic make-up piping may be constructed using hand drawn copper tube type 'K' or "L" and comply to ASTM B88.

3.3 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Install heating water, glycol, piping to CSA B51.
- .3 Route piping in orderly manner, parallel to building structure, and maintain gradient.
- .4 Install piping to conserve building space, and not interfere with use of space.
- .5 Group piping whenever practical at common elevations.
- .6 Sleeve pipe passing through partitions, walls and floors.
- .7 Slope piping and arrange to drain at low points.
- .8 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .9 Inserts:
 - .1 Provide inserts for placement in concrete formwork.
 - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
 - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- .10 Pipe Hangers and Supports:
 - .1 Install to CSA B51.
 - .2 Support horizontal piping as scheduled.
 - .3 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
 - .4 Place hangers within 12" (300 mm) of each horizontal elbow.
 - .5 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - .6 Support vertical piping at every other floor. Support riser piping independently of connected

- horizontal piping.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Provide copper plated hangers and supports for copper piping.
- .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- .11 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- .12 Provide access where valves and fittings are not exposed.
- .13 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- .14 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (VOC content not to exceed 250 g/L) to welds.
- .15 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- .16 Install valves with stems upright or horizontal, not inverted.
- .17 Air vents shall be selected to suit the system operating pressures and shall be automatic and complete with isolating valves.
- .18 All strainers 1-1/2" (38mm) & larger shall be fitted with chain valves.
- .19 Unless specified otherwise, drain piping shall be sloped down in the direction of flow not less than 1" in 40 feet.
- .20 Eccentric reducers shall be provided to keep the bottom of sloped piping aligned in order to minimize risk of water hammer and to facilitate drainage.
- .21 Valves shall be installed with stems upright or angled 45 deg. above horizontal unless instructed otherwise.
- .22 Pipe all discharge from temperature & pressure safety relief valves to a point of safe discharge directly into a floor drain, hub drain or safe outdoor location.

3.4 EQUIPMENT CONNECTIONS

- .1 Install unions or flanges at connections to all equipment and specialty components.
- .2 Arrange piping connections to allow ease of access and removal of equipment.
- .3 Align and independently support piping adjacent to equipment connections in order to prevent piping stresses from being transferred to equipment.
- .4 Piping reducers shall be used where equipment connections differ from pipe sizes indicated. The use of bushings will not be permitted.
- .5 Install removable sections of pipe 12" (300 mm) spool pieces on the suction side of pumps and where needed for ease of maintenance.

3.5 VALVES, COCKS AND FAUCETS

- .1 Use valves of line size unless noted otherwise.
- .2 Provide isolating valves in each branch from the main line and where indicated.
- .3 Provide isolating valves at all equipment connections.
- .4 Provide globe valves or ball valves complete with memory stop at the discharge of each pump and where valves are used for regulating or throttling purposes.
- .5 Provide 1/2" (13 mm) brass hose bibbs at all low points of each system, where the system cannot be drained through the main floor or return piping.
- .6 Where new valves are installed to replace existing valves and it is impractical to shut-down and drain the entire system, valves shall be replaced using pipe freezing techniques.

3.6 HYDRONIC SPECIALTIES

- .1 Air Vents
 - .1 Provide 1" (25 mm) diameter air vent chamber at each riser feeding terminal units. Install chambers as high as possible within unit, and provide manual air vent connected to air chamber by flexible tubing.
 - .2 Provide a float type automatic air vent at any high points of hot water supply and return piping not vented through a convactor etc. and at high point of piping for each hot water coil. The

discharge of air vent shall terminate over a floor drain in mechanical rooms or over a sink in service rooms. A shut-off valve shall be provided on each automatic air vent and an access door and frame shall be provided for air vents located above ceilings.

- .2 Automatic Feed Valves: provide automatic feed valve on the cold water make-up line to each new hot water heating system.
- .3 Air Cushion Tanks
 - .1 Provide air cushion tanks of size noted where indicated.
 - .2 Provide housekeeping pad for floor mounting of tank.
 - .3 Terminate drainout line at nearest funnel floor drain, or service sink.
 - .4 Adjust charge to system static pressure at point of connection plus 5 psi (35 kPa).
- .4 Air Eliminators: provide an air eliminator at each new air cushion (expansion) tank.
- .5 Circuit Balancing Valve (CBV): provide a CBV in each branch serving a heating and/or cooling terminal unit and where indicated on drawings. Installation shall be in accordance with manufacturer's installation instructions. Ensure that manufacturer's recommended clearances are maintained to minimize turbulence and to promote accuracy.
- .6 Supply and install threaded couplings or half coupling for flow switches that are supplied under Section 25
- .7 Install flow switches as supplied under Section 25

3.7 CONTROLS DEVICES

- .1 Install pipe wells for various remote sensors such as temperature, pressure and flow sensors. Supply of sensors and controls wiring will be under Section 25.
- .2 Install control valves for fluid flow control. Supply of valves, valve actuators and controls wiring will be under Section 25.

3.8 TESTING AND INSPECTION

- .1 Test liquid heat transfer piping hydrostatically at not less than 150% of operating pressure or not less than 125 psi (860 kPa) whichever is the greater. Test period shall be not less than six (6) hours duration during which time each joint shall be inspected, given a sharp tap with a hammer and checked for leaks.
- .2 Arrange and pay for inspection by authorities having jurisdiction.

3.9 ADJUSTING AND BALANCING

- .1 Instruments used for this work shall be accurately calibrated and maintained in good working order, and shall include:
 - .1 one set of pressure gauges and fittings.
 - .2 dry bulb thermometer.
 - .3 wet bulb thermometer.
 - .4 thermocouple unit and thermocouple.
 - .5 set of balancing cock adjustment wrenches.
 - .6 portable field flow meter.
- .2 Prepare the liquid heat transfer systems as follows:
 - .1 Install any additional devices required for effective balancing as advised by the Systems Verification Agency.
 - .2 Open all valves, and return line balancing cocks.
 - .3 Remove and clean all strainers.
 - .4 Check pump rotation.
 - .5 Check expansion tanks to make sure they are not air bound and that the system is full of water.
 - .6 Check all air vents at high points of water systems to make sure they are installed properly and are operating freely. Make certain all air is removed from circulating system.
 - .7 Set all temperature controls so that all coils are calling for full cooling. This should close all automatic bypass valves at coil and chillers. To balance hot water coils, set systems to call for full heating.
 - .8 Check operation of automatic bypass valve.

- .9 Check and set operating temperature of heat exchangers to design requirements.
- .3 Balance the liquid heat transfer systems as follows:
 - .1 Complete air balance must have been accomplished before water balance is begun.
 - .2 Set hot water to proper gpm delivery.
 - .3 Adjust flow of hot water through heat exchangers.
 - .4 Check leaving water temperatures and return water temperatures, and pressure drop through heat exchangers. Reset to correct design temperatures.
 - .5 Check water temperature at inlet side of cooling and heating coils. Note rise or drop of temperatures from source.
 - .6 Balance each chilled water and hot water coil.
 - .7 Upon completion of flow readings and coil adjustments, mark all settings and record all data.
 - .8 After making adjustments to coils, recheck settings at pumps, and heat exchangers. Readjust if required.
 - .9 Install pressure gauges on each coil, then read pressure drop through coil at set flow rate on call for full cooling and full heating. Set pressure drop across bypass valve to match coil full flow pressure drop. This prevents unbalanced flow conditions when coils are on full bypass.
 - .10 Check and record the following items at each cooling and heating element:
 - .1 Inlet water and air temperature.
 - .2 Leaving water and air temperature.
 - .3 Pressure drop of each coil.
 - .4 Pump operating suction and discharge pressures and final t.d.h.
 - .5 Pressure drop across bypass valve.
 - .6 All mechanical specifications of pumps.
 - .7 Rated and actual running amperage of pump motor.
- .4 After completion of adjusting and balancing and submittal of records notify the Systems Verification Agency and the Consultant and assist in verifications. If systems fail verification, readjust and balance systems to the satisfaction of the Consultant.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Expansion tanks.
- .2 Air vents.
- .3 Air separators.
- .4 Strainers.
- .5 Pump suction fittings.
- .6 Combination fittings.
- .7 Relief valves.

1.3 REFERENCES

- .1 ASME - SEC 8D - Boilers and Pressure Vessels Code - Rules for Construction of Pressure Vessels.

1.4 SUBMITTALS

- .1 Section 23 01 01: Procedures for submittals.
- .2 Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- .3 Submit inspection certificates for pressure vessels from TSSA.
- .4 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- .5 Record actual locations of flow controls.
- .6 Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- .2 Provide temporary protective coating on cast iron and steel valves.
- .3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

2 PRODUCTS

2.1 DIAPHRAGM-TYPE EXPANSION TANKS

- .1 Manufacturers:
 - .1 Amtrol
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Expanflex.
 - .2 Bell & Gosset.
 - .3 SA Armstrong
 - .4 Taco
- .2 Construction: Welded steel, tested and stamped to ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psi (860 kPa), with flexible butyl diaphragm sealed into tank, and steel support stand.

- .3 Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 11 psi (80 kPa).
- .4 Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
 - .1 Size: As scheduled.

2.2 AIR VENTS

- .1 Manual Type: Short vertical sections of 2" (50 mm) diameter pipe to form air chamber, with 3 mm brass needle valve at top of chamber.
- .2 Float Type:
 - .1 Manufacturers:
 - .1 Armstrong.
 - .2 Amtrol.
 - .3 Taco.
 - .2 Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.3 AIR SEPARATORS

- .1 Air Separators:
 - .1 Manufacturers:
 - .1 Amtrol.
 - .2 Armstrong.
 - .3 Bell & Gossett.
 - .4 Taco
 - .5 Expanflex
 - .2 Steel, tested and stamped to ASME SEC 8-D; for 125 psi (860 kPa) operating pressure, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.4 STRAINERS

- .1 Size 2" (50 mm) and Under:
 - .1 Manufacturers:
 - .1 Sarco SB
 - .2 Crane
 - .3 Armstrong
 - .4 Colton
 - .2 Screwed brass or iron body for 175 psi (1200 kPa) working pressure, Y pattern with 0.8 mm stainless steel perforated screen.
- .3 Size 2-1/2" to 4" (65 mm to 100 mm):
 - .1 Flanged iron body for 175 psi (1200 kPa) working pressure, Y pattern with 1.2 mm stainless steel perforated screen.
- .4 Size 5" (125 mm) and Larger:
 - .1 Flanged iron body for 175 psi (1200 kPa) working pressure, basket pattern with 3.2 mm stainless steel perforated screen.

2.5 PUMP SUCTION FITTINGS

- .1 Manufacturers:
 - .1 Armstrong.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Bell & Gossett.
 - .2 Taco
 - .3 Patterson
- .2 Fitting: Angle pattern, cast-iron body, threaded for 2" (50 mm) and smaller, flanged for 2-1/2" (65 mm) and larger, rated for 175 psi (1200 kPa) working pressure, with inlet vanes, cylinder strainer with 3/16" (5 mm) diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent

- .3 magnet located in flow stream and removable for cleaning.
- .3 Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.6 COMBINATION PUMP DISCHARGE VALVES

- .1 Manufacturers:
 - .1 Armstrong.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Bell & Gossett.
 - .2 Taco
 - .3 Patterson
- .2 Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi (1200 kPa) operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.7 RELIEF VALVES

- .1 Manufacturers:
 - .1 Sarco.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Watts
 - .2 Bell & Gossett
 - .3 Conbraco
- .2 Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled

2.8 GLYCOL SYSTEM

- .1 Packaged hydronic system feeder, 55 US gal storage mixing tank with cover; pump suction hose with inlet strainer, pressure pump with thermal cut-out; integral pressure switch; integral check valve; cord and plug; pre-charged accumulator tank with EPDM diaphragm; manual diverter valve for purging air and agitating contents of storage tank; pressure regulating valve, adjustable (5 - 55 psig), complete with pressure gauge; integral replaceable strainer; built-in check valve; union connection; ½" x 36" long flexible connection hose and check valve; low level pump cut-out. Pressure pump shall be capable of running dry without damage. Power supply 115/60/10.7A. Pre-assembled and certified to CSA standard C22.2 no. 68. Include low level alarm c/w remote monitoring contacts and selectable audible alarm. Axiom, Bell & Gossett, Klenzoid, Armstrong.
- .2 Glycol Solution: [PICK ONE OR EDIT TO SUIT] – **Only use Ethylene if it is an existing condition**
 - .1 50% inhibited ethylene glycol and 50% water solution mixed, suitable for operating temperatures from -40°F to 250°F (-40°C to 121°C).
 - .2 40% inhibited propylene glycol and 60% water solution mixed, suitable for operating temperatures from -6°F to 210°F (-21°C to 100°C).

3 EXECUTION

3.1 INSTALLATION

- .1 Install specialties to manufacturer's instructions.
- .2 Where large air quantities can accumulate, provide enlarged air collection standpipes.
- .3 Provide manual air vents at system high points and as indicated.
- .4 For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain for water systems and to holding tank for glycol/water systems.
- .5 Provide air separator on suction side of system circulation pump and connect to expansion tank.
- .6 Provide valved drain and hose connection on strainer blowdown connection.
- .7 Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- .8 Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
- .9 Support pump fittings with floor mounted pipe and flange supports.

- .10 Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
- .11 Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- .12 Pipe relief valve outlet to nearest floor drain for water systems and to holding tank for glycol/water systems.
- .13 Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- .14 Clean and flush glycol system before adding glycol solution.
- .15 Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12psi (80 kPa).
- .16 Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Circulators
- .2 Vertical in-line pumps.
- .3 Side-stream filters.

1.3 REFERENCES

- .1 UL 778 Motor Operated Water Pumps
- .2 ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 CSA B214 Installation Code for Hydronic Heating Systems

1.4 PERFORMANCE REQUIREMENTS

- .1 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

- .1 Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- .2 Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- .3 Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.6 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum ten years experience.

1.7 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.8 EXTRA MATERIALS

- .1 Provide one set of mechanical seals for each pumps.
- .2 Provide 2 sets of cartridges for each side-stream filter.

2 PRODUCTS

2.1 MANUFACTURERS

- .1 S. A. Armstrong
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Bell & Gosset (XYLEM)
 - .2 Taco
 - .3 Patterson
 - .4 Grundfos

2.2 IN-LINE CIRCULATORS

- .1 Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125psi (860 kPa) maximum working pressure.
- .2 Casing: Cast iron, with flanged pump connections.
- .3 Impeller: Cadmium plated steel, keyed to shaft.
- .4 Bearings: Two, oil lubricated bronze sleeves.
- .5 Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.
- .6 Seal: Carbon rotating against a stationary ceramic seat, 225°F (107°C) maximum continuous operating temperature.
- .7 Seal: Carbon rotating against a stationary ceramic seat, viton fitted 275°F (135°C) maximum continuous operating temperature.
- .8 Drive: Flexible coupling.
- .9 Performance: as scheduled
- .10 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

2.3 VERTICAL IN-LINE PUMPS

- .1 Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi (1200 kPa) working pressure.
- .2 Casing: Cast iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- .3 Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- .4 Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- .5 Seal: Carbon rotating against a stationary ceramic seat, viton fitted 225°F (107°C) maximum continuous operating temperature.
- .6 Performance: as scheduled
- .7 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

3 EXECUTION

3.1 PREPARATION

- .1 Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- .1 Install to manufacturer's instructions and as indicated by flow arrows.
- .2 Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4" (102 mm) and over.
- .3 Provide access space around pumps for service. Provide no less than minimum recommended by manufacturer.
- .4 Base mounted type: supply templates for anchor bolt placement. Furnish anchor bolts with sleeves. Place level, shim unit and grout. Align coupling in accordance with manufacturer's recommended tolerance. Check oil level and lubricate. After run-in, tighten glands.
- .5 Decrease from line size with long radius reducing elbows or reducers.
- .6 Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- .7 Provide air cock and drain connection on horizontal pump casings.
- .8 Provide drains for bases and seals, piped to and discharging into floor drains.
- .9 Check rotation, align, and certify alignment of base mounted pumps prior to start-up.
- .10 Lubricate pumps before start-up.
- .11 Provide side-stream filtration system for heating water systems. Install across pump with flow from pump discharge to pump suction from pump tapings.

3.3 START-UP

- .1 Before starting pump, check that cooling water system, over-temperature and other protective devices are installed and operative.
- .2 After starting pump, check for proper, safe operation.
- .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
- .4 Check base for free-floating, no obstructions under base.
- .5 Run-in pumps for 12 continuous hours.
- .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
- .7 Eliminate air from scroll casing.
- .8 Adjust water flow rate through water-cooled bearings.
- .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
- .10 Adjust alignment of piping and conduit to ensure true flexibility at all times.
- .11 Eliminate cavitation, flashing and air entrainment.
- .12 Adjust pump shaft seals, stuffing boxes, glands.
- .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
- .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
- .15 Verify lubricating oil levels.

3.4 PERFORMANCE VERIFICATION

- .1 General
 - .1 In accordance with manufacturer's recommendations.
- .2 Exclusions:
 - .1 This paragraph does not apply to small in-line circulators.
- .3 Assumptions: These PV procedures assume that:
 - .1 Manufacturer's performance curves are accurate.
 - .2 Valves on pump suction and discharge provide tight shut-off.
- .4 Net Positive Suction Head (NPSH):
 - .1 Application: Measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
 - .2 Measure using procedures prescribed in the Standard.
 - .3 Where procedures do not exist, discontinue PV, report to Engineer/Consultant and await instructions.
- .5 Multiple Pump Installations - Series and Parallel:
 - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .7 Commissioning Reports: Reports to include:
 - .1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
 - .2 Pump performance curves (family of curves).

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Cleaning of pipe and fittings
- .2 Cleaning of equipment
- .3 Supply, installation testing and adjusting of chemical feed equipment
- .4 Chemical treatments of piping systems
- .5 Supply of chemicals

1.3 SUBMITTALS

- .1 Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- .2 Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- .3 Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- .4 Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- .5 Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.4 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience. Company to have local representatives with water analysis laboratories and full time service personnel.
- .2 Installer: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

1.5 REGULATORY REQUIREMENTS

- .1 Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for to public sewage systems.
- .2 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

1.6 MAINTENANCE MATERIALS

- .1 Provide sufficient chemicals for treatment and testing during warranty period.

2 PRODUCTS

2.1 MANUFACTURERS

- .1 GE Water Tech (Dearborn)
- .2 Buckman Laboratories
- .3 Bird Archer.
- .4 Ashland Drew
- .5 Klenzoid
- .6 Chem-Aqua
- .7 Ondeo Nalco
- .8 Specialty Chemicals

2.2 MATERIALS

- .1 System Cleaner:
 - .1 Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
 - .2 Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.
- .2 Closed System Treatment (Water):
 - .1 Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - .2 Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 - .3 Conductivity enhancers; phosphates or phosphonates.
- .3 Chemicals:
 - .1 Provide all chemicals required for cleaning and start-up of systems.
 - .2 In addition, provide 3 months supply of chemicals for each system in full operation.

2.3 BY-PASS (POT) FEEDER

- .1 3 gal. (12 litre) welded steel, quick opening cap, pressure rating of 175 psi (1200 kPa), temperature rating: 195°F (90° C).
- .2 Micron filter for each pot feeder:
 - .1 Capacity 5% of pump recirculating rate at operating pressure.
 - .2 Six (6) sets of filter cartridges for each type, size of micron filter

2.4 TEST EQUIPMENT

- .1 Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
- .2 Provide one set of test equipment for each system to verify performance including;
 - .1 Alkalinity titration test kit.
 - .2 Chloride titration test kit.
 - .3 Sulphite titration test kit.
 - .4 Total hardness titration test kit.
 - .5 Low phosphate test kit.
 - .6 Conductivity bridge, range 0 - 10,000 microhms.
 - .7 Creosol red pH slide complete with reagent.
 - .8 Portable electronic conductivity meter.
 - .9 High nitrite test kit.

2.5 CLOSED SYSTEMS WATER TREATMENT INCLUDING HOT, CHILLED AND GLYCOL LOOPS

- .1 Provide complete water treatment equipment and chemicals for corrosion protection, and sidestream filtration, for each closed system.
- .2 Each Closed System to include the following water treatment equipment:
 - .1 One (1) Bypass Feeder, 3 gallon (12L) capacity.
 - .2 One (1) Bypass Filtler Unit with the capacity to handle 5% of the recirculating pump flow rate.
 - .3 One (1) case of 30 pieces, filter cartridges, 20 micron rated.
 - .4 One (1) corrosion coupon station, 3/4" (19mm) black iron assembled, 4 coupon port connections, 8 gpm (0.5 l/s) flow regulator.
 - .5 One (1) Copper corrosion coupon, holder and plug.
 - .6 One (1) Mild Steel corrosion coupon, holder and plug.

3 EXECUTION

3.1 PREPARATION

- .1 Systems to be operational, filled, started, and vented prior to cleaning. Use water meter to record

- capacity in each system.
- .2 Place terminal control valves in open position during cleaning.
- .3 Verify that electric power is available and of the correct characteristics.

3.2 CLEANING SEQUENCE

- .1 Concentration:
 - .1 As recommended by manufacturer.
 - .2 1 kg per 1000 L of water contained in the system.
 - .3 1 kg per 1000 L of water for hot systems and 1 kg per 500 L of water for cold systems.
 - .4 Fill steam boilers only with cleaner and water.
- .2 Hot Water Heating Systems:
 - .1 Apply heat while circulating, slowly raising temperature to 160°F (71°C) and maintain for 12 hours minimum.
 - .2 Remove heat and circulate to 100°F (37.8°C) or less; drain systems as quickly as possible and refill with clean water.
 - .3 Circulate for 6 hours at design temperatures, then drain.
 - .4 Refill with clean water and repeat until system cleaner is removed.
- .3 Use neutralizer agents on recommendation of system cleaner supplier and approval of Consultant.
- .4 Remove, clean, and replace strainer screens.
- .5 Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

- .1 Install to manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

- .1 Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- .2 Introduce closed system treatment through bypass feeder when required or indicated by test.
- .3 Provide 3/4" (19 mm) water coupon rack around circulating pumps with space for 4 test specimens.

3.5 CLOSED SYSTEMS

- .1 Equipment Installation
 - .1 Install the feeder and filter in a by-pass arrangement across the headers of the primary pump set. Isolation, venting and drain valves to be installed as per installation drawing and on-site instruction by water treatment representative. Installation and electrical connections as required is the responsibility of the Mechanical Trade.
- .2 System Flushing
 - .1 Thoroughly flush the closed system(s) with raw water to remove loose mill scale and debris. Remove and clean all strainers and flush low points before chemical cleaner is added to the system.
- .3 Add new system cleaner CSW 600 6.8 - 9 kg per 3800 litres system water for the removal of oil, mill scale and iron oxides. Recirculate for a minimum of 24 hours and flush. Repeat fill and flush procedure as often as required, adding inhibitor with each fill, to achieve prescribed maintenance levels.
- .4 Acceptability of water condition to be determined through testing and visual examination of representative water samples, by the water treatment supplier. Copies of test reports to be submitted by the water treatment supplier to the Mechanical Trade for verification to the Engineer.
 - .1 Add corrosion inhibitor CSW 311 at 23 kg per 3800 litres to the final water fill to achieve prescribed maintenance levels.
 - .2 Insert cartridges in filter.

3.6 MAINTENANCE

- .1 Maintain inhibitor levels and other water quality control ranges as they apply, from the time the system is brought on-line after flushing and cleaning, up to Substantial Completion of contract. The chemical supply allotment provided by the water treatment supplier is effective from the time the system is brought on line.
- .2 The water treatment supplier shall provide all necessary supervision during installation and shall test the system over the course of the construction period to ensure that proper treatment is being maintained, up to Substantial Completion. Reports generated by the water treatment supplier and left on-site are to be compiled for the Engineer's review.
- .3 The water treatment supplier shall provide a chemical supply service program for a period of one year from Substantial Completion. This program shall include training of operating personnel, laboratory testing as required, technical assistance and routine water analysis and recommendations.
- .4 Frequency of service calls by the water treatment supplier to be sufficient to meet system stability requirements.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Boilers.
- .2 Controls and boiler trim.
- .3 Hot water connections.
- .4 Fuel connection.
- .5 Flue Gas Venting.

1.3 REFERENCES

- .1 CSA B51 Boiler, Pressure Vessel and Pressure Piping Code as adopted
- .2 CSA B149.1 Natural Gas and Propane Installation Code as adopted.
- .3 AGA - Directory of Certified Appliances and Accessories.
- .4 AGA Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .5 ASME SEC 4 - Boiler and Pressure Vessel Codes - Rules for Construction of Heating Boilers.
- .6 ASME SEC 8D - Boilers and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.
- .7 HI (Hydronics Institute) - Testing and Rating Standard for Cast Iron and Steel Heating Boilers.
- .8 NFPA 54 (AGA Z223.1) - National Fuel Gas Code.

1.4 SUBMITTALS

- .1 Refer to Division 23 01 01 procedures for submittals.
- .2 Product Data: Provide data indicating general layout, dimensions, and size and location of water, gas, and vent connections, and electrical characteristics and connection requirements.
- .3 Submit manufacturer's installation instructions.
- .4 Manufacturer's Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.
- .5 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.5 REGULATORY REQUIREMENTS

- .1 CSA B51 Boiler, Pressure Vessel and Pressure Piping Code as adopted
- .2 CSA B149.1 Natural Gas and Propane Installation Code as adopted.
- .3 Conform to ASME SEC 4 and SEC 8D for boiler construction.
- .4 Units: CSA/CGA certified.
- .5 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND PROTECTION

- .1 Transport, handle, store, and protect products.
- .2 Protect units before, during, and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 WARRANTY

- .1 The cast aluminum heat exchanger shall carry a non-prorated 10-year warranty against failure due to

- condensate corrosion, thermal stress, mechanical defects or workmanship.
- .2 All other components and controls supplied with the boiler shall carry a 2 year warranty against failure due to defective materials or workmanship.
 - .3 Boiler must be registered with the manufacturer at time of start up with warranty card and start up report.

2 PRODUCTS

2.1 MANUFACTURERS

- .1 Basis of Design: Lochinvar
- .2 Other acceptable manufacturers;
 - .1 Buderus
 - .2 Viessmann
 - .3 Cleaver Brooks

2.2 BOILERS

- .1 The boiler shall have a modulating input rating and output rating as scheduled and shall operate on natural gas. The boiler shall be capable of full modulation firing down to 20% of rated input with a turndown ratio of 5:1.
- .2 The boiler shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. There shall be no banding material, bolts, gaskets or "O" rings in the header configuration. The boiler shall have a 316L stainless steel heat exchanger. The combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly including a condensate trap. The complete heat exchanger assembly shall carry a ten (10) year limited warranty.
- .3 The boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The boiler shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The boiler shall operate at a minimum of 94% thermal efficiency at full fire. All models shall operate up to 98% thermal efficiency with return water temperatures at 100°F or below. The boiler shall be certified for indoor installation.
- .4 The boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The boiler shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The boiler shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column.
- .5 The boiler shall be equipped with two terminal strips for electrical connection.
 - .1 A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, two (2) Flow Switches, Tank Thermostat, Enable/Disable (Wall Thermostat/Zone Control), System Supply Sensor, Outdoor Sensor, Tank Sensor, Building Management System signal and Cascade control circuit.
 - .2 A high voltage terminal strip shall be provided for 120 volt / 60 hertz / single phase. The high voltage terminal strip plus integral relays are provided for independent pump control of the Boiler pump. The System pump and boiler pump dry contacts shall be sized for up to 1.5 HP/208V, or 30 amp pumps.
- .6 The boiler shall be installed and vented with a direct vent system with vertical rooftop termination of both the exhaust vent and combustion air. The flue shall be Category IV approved Stainless Steel AL29-4C alloy sealed vent material terminating at the roof top with the manufacturers specified vent termination. A separate ULC-S636 pipe shall supply combustion air directly to the boiler from the outside. The air inlet pipe may be PVC or CPVC sealed pipe with flame spread/smoke developed ratings of 25/50 or less. The air inlet must terminate on the roof top with the manufacturer's specified air inlet cap. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The

boiler's total combined exhaust venting length shall not exceed 100 equivalent feet. The air inlet must terminate on the same sidewall as the exhaust. Foam Core pipe is not an approved material for exhaust piping.

- .7 The boiler shall have an independent laboratory rating for Oxides of Nitrogen (NOx) of 30 ppm or less corrected to 3% O₂. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.
- .8 The boiler shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.

2.3 BOILER CONTROLS - Lochinvar

- .1 The boiler shall utilize a 24 VAC control circuit and components. The control system shall have a electronic display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front of the jacket. The boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 30 psi; outlet water temperature sensor; return water temperature sensor; outdoor air sensor, flue temperature sensor; high and low gas pressure switches, low water cut off with manual reset and a condensate trap for the heat exchanger condensate drain.
- .2 The BOILER shall feature the "Smart System" control with a Multi-Coloured Graphic LCD display and for password security, three loop temperature setpoints with individual outdoor air reset curves; pump delay with adjustable freeze protection, pump exercise, USB PC port connection. The BOILER shall be capable of controlling a variable speed boiler pump to keep a constant Delta T at all modulation rates. The BOILER shall have the capability to accept a 0-10 VDC input connection for BMS control of modulation or setpoint, enable/disable of the boiler, variable system pump signal and a 0-10 VDC output of boiler modulation rate. The Boiler shall have a built-in "Cascade" with sequencing options for "lead lag" of "efficiency optimized" modulation logic, with both capable of rotation while maintaining modulation of up to eight boilers without utilization of an external controller. Supply voltage shall be 120 volt/60 hertz/single phase.

3 EXECUTION

3.1 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Install to Ontario Gas Utilization Code.
- .3 Install boiler on concrete housekeeping base, sized minimum 100 mm larger than boiler base.
- .4 Provide connection of natural gas service to each boiler. Each boiler shall require a minimum gas pressure of 4" W.C. to 14" W.C.
- .5 Provide piping connections and accessories. Each boiler shall have individually isolating shutoff valves for service and maintenance.
- .6 Pipe relief valves to nearest floor drain.
- .7 Install circulator and diaphragm expansion tank on boiler.
- .8 Provide for connection to electrical service.

3.2 MANUFACTURER'S FIELD SERVICES

- .1 A manufacturer's factory authorized service technician must be used to start-up and service the boilers.
- .2 Instruct operating personnel in the operation and maintenance of units.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 MECHANICAL-ELECTRICAL EQUIPMENT SCHEDULE

- .1 The following Mechanical-Electrical Equipment Schedule is provided to assist the Contractor in coordinating the efforts of sub-trades. The assignment of work among subcontractors is the Contractor's responsibility and the Contractor is free to amend the schedule as he sees fit.
- .2 The Mechanical-Electrical Equipment Schedule also describes work that is required and may or may not be described elsewhere. All work indicated in the Mechanical-Electrical Equipment Schedule shall be included in the Bid Price.
- .3 The Mechanical-Electrical Equipment Schedule shall not limit the extent of the Contract in any way. Work indicated elsewhere or otherwise needed for a complete and functioning installation shall be provided whether or not shown in the Mechanical-Electrical Equipment Schedule.

1.3 RESPONSIBILITY CODES

- .1 Responsibility Codes in the Mechanical Equipment Schedule shall be interpreted as follows:
 - .1 "Supplied by Div." means that the equipment is to be supplied to the site under the division described by number.
 - .2 "Installed by Div." means that the equipment is to be received from the supplier, handled, set in place and installed at the site under the Division described by number.
 - .3 "Wired and connected by Div." means that the equipment and its associated devices are to be wired and connected to the various electrical systems in accordance with the equipment manufacturer's installation instructions and wiring diagrams under the Division described by number.

No.	Equipment			Controls			Responsibility			
	Item	Characteristics	Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.	
1	B-1A HOT WATER BOILER	HP	FHP	MECHANICAL ROOM #2	Disconnect (1)	At Unit	See Elec Spec	26	26	26
		Voltage	120		Starter (1)	At unit	See Mech Spec	23	23	26
		Phases	1		Boiler Controls (1)	See Dwgs.	See Mech Spec	23	23	23
		Freq.	60		BAS (stand alone)		See Mech Spec	25	25	25
					Control wiring from boiler control panel to boiler circ. pump by Div. 23					
2	B-1B HOT WATER BOILER	HP	FHP	MECHANICAL ROOM #2	Disconnect (1)	At Unit	See Elec Spec	26	26	26
		Voltage	120		Starter (1)	At unit	See Mech Spec	23	23	26
		Phases	1		Boiler Controls (1)	See Dwgs.	See Mech Spec	23	23	23
		Freq.	60		BAS (stand alone)		See Mech Spec	25	25	25
					Control wiring from boiler control panel to boiler circ. pump by Div. 23					

No.	Equipment			Controls			Responsibility			
	Item	Characteristics	Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.	
3	B-2A HOT WATER BOILER	HP	FHP	MECHANICAL ROOM #4	Disconnect (1)	At Unit	See Elec Spec	26	26	26
		Voltage	120		Starter (1)	At unit	See Mech Spec	23	23	26
		Phases	1		Boiler Controls (1)	See Dwgs.	See Mech Spec	23	23	23
		Freq.	60		BAS (stand alone)		See Mech Spec	25	25	25
					Control wiring from boiler control panel to boiler circ. pump by Div. 23					
4	B-2B HOT WATER BOILER	HP	FHP	MECHANICAL ROOM #4	Disconnect (1)	At Unit	See Elec Spec	26	26	26
		Voltage	120		Starter (1)	At unit	See Mech Spec	23	23	26
		Phases	1		Boiler Controls (1)	See Dwgs.	See Mech Spec	23	23	23
		Freq.	60		BAS		See Mech Spec	25	25	25
					Control wiring from boiler control panel to boiler circ. pump by Div.23					
5	BOILER PUMP BP-1	HP	1 1/2	MECHANICAL ROOM #2	Disconnect	At Pump	In starter	26	26	26
		Voltage	208		Starter	Near Unit		26	26	26
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60							
6	BOILER PUMP BP-2	HP	1 1/2	MECHANICAL ROOM #2	Disconnect	At Pump	In starter	26	26	26
		Voltage	208		Starter	Near Unit		26	26	26
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60							
7	BOILER PUMP BP-3	HP	1 1/2	MECHANICAL ROOM #4	Disconnect	At Pump	In starter	26	26	26
		Voltage	208		Starter	Near Unit		26	26	26
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60							
8	BOILER PUMP BP-4	HP	1 1/2	MECHANICAL ROOM #4	Disconnect	At Pump	In starter	26	26	26
		Voltage	208		Starter	Near Unit		26	26	26
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60							
9	SECONDARY PUMP CP-1A	HP	1 1/2	MECHANICAL ROOM #2	Disconnect	Near Unit	See Elec Dwgs	26	26	26
		Voltage	208		VFD	At pump	See Mech spec	23	23	23
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60		BAS (stand alone)	See mech spec	See mech spec	25	25	25
10	SECONDARY PUMP CP-1B	HP	1 1/2	MECHANICAL ROOM #2	Disconnect	Near Unit	See Elec Dwgs	26	26	26
		Voltage	208		VFD	At pump	See Mech Dwgs	23	23	23
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60		BAS (stand alone)	See mech spec	See mech spec	25	25	25

No.	Equipment			Controls			Responsibility			
	Item	Characteristics		Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
11	SECONDARY PUMP CP-1C	HP	1 1/2	MECHANICAL ROOM #2	Disconnect	Near Unit	See Elec Dwgs	26	26	26
		Voltage	208		VFD	N/A	N/A	-	-	-
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60		BAS (stand alone)	See mech spec	See mech spec	25	25	25
12	SECONDARY PUMP CP-1D	HP	1/4	MECHANICAL ROOM #2	Disconnect	Near Unit	See Elec Dwgs	26	26	26
		Voltage	120		VFD	N/A	N/A	-	-	-
		Phases	1		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60		BAS (stand alone)	See mech spec	See mech spec	25	25	25
13	SECONDARY PUMP CP-2A	HP	1 1/2	MECHANICAL ROOM #4	Disconnect	Near Unit	See Elec Dwgs	26	26	26
		Voltage	208		VFD	At pump	See mech spec	23	23	23
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60		BAS (stand alone)	See mech spec	See mech spec	23	23	23
14	SECONDARY PUMP CP-2B	HP	1 1/2	MECHANICAL ROOM #4	Disconnect	Near Unit	See Elec Dwgs	26	26	26
		Voltage	208		VFD	At pump	See mech spec	23	23	23
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60		BAS (stand alone)	See mech spec	See mech spec	25	25	25
15	SECONDARY PUMP CP-2C	HP	2	MECHANICAL ROOM #4	Disconnect	Near Unit	See Elec Dwgs	26	26	26
		Voltage	208		VFD	N/A	N/A	-	-	-
		Phases	3		Other Controls	See mech spec	See mech spec	23	23	23
		Freq.	60		BAS (stand alone)	See mech spec	See mech spec	25	25	25

END OF SECTION



DESIGNATED SUBSTANCES SURVEY

REASSESSMENT 2014

**St. Anne School
Blenheim, Ontario**

Prepared for:

St. Clair Catholic District School Board
245 Tecumseh Street
Sarnia, Ontario
N7T 2L1

September 2, 2014

Project No.: 14-0252

TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
2.0	SURVEY METHODOLOGY	1
2.1	ASBESTOS	2
2.2	OTHER HAZARDOUS BUILDING MATERIALS AND DESIGNATED SUBSTANCES	2
3.0	REGULATORY REQUIREMENTS	2
4.0	RESULTS	3
4.1	LEAD.....	3
4.2	MERCURY	3
4.3	SILICA	3
4.4	ACRYLONITRILE, BENZENE, ISOCYANATES, ARSENIC, ETHYLENE OXIDE, VINYL CHLORIDE AND COKE OVEN EMISSIONS.....	3
4.5	MOULD	4
5.0	RECOMMENDATIONS.....	5
5.1	LEAD.....	5
5.2	MERCURY	5
5.3	SILICA	6
5.4	MOULD	6
6.0	LIMITATIONS AND WARRANTY.....	6

APPENDICES

APPENDIX I DRAWINGS

1.0 INTRODUCTION

OH Solutions Inc. (OHS) was retained by the St. Clair Catholic District School Board to conduct a visual inspection for mould at St. Anne School located at 183 Snow Avenue in Blenheim, Ontario.

The school is a single storey structure, with a total area of 34,000 square feet. The original building was constructed in 1992. In addition to the investigation for mould, the school was evaluated for the presence of any other designated substances.

Under the *Occupational Health & Safety Act* (OHSA), an owner must determine whether any Designated Substances are present at a site and is required to prepare a list of all Designated Substances that are present. These substances may require special handling procedures. The current OHSA regulation lists the following eleven (11) substances as Designated Substances in the workplace: acrylonitrile, arsenic, asbestos, benzene, coke oven emissions, ethylene oxide, isocyanates, lead, mercury, silica and vinyl chloride.

Based on the estimated construction date and the reported use of the building, the review undertaken by OHS targeted lead, mercury, and silica which, in our experience, are most likely to be present on-site.

The following report explains our survey methodology and summarizes the hazardous building materials found at the Site.

2.0 SURVEY METHODOLOGY

During this investigation the surveyor inspected the building for construction materials suspected of containing Designated Substances.

Note:

- Repetitive testing was generally not performed. Items, which were visually similar to others tested, were considered to be of like material and were not sampled again. However, due to the variable nature of some products, several samples may have been collected of some materials.
- No destructive testing was performed. The inaccessible spaces within the building were not inspected. This includes areas above plaster or drywall ceilings (in the absence of access panels) as well as shafts, chases and bulkheads. Similarly, doors, motors and other equipment were not disassembled to determine composition.

There was no access to the roof at the time of the assessment.

2.1 Asbestos

This school was constructed at a time when asbestos materials were not used in most construction. Asbestos may be present in some products such as gaskets, mastics, and caulking which were not sampled as a part of the survey.

2.2 Other Hazardous Building Materials and Designated Substances

All other hazardous building materials or Designated Substances were identified based on visual assessment and historical usage.

3.0 REGULATORY REQUIREMENTS

“Designated Substance” as defined by the Ontario *Occupational Health & Safety Act* (OHSa) means “a biological, chemical or physical agent or combination thereof prescribed as a Designated Substance to which the exposure of a worker is prohibited, regulated, restricted, limited or controlled.” Under Section 30 of the OHSa an owner is required to determine whether any Designated Substances are present at a project site before beginning construction. If any portion of the project is tendered, the person issuing the tenders is required to list the Designated Substances present at the project site. The constructor is then required to ensure that every contractor and sub-contractor receives a copy of the list.

Designated Substances are regulated under Ontario Regulation 490/09, which identifies the occupational exposure limits for these materials. Under Subsection 3(3) of the Regulation, construction projects are excluded from the OELs and most of the other requirements of the Regulation. For this reason, the Ministry of Labour (MOL) has issued regulations and guidelines to cover asbestos, lead and silica on construction.

Ontario Regulation 278/05 classifies all disturbance of asbestos as Type 1, Type 2 or Type 3, each of which is associated with defined work practices. All asbestos material waste is subject to special handling and disposal practices, and must be removed prior to partial or full demolition. Removal of any quantity of asbestos of more than 1m² requires notification of the MOL. Disposal of asbestos waste is subject to waste management regulations under Ontario Regulation 347/90 as amended to Ontario Regulation 102/07.

The Guidelines: “Silica on Construction Projects” and “Lead on Construction Projects” identify precautions required for various activities that may disturb silica, or lead during construction, renovation or maintenance activities.

The MOL guideline for the control of lead exposures during the removal of lead on construction projects does not include criteria for categorizing lead paint. The

Ontario Ministry of Labour (MOL) does not have a standard to state what percentage of lead a material must have to be considered lead-containing. The Environmental Abatement Council of Ontario (EACO) has issued a "Lead Guideline for Construction, Renovation, Maintenance or Repair". This guideline recommends procedures to protect against lead exposure when concentrations of lead in paint exceed 0.1% by weight, but suggests that finishes with concentrations below 0.1% by weight do not require lead specific precautions provided the material is not disturbed in an aggressive manner (e.g. grinding or sandblasting) and that general dust control is adequate.

There are currently no regulations specifically covering exposure to mould or outlining mould remediation practices. In addition, there are no occupational exposure limits stating acceptable levels of exposure without adverse health effects.

However, Sections 25 and 27 of the Ontario *Occupational Health and Safety Act* states that an employer must take every reasonable precaution to ensure the health and safety of their workers. This includes exposure to moulds.

4.0 RESULTS

4.1 Lead

Painted finishes in the building were not sampled. Lead may be present in some finishes within the building.

4.2 Mercury

Mercury is present in fluorescent light tubes and may be present in thermostats located within the building.

4.3 Silica

Common construction sand contains free crystalline silica and is present in concrete products, mortar, brick, etc. These construction products are typically found throughout building structures.

4.4 Acrylonitrile, Benzene, Isocyanates, Arsenic, Ethylene Oxide, Vinyl Chloride and Coke Oven Emissions

Evidence suggesting the presence of acrylonitrile, benzene, isocyanates, arsenic, ethylene oxide, vinyl chloride monomer or coke oven emissions was not observed at St. Anne School.

4.5 Mould

In recent years, contamination of buildings with mould has become a major concern. Mould growth will occur on any water damaged building material. Evidence does exist to support the relationship between exposure to mould in buildings and many health effects.

This re-assessment included the inspection of areas for visible mould growth. In the absence of occupants experiencing symptoms, the inspection for and remediation of visible mould present in the building will be an appropriate response to the issue. Where occupants are experiencing symptoms, in the absence of visible mould growth, some invasive inspection may be necessary to find potential sources of mould. In general this was beyond the scope of this assessment.

Although some evidence of water damage was present, visible mould was not evident in the course of this inspection. Locations where water stained/damaged tiles were identified are outlined in the following table:

Location	Quantity of Water Damaged Material
Corridor To Gym	1 stained ceiling tile.
Classroom 10	1 stained ceiling tile.
Office 35	3 stained ceiling tiles.
Classroom 47	Less than 1sf of water staining/mould growth on drywall around windows.
Kitchen For Childcare	3sf of water staining/mould growth on drywall behind coolers.
Storage Room 66	1 stained ceiling tile.
Childcare 70	2 stained ceiling tiles.
Storage Room 78	2 stained ceiling tiles.

5.0 RECOMMENDATIONS

The following recommendations are made with respect to Designated Substances noted at St. Anne School:

5.1 Lead

Although samples were not collected, it should be assumed that lead is present within paint finishes at the site. As a result, the handling or disturbance of painted finishes should be evaluated to help ensure that workers are not adversely affected.

The lead-containing materials in the building will not generate airborne lead dust in the absence of disturbance. However, significant lead dust levels can result when uncontrolled work procedures are used on lead-based materials. The control of dust levels during the demolition of the buildings can be accomplished through proper work practises such as wetting the surface of the materials to reduce overall dust levels and providing workers with washing facilities and proper respiratory protection.

The procedures outlined in the MOL document 'Guideline – Lead on Construction Projects' (2004) should provide an adequate standard for the handling or disturbance of the material.

The disposal of construction waste containing lead is controlled under Ontario Regulation 347, as amended by O. Reg. 102/07, and may be subject to Leachate Criteria (Schedule 4) of this regulation.

5.2 Mercury

The presence of mercury in fluorescent light tubes and thermostats poses minimal risk to occupants or workers provided the equipment is handled properly and the mercury is not allowed to escape. In the event of future renovations, light tubes and thermostat tubes should be removed intact to prevent the mercury vapour from escaping.

It is good management practice to take precautions to prevent mercury vapours from becoming airborne during building demolition. Exposure to airborne mercury is regulated under Ontario Regulation 490/09 made under the *Occupational Health and Safety Act*. The current TWAEV for mercury vapour is 0.025 mg/m³ (except alkyl compounds).

Mercury waste must be handled and disposed of according to Ontario Regulation 347, as amended by O. Reg. 102/07, and may be subject to Leachate Criteria (Schedule 4) of this regulation.

5.3 Silica

Disturbance of materials containing silica will occur during demolition of walls and ceilings, saw cutting floor slabs and removal of lay-in acoustic ceiling tiles containing silica and is regulated under Ontario Regulation 490/09. The current TWAEV for amorphous fused silica is 0.1 mg/m³ and is 0.05 mg/m³ for crystalline silica (quartz). This can be accomplished through proper work practises such as wetting the surface of the materials to reduce overall dust levels and providing workers with washing facilities and proper respiratory protection.

5.4 Mould

Mould growth on building materials was not observed during this investigation. At this time, no further action is required regarding conditions observed. However water damaged acoustic tiles and mould impacted drywall were observed throughout the school. OHS recommends that this material be removed to reduce the potential for mould growth on the water impacted surface.

Moisture issues are the only factor in the growth of mould that may be controlled by the building operator. Any existing moisture problems in the building must be addressed to prevent or control mould growth. The following general recommendations are made to reduce the potential for future mould growth within the building:

- Promptly respond to any water infiltration, including minor leaks.
- Where HVAC units permit, maintain relative humidity below 60%.
- Maintain caulking at sinks, bathrooms and at exterior locations.

In the event of a flood, remove water by pumping or vacuuming as soon as possible. Drying of construction and finishing materials must begin promptly (in less than 24 hours). It may be practical to remove and dispose of some wetted materials, (e.g. drywall and carpet) in some cases.

6.0 LIMITATIONS AND WARRANTY

OHS has prepared this report for the exclusive use of the Client in evaluating the Site at the time of OHS's assessment. OHS will not be responsible for the use of this report by any third party, or reliance on or any decision to be made based on it without the prior written consent of OHS. OHS accepts no responsibility for damages, if any, by any third party because of decisions or actions based on this report.

The findings and conclusions documented in this report have been prepared for specific application to this project and have been developed in a manner consistent with that level of care and skill normally exercised by qualified professionals currently practising in this area of environmental assessment. No other warranty, expressed or implied, is made.

The findings contained in this report are based upon conditions as they were observed at the time of investigation. No assurance is made regarding changes in conditions subsequent to the time of investigation.

If new information is developed in future work, OHS should be contacted to re-evaluate the conclusions of this report and to provide amendments as required.

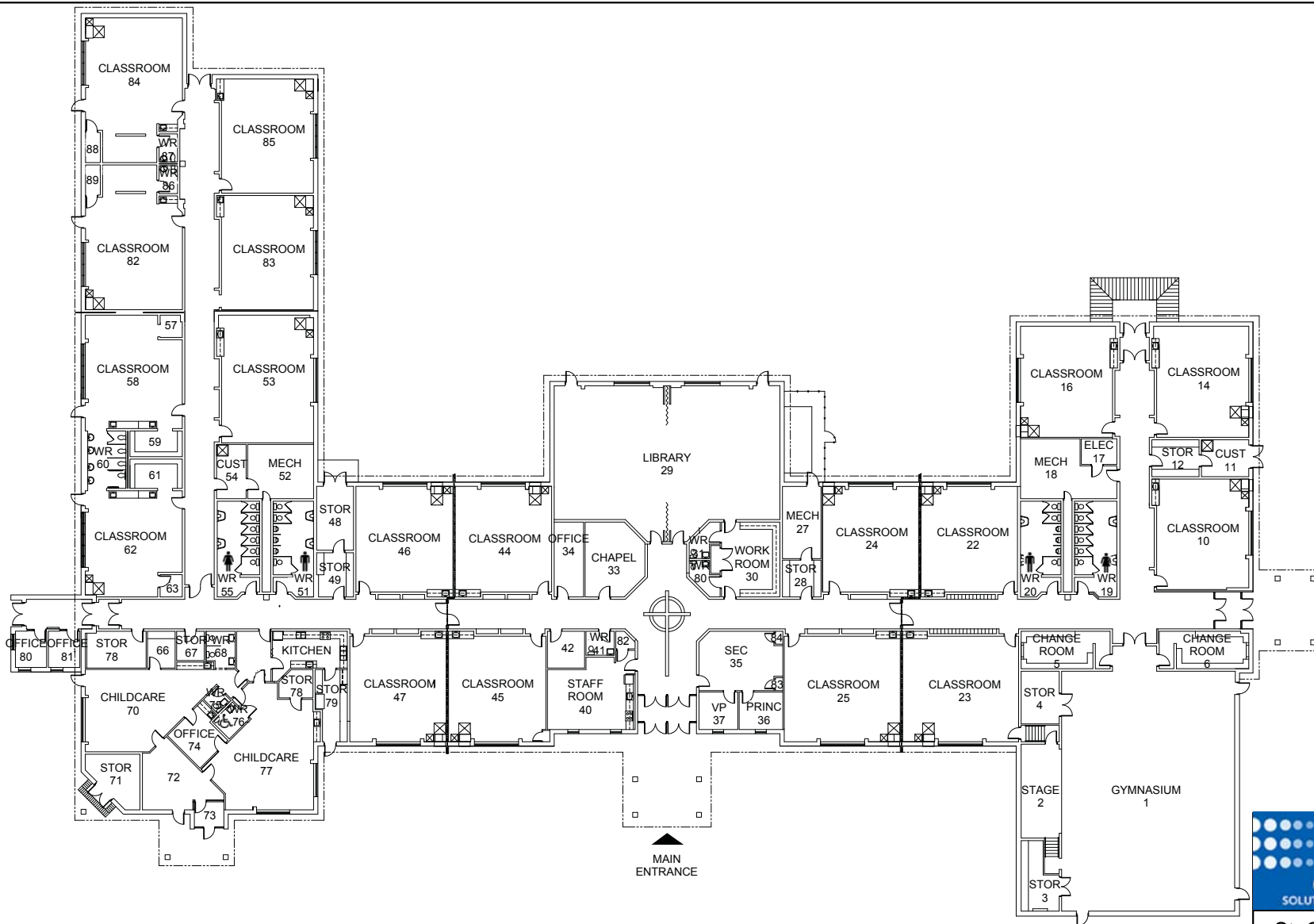
Respectfully submitted,

OH Solutions Inc.

A handwritten signature in black ink, appearing to read 'K. Olson', is positioned above the printed name and title.

Kris Olson, P.Eng.
Senior Project Manager

APPENDIX I
DRAWINGS



Occupational Hygiene Solutions
 119 Thames Street South
 Ingersoll, Ontario
 N5C 2T3

St. Clair Catholic School Board
St. Anne School
Blenheim
Main Floor
Survey Locations

Project: 14-0252	Prepared by: AW
Scale: N.T.S.	Date: Aug 2014

PUMP SCHEDULE							
DESCRIPTION	CP-1A	CP-1B	CP-1C	CP-1D	CP-2A	CP-2B	CP-2C
SERVICE:	RADIATION	RADIATION	FAN COILS	LOW TEMP RADIATION	RADIATION	RADIATION	FAN COILS
FLUID:	WATER	WATER	WATER	WATER	WATER	WATER	WATER
FLUID FLOW RATE: (GPM)	80	80	45	10	80	80	85
HEAD: (FT.H2O)	30	30	40	20	30	30	40
PUMP SPEED: (RPM)	2,736	2,736	1,655	1,750	2,736	2,736	1,712
MOTOR SIZE: (HP)	1.5	1.5	1.5	0.25	1.5	1.5	2
ELECTRICAL: (V/PHHZ)	208/3/60	208/3/60	208/3/60	120/1/60	208/3/60	208/3/60	208/3/60
PUMP TYPE:	VERTICAL INLINE	VERTICAL INLINE	VERTICAL INLINE	VERTICAL INLINE	VERTICAL INLINE	VERTICAL INLINE	VERTICAL INLINE
ARRANGEMENT:	DUTY/STANDBY	STANDBY/DUTY	DUTY	DUTY	DUTY/STANDBY	STANDBY/DUTY	DUTY
MODEL REFERENCE:	ARMSTRONG SERIES 4380 SUITABLE FOR FUTURE VFD ADDITION	ARMSTRONG SERIES 4380 SUITABLE FOR FUTURE VFD ADDITION	ARMSTRONG SERIES 4380	ARMSTRONG SERIES H51	ARMSTRONG SERIES 4380 C/W VFD AND INTEGRATED (SENSORLESS) PUMP CONTROL	ARMSTRONG SERIES 4380 C/W VFD AND INTEGRATED (SENSORLESS) PUMP CONTROL	ARMSTRONG SERIES 4380

BOILER PUMP SCHEDULE				
DESCRIPTION	BP-1	BP-2	BP-3	BP-4
SERVICE:	BOILER CIRC. PUMP	BOILER CIRC. PUMP	BOILER CIRC. PUMP	BOILER CIRC. PUMP
FLUID:	WATER	WATER	WATER	WATER
FLUID FLOW RATE: (GPM)	55	55	55	55
HEAD: (FT.H2O)	40	40	40	40
PUMP SPEED: (RPM)	1,750	1,750	1,750	1,750
MOTOR SIZE: (HP)	1.5	1.5	1.5	1.5
ELECTRICAL: (V/PHHZ)	208/3/60	208/3/60	208/3/60	208/3/60
PUMP TYPE:	INLINE	INLINE	INLINE	INLINE
ARRANGEMENT:	DUTY	DUTY	DUTY	DUTY
MODEL REFERENCE:	ARMSTRONG SERIES H68	ARMSTRONG SERIES H68	ARMSTRONG SERIES H68	ARMSTRONG SERIES H68

BOILER SCHEDULE		
DESIGNATION	B-1A & B-1B	B-2A & B-2B
LOCATION:	MECH ROOM # 2	MECH ROOM # 4
SERVICE:	HOT WATER HEATING	HOT WATER HEATING
INPUT- NATURAL GAS (BTUH):	600,000	600,000
MAX. OUTPUT KW (BTUH):	567,000	567,000
FLUID:	WATER	WATER
ENTERING FLUID TEMP (°F):	170	170
LEAVING FLUID TEMP (°F):	190	190
FLUID FLOW (USGPM):	26	26
FLUID PRESSURE DROP (FT.HEAD):	13	13
TURNDOWN / # OF STAGES:	5	5
DRY WEIGHT (KGS):	243	243
ELECTRICAL: V/PHHZ	120/1/60	120/1/60
MODEL REFERENCE:	LOCHINVAR - KBN-601	LOCHINVAR - KBN-601
DIMENSIONS :	42.5"(H)x15.5"(W)x36.25"(D)	42.5"(H)x15.5"(W)x36.25"(D)
NOTES:	UNIT COMPLETE WITH INTEGRATED CONTROLS, WIRELESS OUTDOOR TEMPERATURE SENSOR, AND CONDENSATE NEUTRALIZATION KIT SUPPLIED BY BOILER MANUFACTURER.	UNIT COMPLETE WITH INTEGRATED CONTROLS, WIRELESS OUTDOOR TEMPERATURE SENSOR, AND CONDENSATE NEUTRALIZATION KIT SUPPLIED BY BOILER MANUFACTURER.

EXPANSION TANK SCHEDULE		
DESIGNATION	ET-1	ET-2
LOCATION:	MECH. RM. # 2	MECH. RM. # 4
SERVICE:	HEATING SYSTEM	HEATING SYSTEM
EXCHANGER TYPE TANK:	FULL ACCEPTANCE	FULL ACCEPTANCE
FLUID TYPE:	WATER	WATER
TANK VOLUME: (GAL)	33.6	33.6
ACCEPTANCE VOLUME: (GAL)	11.3	11.3
MINIMUM PRESSURE: (PSI)	11	11
MAXIMUM PRESSURE: (PSI)	35	35
MINIMUM SUPPLY TEMP.: (°F)	40	40
MAXIMUM SUPPLY TEMP.: (°F)	190	190
MODEL REFERENCE:	AMTROL AX-60V	AMTROL AX-60V

LEGEND	
SYMBOL	DESCRIPTION
— EX (NAME) —	EXISTING PIPING TO REMAIN
#####	EXISTING PIPING TO BE REMOVED
—HWS—	HOT WATER HEATING SUPPLY
---HWR---	HOT WATER HEATING RETURN
—EG—	EXISTING GAS PIPING
—G—	GAS PIPING
— -- —	DOMESTIC COLD WATER PIPING
— -- -- —	DOMESTIC HOT WATER PIPING
— -- -- -- —	DOMESTIC HOT WATER RECIRC. PIPING
—□—	CAPPED PIPE
○FD	FLOOR DRAIN
⊙HD	HUB DRAIN
○FFD	FUNNEL FLOOR DRAIN
—X—	ISOLATION VALVE
—X—	THROTTLING VALVE
—R—	CHECK VALVE
—PRV—	PRESSURE REDUCING VALVE (WATER / GAS)
—X—X—X—	REDUCED PRESSURE BACKFLOW PREVENTER
▼	GAS VALVE
⊥T	THERMOMETER
⊙	PUMP
—○—	PIPING RISER UP
—○—	PIPING DROP
—X—	ISOLATING (SHUT-OFF) VALVE
—X—	CIRCUIT BALANCING VALVE
—X—	2-WAY CONTROL VALVE
⊙	PRESSURE GAUGE
—S—	STRAINER
—S—	FLOW SWITCH
—□—	LOW WATER CUTOFF DEVICE
—X—X—X—	EXISTING DUCTWORK TO BE REMOVED
—X—X—X—	EXISTING DUCTWORK TO REMAIN
—X—X—X—	NEW DUCTWORK
⊙	THERMOSTAT
CAP	CAP
CTE	CONNECT TO EXISTING
C/W	COMPLETE WITH
OAT	OUTSIDE AIR THERMOSTAT
[STS]	SYSTEM TEMPERATURE SENSOR
—	ELECTRICAL PANEL (78" TO TOP OF PANEL)
□	DISCONNECT SWITCH
⊙E#	REFER TO ELECTRICAL NOTE NUMBER ON DRAWINGS
NOTE: NOT ALL SYMBOLS MAY BE USED ON THIS PROJECT.	

GENERAL NOTES	
1.	ALL DEMOLITION AND INSTALLATIONS SHALL BE IN ACCORDANCE WITH CODES, AMENDMENTS, BULLETINS ETC. AND REQUIREMENTS OF ALL INSPECTION AUTHORITIES FOR THE CITY OF LONDON.
2.	CONTRACTOR IS TO VERIFY LOCATIONS OF ALL EXISTING BOILER ROOM UTILITIES PRIOR TO DEMOLITION.
3.	ALL EXISTING UTILITIES AND SERVICES ARE TO BE MAINTAINED AND SUPPORTED BY THE CONTRACTOR TO THE SATISFACTION OF THE OWNER OF THE UTILITY.
4.	REFER TO MECH. SPECIFICATION SECTIONS AND SCHEDULE
5.	REFER TO OWNERS INSTRUCTIONS AND SCHEDULE FOR DEMOLITION AND INSTALLATION OF BOILER EQUIPMENT.
6.	THE CONTRACTOR SHALL COORDINATE WITH THE ROOFING CONTRACTOR TO PROVIDE OPENINGS AND SLEEVES THROUGH ROOF ELEMENTS WHERE REQUIRED.
7.	THE CONTRACTOR SHALL HAVE ROOF PENETRATIONS MADE OR REPAIRED SEALED BY AN APPROVED ROOFING CONTRACTOR.
8.	MECHANICAL, GENERAL AND ELECTRICAL TRADES SHALL WORK IN CONJUNCTION WITH ONE ANOTHER SO AS TO AVOID INTERFERENCES BETWEEN PIPING, DUCTWORK, CONDUIT, LIGHTING FIXTURES, ETC.
9.	WORK SHALL BE COORDINATED THROUGH THE GENERAL CONTRACTOR PRIOR TO INSTALLATION OF ANY EQUIPMENT, DUCTWORK AND CONTROLS.
10.	PROPERLY SUPPORT CEILING MOUNTED EQUIPMENT AND ANY OTHER EQUIPMENT INDEPENDENT OF CEILING SUPPORT SYSTEM.
11.	EXISTING ITEMS TO BE REMOVED REMAIN THE PROPERTY OF THE OWNER AND SHALL BE DELIVERED TO A LOCATION ON SITE DESIGNATED BY THE OWNER. IF THE OWNER DECLARES NO INTEREST IN THE REMOVED ITEMS, ASSUME OWNERSHIP AND REMOVE THE ITEMS FROM THE SITE.
12.	MECHANICAL AND ELECTRICAL SYSTEMS SHOWN ON DEMOLITION PLANS ARE BASED ON INFORMATION OBTAINED FROM ORIGINAL CONSTRUCTION CONTRACT/TENDER DOCUMENTS. THESE DRAWINGS ARE NOT BASED ON 'AS-BUILT RECORDS' OR ON EXHAUSTIVE FIELD MEASUREMENT AND ARE PROVIDED TO ASSIST THE CONTRACTOR IN DETERMINING THE EXTENT OF WORK REQUIRED. THE CONTRACTOR SHALL MAKE ALLOWANCE IN THIS TENDER PRICE FOR THE REMOVAL OF ADDITIONAL ABANDONED SERVICES AND THE PROTECTION OF EXISTING SERVICES THAT MUST REMAIN. RECORD THE LOCATION OF ALL EXISTING SERVICES THAT REMAIN ON AS-BUILT RECORD DRAWINGS.
13.	CONTRACTOR IS TO VISIT THE SITE AND BECOME FULLY FAMILIAR WITH THE EXTENT OF THE WORK PRIOR TO TENDER CLOSING.
14.	EXACT SIZE AND EXACT LOCATION OF ALL EXISTING SERVICES IS TO BE CONFIRMED ON SITE.
15.	CO-ORDINATE LOCATION OF NEW PIPING WITH EXISTING OR NEW SERVICES (PIPING, DUCTWORK, ELECTRICAL CONDUITS, LIGHTS AND BUILDING STRUCTURE). IF REQUIRED REMOVE EXISTING SERVICES AND REINSTALL. TEST SERVICES AFTER WORK IS COMPLETED.
16.	CHECK AND VERIFY LOCATION OF ALL PIPES, DUCTS AND EQUIPMENT WITH ALL OTHER TRADES TO PREVENT INTERFERENCE. REMOVAL OR RELOCATION OF ANY SUCH WORK INTERFERING WITH WORK OF OTHER TRADES IS THE RESPONSIBILITY OF THE MECHANICAL TRADE CONCERNED UNLESS OTHERWISE APPROVED IN WRITING.
17.	DUE TO INCONSISTENT RECORDS OF EXISTING SERVICES NOT ALL PIPING MAY BE SHOWN, OR IF SHOWN MAY NOT BE ACCURATE. IT IS CONTRACTOR RESPONSIBILITY TO FIELD CONFIRM ALL SERVICES.
18.	FOR CUTTING AND PATCHING OF EXISTING STRUCTURE REFER TO MECHANICAL SPECIFICATION SECTION.
19.	ALL VALVES, DAMPER CONTROLS, ACCESS DOORS, TEST PORTS, AND FILTERS TO BE LOCATED SO THAT THEY ARE EASILY ACCESSIBLE. ALL GAUGES TO BE LOCATED AT EYE LEVEL.
20.	ALL PIPING BRANCH LINES SERVING MORE THAN ONE PIECE OF EQUIPMENT TO BE PROVIDED WITH SHUT OFF VALVES.

CONTRACT NOTES	
THE MECHANICAL CONTRACTOR IS TO ACT AS THE GENERAL CONTRACTOR FOR ALL WORK ASSOCIATED WITH THIS CONTRACT. GENERAL CONTRACTOR (MECHANICAL CONTRACTOR) TO COORDINATE ALL DIVISIONS AND SUB TRADE WORK AND ENSURE THAT ALL WORK IS COMPLETED BY ALL APPROVED SUB-TRADES.	
THE BUILDING IS OCCUPIED AT ALL TIMES. CONTRACTOR IS RESPONSIBLE FOR SHUT-DOWN COORDINATION WITH OWNER AS WELL AS MAINTAINING TENANT SERVICES IN OPERATION AT ALL TIMES.	

MECHANICAL DRAWING LIST	
ME-1	MECHANICAL DRAWING LIST, LEGEND, SCHEDULES, AND NOTES
ME-2	MECHANICAL/ELECTRICAL PLANS DEMOLITION AND NEW BOILER RM.
ME-3	MECHANICAL SCHEMATICS AND DETAILS

DEMOLITION NOTES	
1.	CONTRACTOR SHALL START DEMOLITION AND REMOVAL OF BOILER ROOM EQUIPMENT AFTER COMPLETE COORDINATION AND APPROVAL FROM THE BUILDINGS OWNER.
2.	DISCONNECT AND MAKE SAFE ALL MECHANICAL AND ELECTRICAL SERVICES TO THE BOILER ROOM EQUIPMENT REQUIRED TO BE REMOVED.
3.	REMOVE AND DISPOSE OFFSITE THE EXISTING HEATING BOILERS AND DEDICATED ACCESSORIES, PIPING, AND FLUE VENTING SYSTEM.
4.	REMOVE AND DISPOSE OFFSITE THE HEATING CIRCULATOR PUMPS, EXPANSION TANK AND ALL DEDICATED PIPING ACCESSORIES.
5.	CONTRACTOR SHALL REPAIR THE WALLS AND FLOOR AFFECTED BY THIS CONTRACT TO MATCH EXISTING.

GENERAL NOTES (ELECTRICAL)	
1.	DO NOT SCALE DRAWINGS FOR INSTALLATION PURPOSES. OBTAIN ALL DIMENSIONS FROM MANUFACTURER'S SHOP DRAWINGS, AND ON SITE INSPECTIONS.
2.	PRIOR TO INSTALLATION OF BOXES IN WALLS, VERIFY THAT NO INTERFERENCES EXIST. CHECK MECHANICAL PLANS AND ELEVATIONS.
3.	MECHANICAL AND ELECTRICAL TRADES SHALL WORK IN CONJUNCTION WITH ONE ANOTHER SO AS TO AVOID INTERFERENCES BETWEEN PIPING, DUCTWORK, CONDUIT, LIGHTING FIXTURES, ETC.
4.	ALL EXISTING DEAD WIRING AND CONDUIT IN RENOVATED AREAS SHALL BE REMOVED IN ITS ENTIRETY WHERE ACCESSIBLE. WHERE NOT ACCESSIBLE, WIRING ONLY SHALL BE REMOVED AND CONDUIT SHALL REMAIN.
5.	REWORK ALL EXISTING WIRING, CONDUIT, ETC. REMAINING IN USE AND FALLING WITHIN EXISTING WALLS WHICH ARE BEING REMOVED, TO NEAREST EXISTING WALLS REMAINING. ALL REWORKED WIRING SHALL BE CONCEALED.
6.	DISCONNECT AND REMOVE ANY ELECTRICAL EQUIPMENT IN CEILING SPACE OR WALLS THAT CAUSES INTERFERENCES DURING RENOVATION WORK. ALL EQUIPMENT SHALL BE REPLACED AND RECONNECTED UPON COMPLETION OF RENOVATION WORK.
7.	ELECTRICAL EQUIPMENT BEING REMOVED AND NOT BEING REUSED WILL BE STORED ON SITE AND REMAIN THE PROPERTY OF THE OWNER. ANY SUCH EQUIPMENT THE OWNER DOES NOT WISH TO RETAIN WILL BE REMOVED FROM SITE AND DISPOSED OF BY THIS TRADE.
8.	REVIEW MECHANICAL DRAWINGS AND PROVIDE ON SITE INSPECTIONS TO DETERMINE FULL EXTENT OF PROJECT PRIOR TO SUBMITTING BID.
9.	POWER AND CONTROL WIRING MUST RISE TO ROOFTOP EQUIPMENT WITHIN CURB OF UNIT UNLESS OTHERWISE APPROVED BY CONSULTANT. CONFIRM EXACT LOCATION ON SITE WITH CONSULTANT BEFORE INSTALLATION.
10.	ELECTRICAL SYSTEMS SHOWN ON DEMOLITION PLANS ARE BASED ON INFORMATION OBTAINED FROM ORIGINAL CONSTRUCTION CONTRACT/TENDER DOCUMENTS. THESE DRAWINGS ARE NOT BASED ON 'AS-BUILT RECORDS' OR ON EXHAUSTIVE FIELD MEASUREMENT AND ARE PROVIDED TO ASSIST THE CONTRACTOR IN DETERMINING THE EXTENT OF WORK REQUIRED. THE CONTRACTOR SHALL MAKE ALLOWANCE IN THEIR TENDER PRICE FOR THE REMOVAL OF ADDITIONAL ABANDONED SERVICES AND THE PROTECTION OF EXISTING SERVICES THAT MUST REMAIN. RECORD THE LOCATION OF ALL EXISTING SERVICES THAT REMAIN ON AS-BUILT RECORD DRAWINGS.



ST. CLAIR CATHOLIC DISTRICT SCHOOL BOARD
Lighting the Way - Rejoicing in Our Journey

No.	Revisions	Date
1	ISSUED FOR TENDER	MAY 8, 2015

REVIEW ALL DRAWINGS AND VERIFY ALL DIMENSIONS AT THE SITE. REPORT ALL DISCREPANCIES TO THE CONSULTANT BEFORE PROCEEDING WITH ANY CONSTRUCTION OR SHOP FABRICATION. ALL DRAWINGS, SPECIFICATIONS AND RELATED DOCUMENTS ARE THE COPYRIGHT PROPERTY OF 'VANDERWESTEN RUTHERFORD MANTECON' AND MUST BE RETURNED UPON REQUEST. REPRODUCTION OF DRAWINGS, SPECIFICATIONS AND RELATED DOCUMENTS IN PART OR WHOLE IS FORBIDDEN WITHOUT THE CONSULTANTS WRITTEN PERMISSION.		
CONSULTANT		
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VRM 15-048

Project:

St. Anne Elementary School - Boiler Replacement

Client:

St. Clair Catholic District School Board - St. Anne Elementary School
183 Snow Ave, Blenheim, ON N0P 1A0

Drawing Title:

MECHANICAL DRAWING LIST, LEGEND, SCHEDULES, AND NOTES

Drawn By: SVM/JVS/TR	Checked By: NV
Date: APRIL 2015	Scale: N.T.S.
Computer File Name:	Drawing No.: ME-1



- NOTES:**
- FOR COMPLETE PIPING AND VENTING CONNECTIONS, SIZING AND ACCESSORIES SEE MECHANICAL SCHEMATIC ON SHEET ME-3.
 - NEW BOILERS AND PUMPS TO BE MOUNTED ON EXISTING CONCRETE HOUSEKEEPING PAD.
 - PROVIDE 120V, 15A CIRCUIT FOR BOILER CONTROLS AND CONNECT TO CIRCUIT NP-10. COORDINATE WITH MECHANICAL FOR LOCATION OF BOILER CONTROL PANEL.

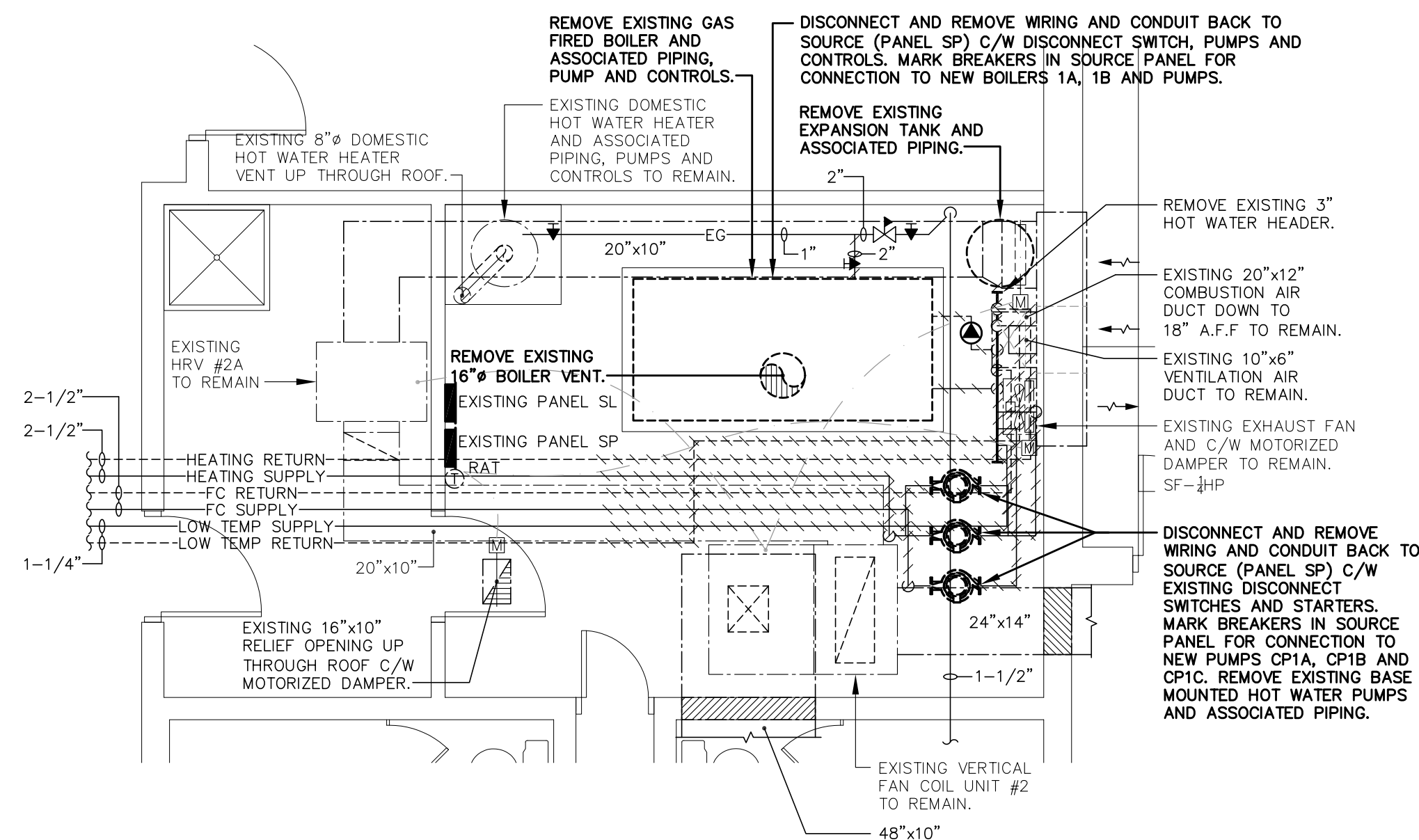
PANEL NP	225AMP 120/208V 3Ø 4W	**** MTD
WATTS/FOR	P I AMP CCT CCT AMP P FOR	**** MAIN BRKR
* HAND DRYER GIRLS	1 15 3 4 15 1	
* HAND DRYER BOYS	1 15 5 6 15 1	
* HEATER VESTIBULE	1 15 7 8 15 1	
* HEATER VESTIBULE	1 15 9 10 15 1	
* HEATER VESTIBULE	1 15 11 12 15 1	
* Foyer Fan	1 15 13 14 15 1	
* GLYCOL FUEL PUMP	1 20 15 16 15 1	
* CIRCULATION PUMP 1E	1 20 17 18 15 1	
* HRV # 1A	1 15 19 20 15 1	
* HRV # 1B	1 15 21 22 15 1	
* HRV # 1C	1 15 23 24 15 1	
* SP	1 15 25 26 15 1	
* SPARE	1 15 27 28 15 1	
* SPARE	1 15 29 30 15 1	
* SPARE	1 15 31 32 20 3	
* SPARE	1 15 33 34 15 1	
* TELEPHONE SYSTEM	1 15 35 36 15 1	
* TELEPHONE SYSTEM	1 15 37 38 15 1	
* HYDRO METER	1 15 39 40 15 1	
* HYDRO METER	1 15 41 42 15 1	

PANEL NL	225AMP 120/208V 3Ø 4W	**** MTD
WATTS/FOR	P I AMP CCT CCT AMP P FOR	**** MAIN BRKR
* LTG/REC	1 15 1 2 15 1	
* LTG/REC	1 15 3 4 15 1	
* LTG/REC	1 15 5 6 15 1	
* LTG/REC	1 15 7 8 15 1	
* LTG/REC	1 15 9 10 15 1	
* LTG/REC	1 15 11 12 15 1	
* LTG/REC	1 15 13 14 15 1	
* LTG/REC	1 15 15 16 15 1	
* LTG/REC	1 15 17 18 15 1	
* LTG/REC	1 15 19 20 15 1	
* LTG/REC	1 15 21 22 15 1	
* LTG/REC	1 15 23 24 15 1	
* LTG/REC	1 15 25 26 15 1	
* LTG/REC	1 15 27 28 15 1	
* LTG/REC	1 15 29 30 15 1	
* LTG/REC	1 15 31 32 15 1	
* LTG/REC	1 15 33 34 15 1	
* LTG/REC	1 15 35 36 15 1	
* LTG/REC	1 15 37 38 15 1	
* LTG/REC	1 15 39 40 15 1	
* LTG/REC	1 15 41 42 15 1	

PANEL OL	125AMP 120/208V 3Ø 4W	**** MTD
WATTS/FOR	P I AMP CCT CCT AMP P FOR	**** MAIN BRKR
* NORTH PARKING	1 15 1 2 15 1	
* NORTH ENTRANCE	1 15 3 4 15 1	
* FRONT	1 15 5 6 15 1	
* *	1 15 7 8 15 1	
* *	1 15 9 10 15 1	
* *	1 15 11 12 15 1	
* *	1 15 13 14 15 1	
* *	1 15 15 16 15 1	
* *	1 15 17 18 15 1	
* *	1 15 19 20 15 1	
* *	1 15 21 22 15 1	
* *	1 15 23 24 15 1	
* *	1 15 25 26 15 1	
* *	1 15 27 28 15 1	
* *	1 15 29 30 15 1	
* *	1 15 31 32 15 1	
* *	1 15 33 34 15 1	
* *	1 15 35 36 15 1	
* *	1 15 37 38 15 1	
* *	1 15 39 40 15 1	
* *	1 15 41 42 15 1	

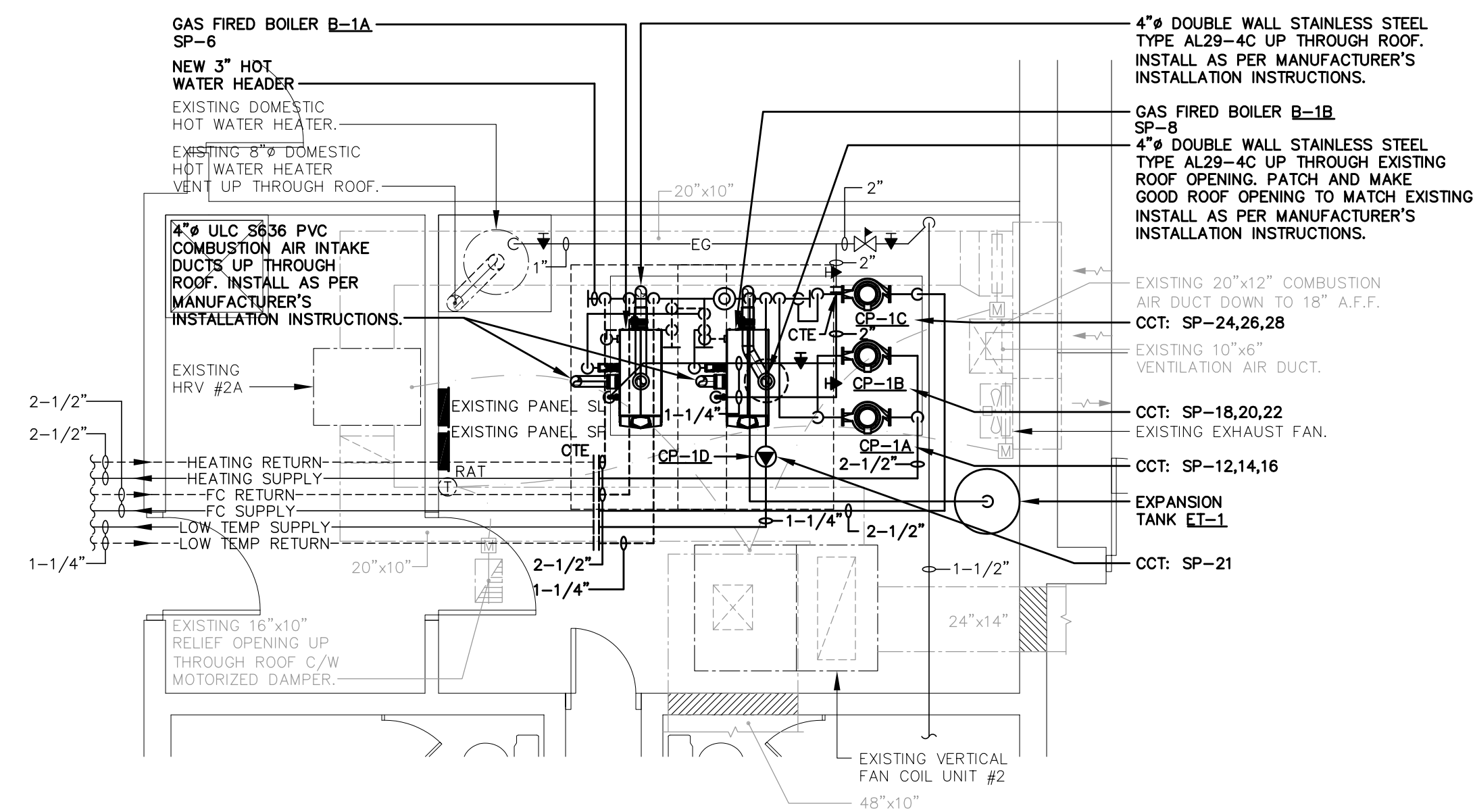
PANEL SL	225AMP 120/208V 3Ø 4W	**** MTD
WATTS/FOR	P I AMP CCT CCT AMP P FOR	**** MAIN BRKR
* LTG/REC	1 15 1 2 15 1	
* LTG/REC	1 15 3 4 15 1	
* LTG/REC	1 15 5 6 15 1	
* LTG/REC	1 15 7 8 15 1	
* LTG/REC	1 15 9 10 15 1	
* LTG/REC	1 15 11 12 15 1	
* LTG/REC	1 15 13 14 15 1	
* LTG/REC	1 15 15 16 15 1	
* LTG/REC	1 15 17 18 15 1	
* LTG/REC	1 15 19 20 15 1	
* LTG/REC	1 15 21 22 15 1	
* LTG/REC	1 15 23 24 15 1	
* LTG/REC	1 15 25 26 15 1	
* LTG/REC	1 15 27 28 15 1	
* LTG/REC	1 15 29 30 15 1	
* LTG/REC	1 15 31 32 15 1	
* LTG/REC	1 15 33 34 15 1	
* LTG/REC	1 15 35 36 15 1	
* LTG/REC	1 15 37 38 15 1	
* LTG/REC	1 15 39 40 15 1	
* LTG/REC	1 15 41 42 15 1	

PANEL SP	225AMP 120/208V 3Ø 4W	**** MTD
WATTS/FOR	P I AMP CCT CCT AMP P FOR	**** MAIN BRKR
* HAND DRYER GIRLS	1 15 1 2 15 1	
* HAND DRYER GIRLS	1 15 3 4 15 1	
* HAND DRYER BOYS	1 15 5 6 15 1	
* HAND DRYER BOYS	1 15 7 8 15 1	
* DRYER	2 30 9 10 15 1	
* WASHER	1 15 13 14 15 1	
* RECEPTACLE	1 15 15 16 15 1	
* HEATER VESTIBULE 3	1 15 17 18 15 1	
* HEATER VESTIBULE 2	1 15 19 20 15 1	
* CP-10 1/2HP 120/1	1 15 21 22 15 1	
* GLYCOL FUEL PUMP	1 15 23 24 15 1	
* CIRCULATION PUMP 2E	1 15 25 26 15 1	
* CIRCULATION PUMP 2G	1 15 27 28 15 1	
* HRV # 2A	1 15 29 30 15 1	
* HRV # 2B	1 15 31 32 15 1	
* HRV # 2C	1 15 33 34 15 1	
* SP	1 15 35 36 15 1	
* SPARE	1 15 37 38 15 1	
* SPARE	1 15 39 40 15 1	
* SPARE	1 15 41 42 15 1	



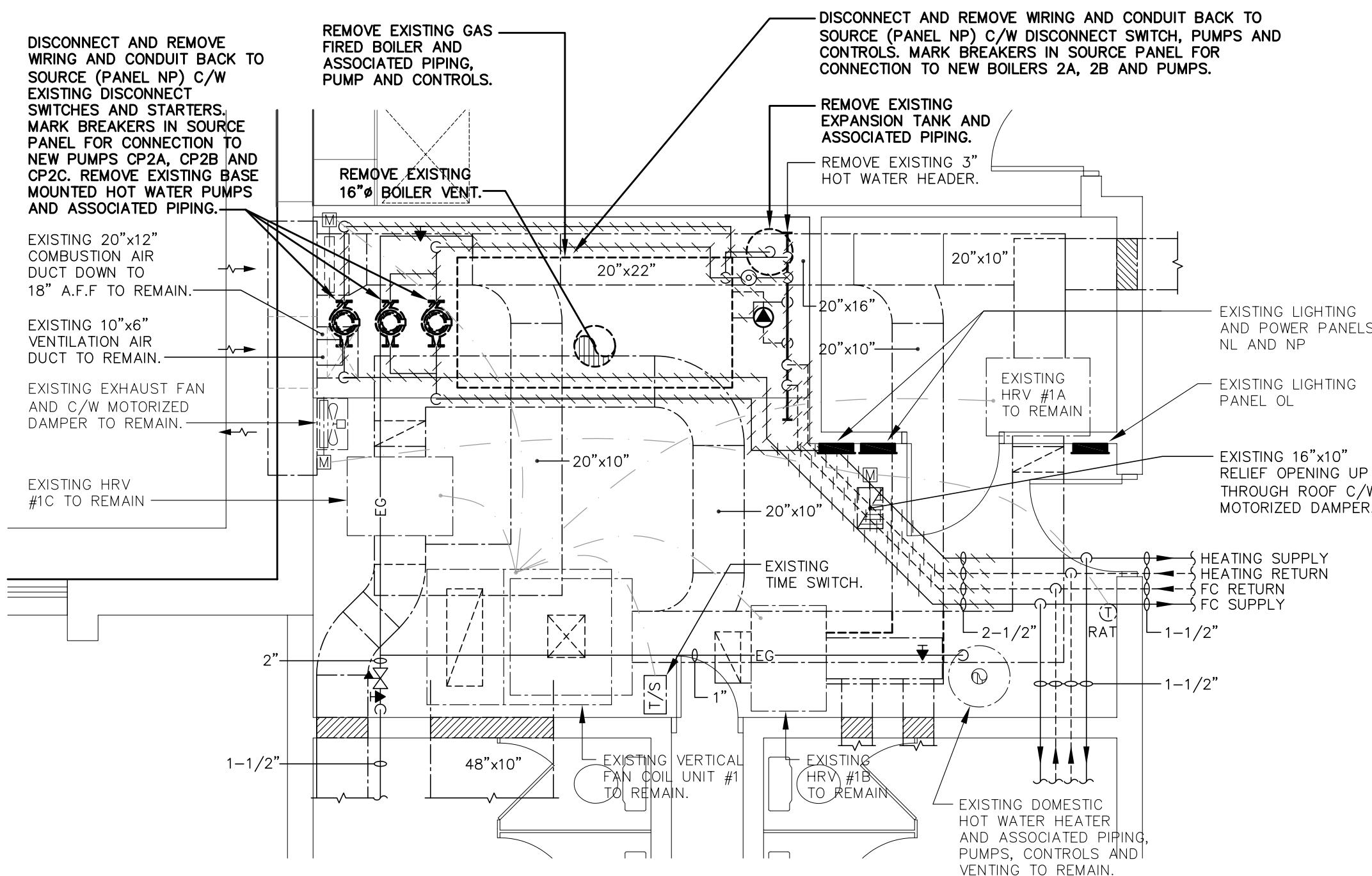
MECH. ROOM #2 FLOOR PLAN - DEMOLITION

SCALE: 1/4" = 1'-0"



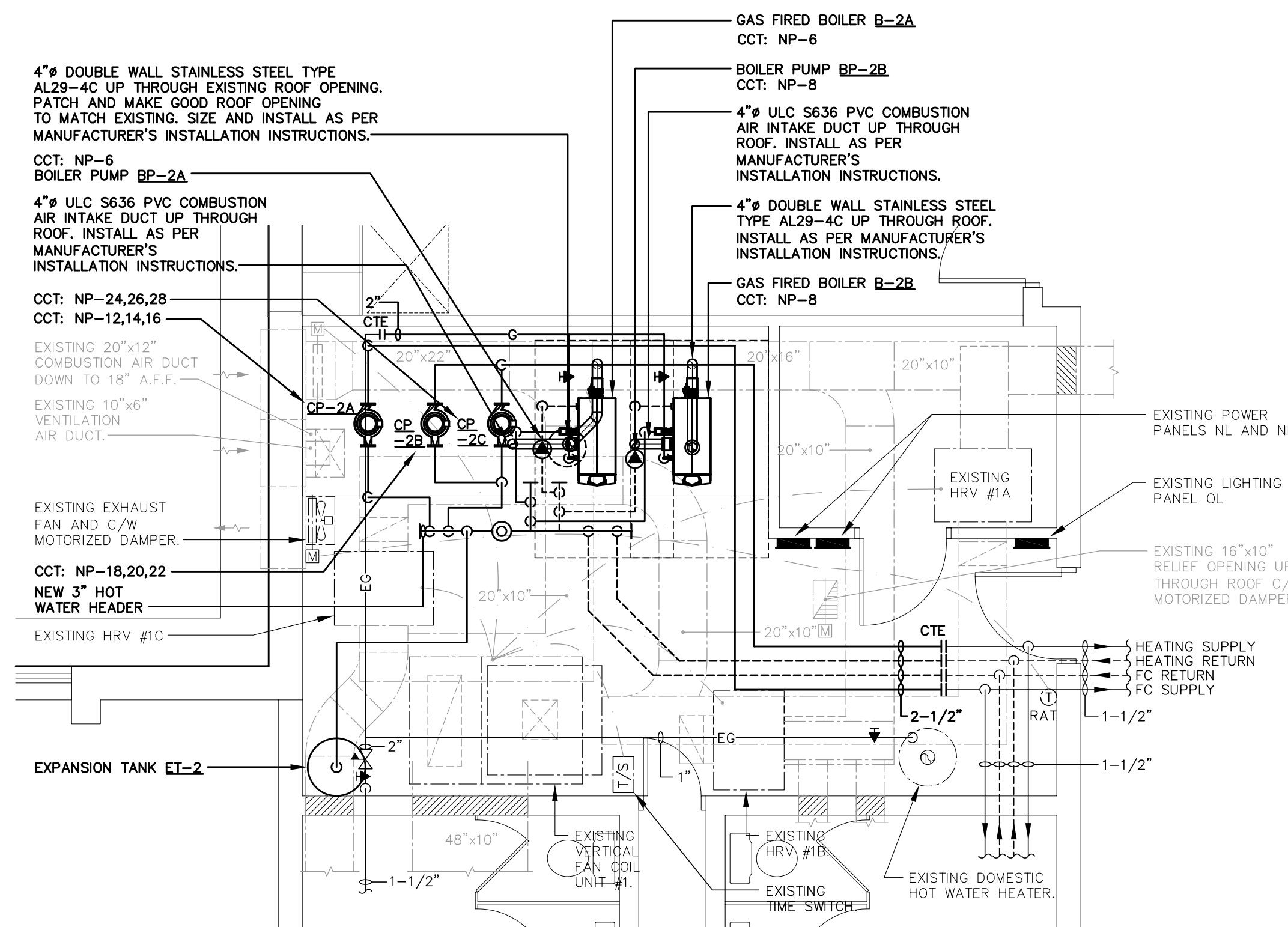
MECH. ROOM #2 FLOOR PLAN - NEW

SCALE: 1/4" = 1'-0"



MECH. ROOM #4 FLOOR PLAN - DEMOLITION

SCALE: 1/4" = 1'-0"



MECH. ROOM #4 FLOOR PLAN - NEW

SCALE: 1/4" = 1'-0"

No.	Revisions	Date
1	ISSUED FOR TENDER	MAY 8, 2015

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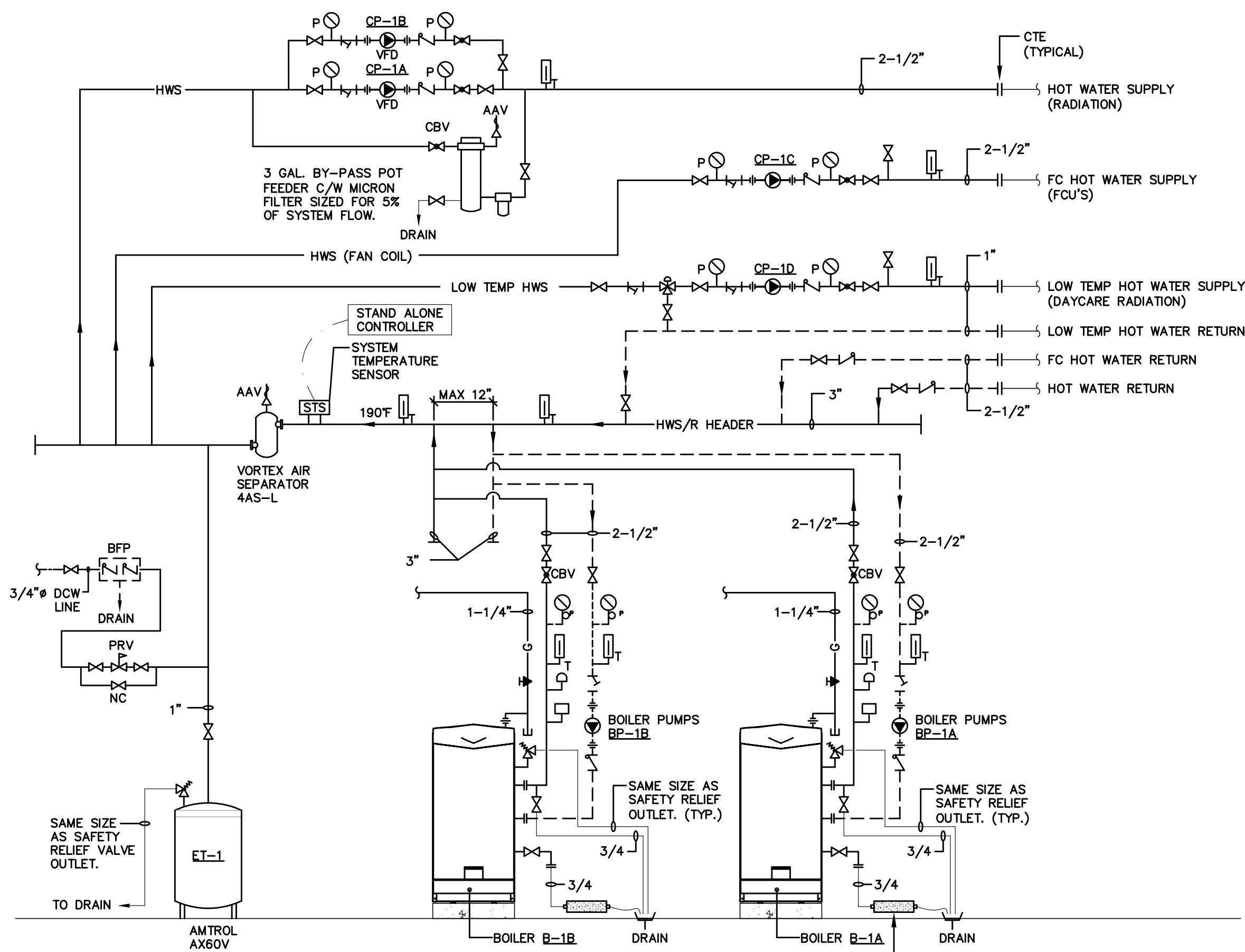
VRM 15-048

Project:
St. Anne Elementary School - Boiler Replacement

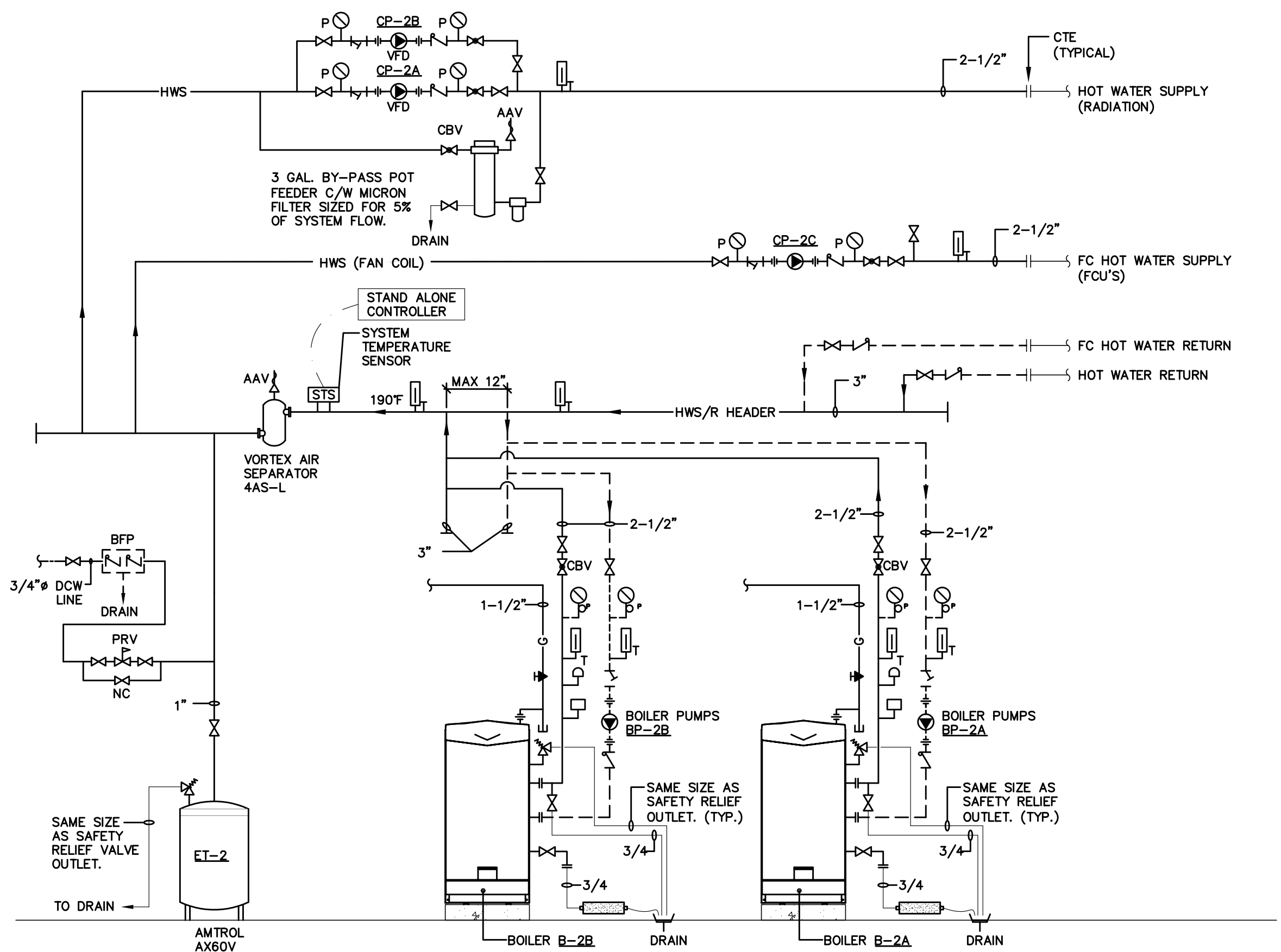
Client:
St. Clair Catholic District School Board - St. Anne Elementary School
183 Snow Ave, Blenheim, ON N0P 1A0

Drawing Title:
MECHANICAL/ELECTRICAL PLANS - DEMOLITION AND NEW BOILER RM.

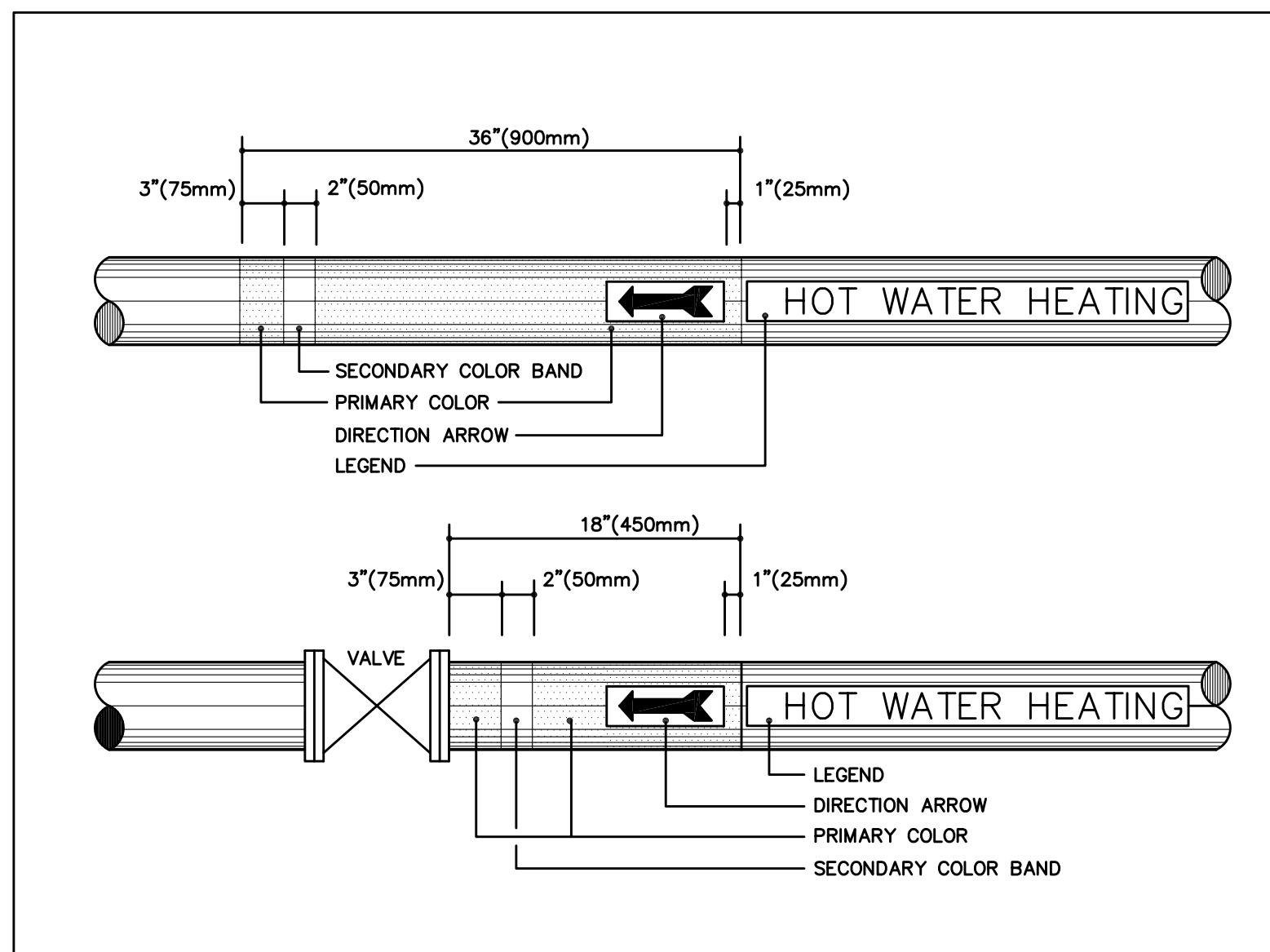
Drawn By: SVM/JVS/TR	Checked By: NV
Date: APRIL 2015	Scale: AS SHOWN
Computer File Name:	Drawing No.: ME-2



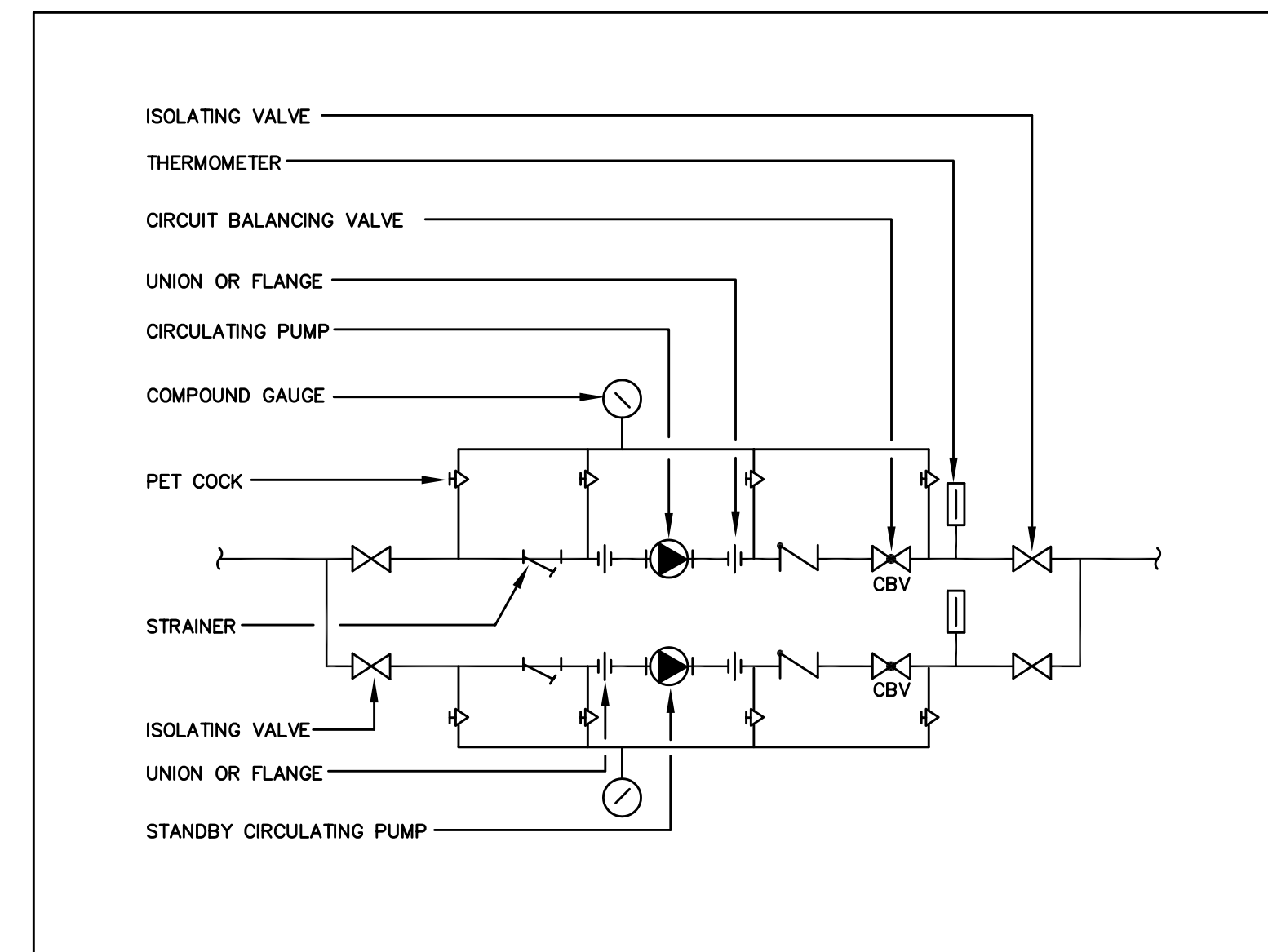
MECH. RM. #2 HEATING SCHEMATIC



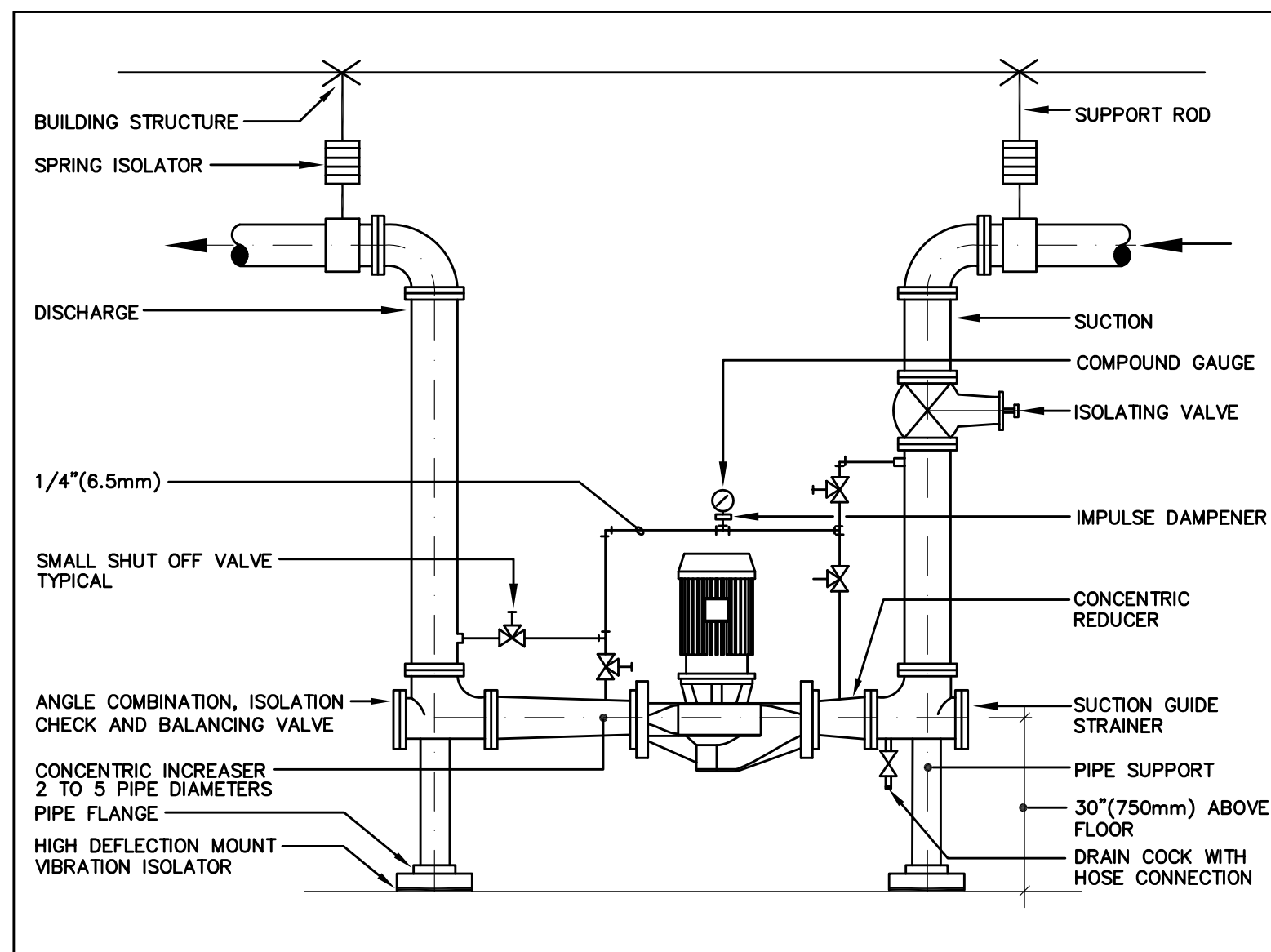
MECH. RM. #4 HEATING SCHEMATIC



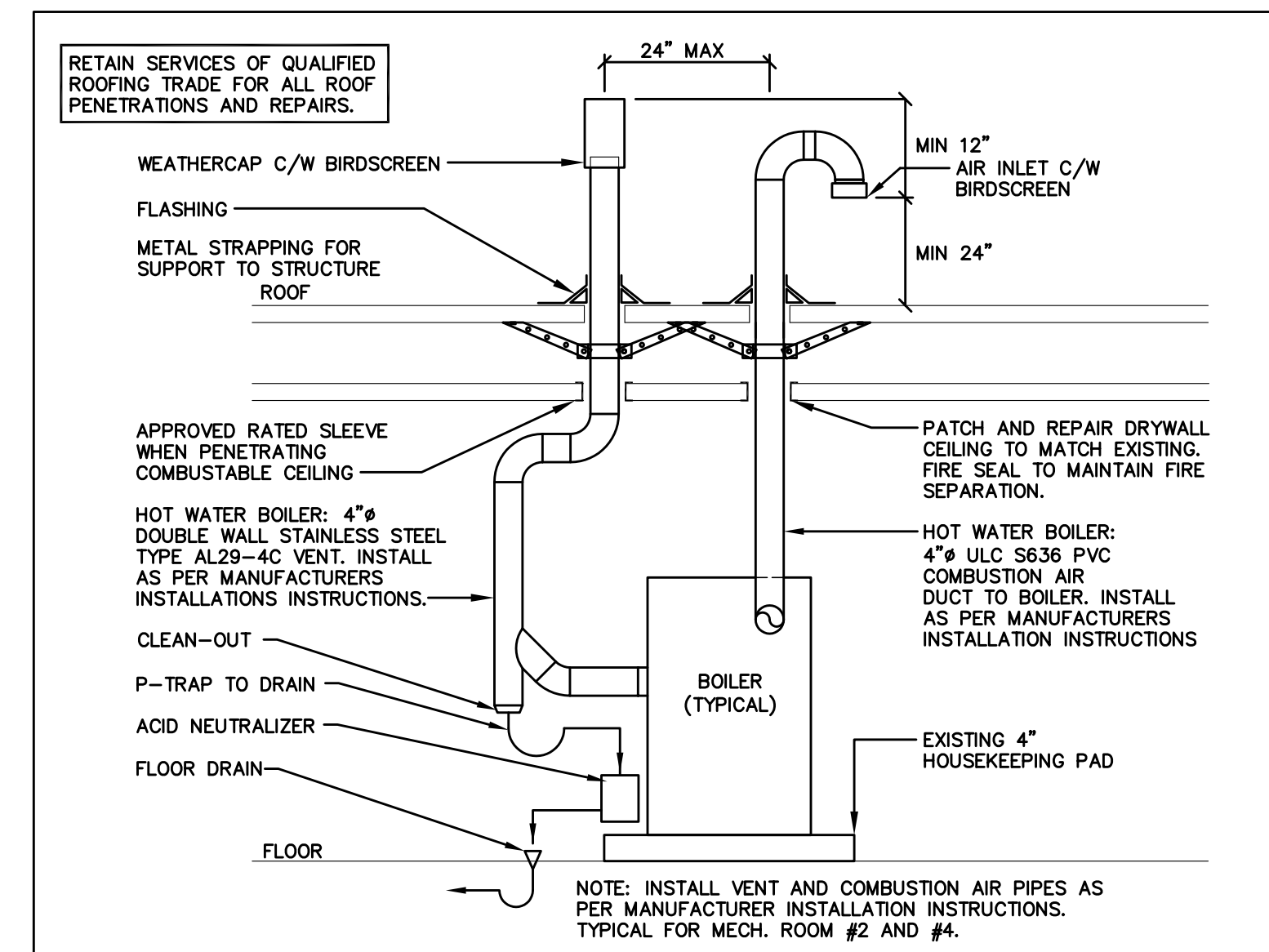
1
ME-3
DETAIL OF PIPING IDENTIFICATION



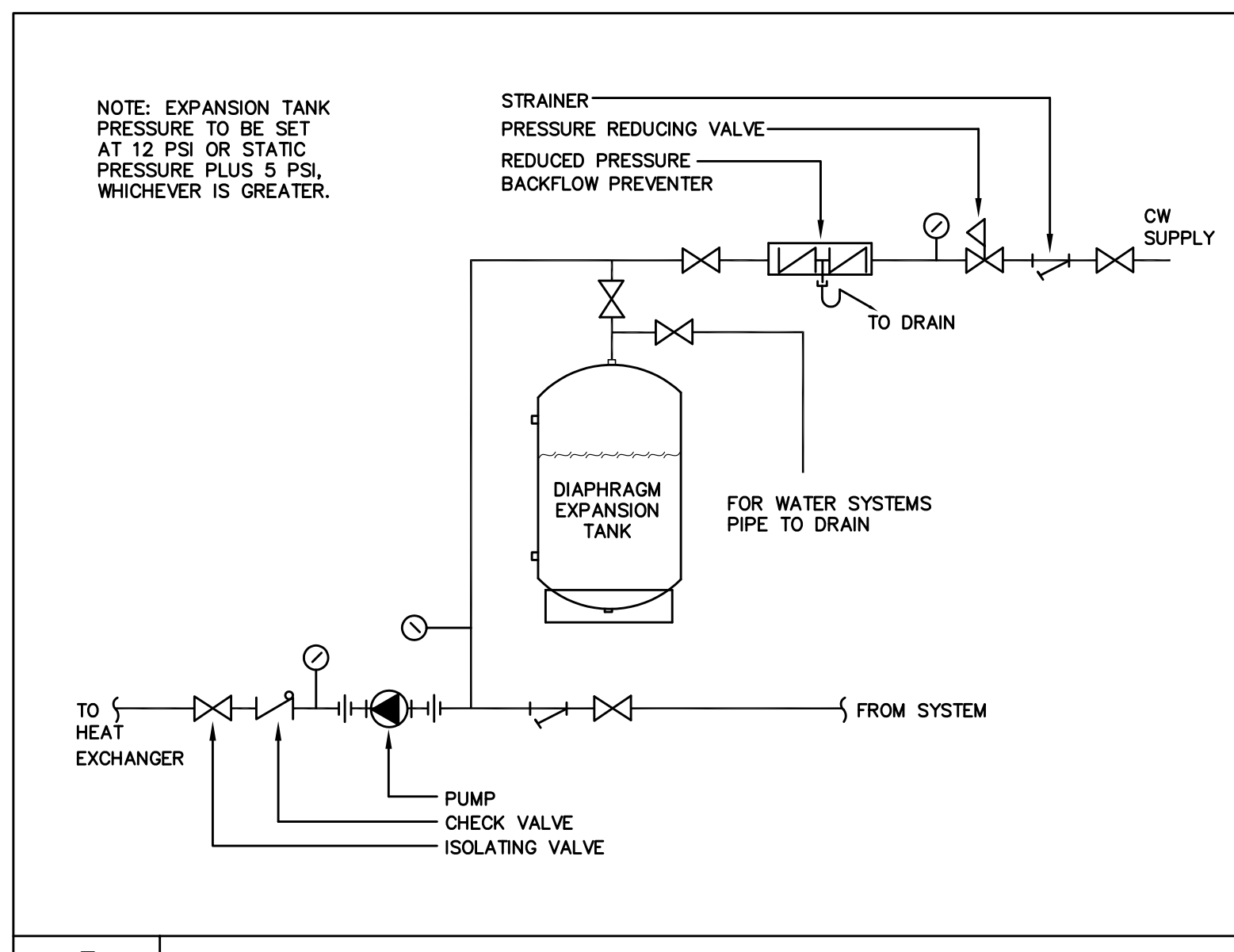
2
ME-3
PIPING SCHEMATIC OF INLINE CIRCULATING PUMP



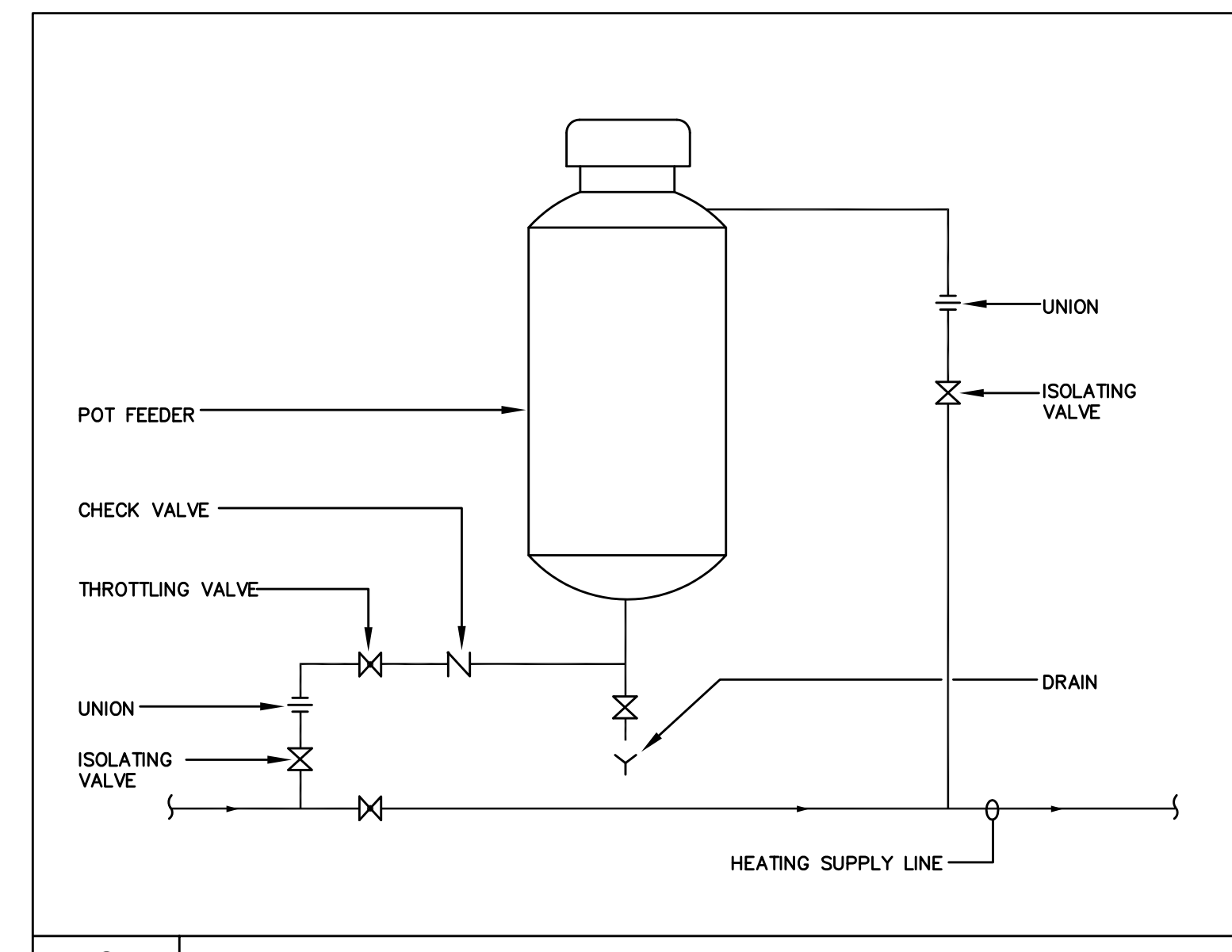
3
ME-3
DETAIL OF VERTICAL INLINE PUMP



4
ME-3
DETAIL OF BOILER COMBUSTION AND VENTING SYSTEM INSTALLATION



5
ME-3
TYPICAL EXPANSION TANK AND FILL CONNECTION



6
ME-3
DETAIL OF BYPASS POT FEEDER

No.	Revisions	Date
1	ISSUED FOR TENDER	MAY 8, 2015

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VRM 15-048

Project:
St. Anne Elementary School - Boiler Replacement

Client:
St. Clair Catholic District School Board - St. Anne Elementary School
183 Snow Ave, Blenheim, ON N0P 1A0

Drawing Title:
MECHANICAL SCHEMATICS AND DETAILS

Drawn By: SVM/JVS	Checked By: NV
Date: APRIL 2015	Scale: N.T.S.
Computer File Name:	Drawing No.: ME-3