

APPENDIX “G”

BOILERS REPLACEMENT

CFIA LABAROTORY SASKATOON, SASKATCHEWAN

CFIA PROJECT NUMBER# L0683

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1 DRAWINGS

The following is a list of the Drawings:

SERIES	NAME/TITLE	DATE	REVISION
M -001	Partial Mechanical Room and Equipment Layout	January 25, 2013	A
M -002	System Schematic	January 25, 2013	A
M -003	Partial Crawlspace Layout and Schematic	January 25, 2013	A
M -004	Mechanical Details and Equipment Schedules	January 25, 2013	A
E - 001	Electrical Demolition Layouts	January 25, 2013	A
E - 002	Electrical New Layouts	January 25, 2013	A

END OF LIST OF DRAWING SHEETS

1 THE PROJECT

- .1 The Work is a part of the Project, which comprises the following:
 - .1 Owner requires that mechanical contractor or boilers supplier shall be a member of “SaskEnergy Commercial Network Member”. SaskEnergy Commercial Network Member will need to apply for the Commercial Boiler & HVAC Program incentive offered by SaskEnergy.
 - .2 Replace three (3) existing steam boilers units complete with associate, valves, piping and controls with:
 - .1 Three (3) new high efficiency condensing boilers complete with associated pumps, valves, piping and control system;
 - .2 One (1) new steam boiler for existing animal process system complete with new condensate pump, valves, piping and controls system,
 - .1 Provide new condensate / boiler feed package for steam boiler;
 - .3 Remove and return to CFIA three (3) existing shell-plate (steam-water) heat exchangers and their associate pumps, valves and piping package, all system to be removed in a perfect condition without any damage to enable owner return the equipments;
 - .4 All vessels removed from the site with a Technical Safety Authority of Saskatchewan (TSASK) number must either have the number removed and TSASK notification form filled in. If the vessel is to be used again transfer forms from TSASK must be filled in by the receiver and site and the forms sent to TSASK;
 - .5 Install new Glycol/Glycol plate heat exchanger;
 - .6 Replace existing building perimeter radiation pumps (P-7 & 6) with new pump and associate valves;
 - .7 Remove and replace existing domestic hot water tanks with two (2) new high-efficiency unit complete with associated pip, valves and controls;
 - .1 During construction facility must have DHW for all use, all Interruptions must be planned and down time minimized for low use times only, no alternative will be accepted; for mechanical contractor require planning for temporally DHW system.
 - .8 Limited structural works as follows:
 - .1 Infill of the existing floor opening in existing mechanical rooms;
 - .2 Remove of the concrete curb around demolished boilers in existing mechanical room;

- .9 Epoxy the following floors:
 - .1 Epoxy floor material shall be glossy finished and approved by CFIA facility manager;
 - .2 Prior to new boilers installation, after removing the additional curb the existing boilers housekeeping pad on second floor;
 - .3 Electrical room floor;
 - .4 Prior to substantial completion:
 - .1 Remaining of the second floor mechanical room;
 - .2 Main floor mechanical room;
 - .3 Entire floor of "Expanded mechanical room".
- .10 Contractor shall patch and paint and restore all walls and ceilings which are affected under this contract to original and acceptable condition by CFIA, visible touch-up work will not be acceptable forms of patching.
 - .1 Note that for opening on the roof contractor retain and use of "Century Roofing" services in order to maintain the warranty on the roof, no other alternative will be accepted.
- .11 Existing "New Expanded Mechanical Room" and existing building original drawings will be provided in PDF format to the successful bidder and for information only.
- .12 Contractor shall repair to all affected area ceilings, opening and walls under this contract back to original condition prior to substantial completion.
- .13 All painting to match existing and approved by CFIA facility manager; Contractor to ensure that all serviceable valves, controls to be mounted at height that is accessible by O&M staff, coordinate with CFIA facility manager prior to final installation;
- .14 All piping or components arrive to the site must have caps to prevent contamination during shipping and storage; and
- .15 All existing demolished piping to be removed from site, no abandoned piping shall be left behind in the facility.
- .16 Electrical Scope of Work comprises the following:
 - .1 Electrical demolition pertaining to mechanical equipment demolition (unit heater, hot water tank, boilers and pumps) as noted on drawing E001 "Electrical Demolition Layouts".

- .2 Electrical new installations pertaining to mechanical equipment new installations (unit heater, hot water tank, boilers and pumps) as noted on drawing E002 "Electrical New Layouts".
- .3 Replace three 208V/3Φ/15A fuse switches in existing "MCC-2" located in Main Electrical room with three 208V/3Φ/20A fuse switches for new boiler B-2W/3W/4W.
- .4 Install one 120V/1Φ/15A circuit breaker in 120/208V panel in "MCC-X" in main mechanical room for new boiler B-1S.
- .5 Remove motor starters and install new circuit breakers, manual motor switches, motor disconnect switches as shown on drawing E001 & E002.
- .6 Install Boiler Emergency Shut Down and Boiler Emergency Stop Button as shown on drawing E002.
- .7 Install Variable Frequency Drive cabinets and associated unistrut free standing structure for pump P-25 & P-26 (575V/3F/7.5HP), each pump is to have a VFD; install VFD cables between VFD cabinets and pumps. Control by Div.23.
- .8 Because the facility will be fully occupied and functional during construction of this contract, electrical contractor is to minimize interruptions to any existing electrical services outside of this contract. When electrical shutdown to certain equipment is inevitable, contractor must provide 7 days notice in advance for facility to make appropriate arrangements.

- .2 The Project is being carried out utilizing single contract.

2 CONTRACT TIME

- .1 Date of commencement of the Contract shall be the date of issue by CFIA of a letter acknowledging acceptance of the Bid, conditional on the bidder executing the required number of copies of the Contract, as completed by CFIA to conform to the Bid, without alteration by the bidder.
- .2 Upon receipt of the letter referenced in item 2.1, the Contractor will promptly, and without undue delay, commence Work at the Project Site.

3 CONTRACTUAL ARRANGEMENT

- .1 Work shall be performed under a single contract, stipulated price arrangement.

4 WORK SEQUENCE

- .1 Construct Work in stages to accommodate Owner's continued use of premises during construction.

- .2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction.
- .3 Maintain fire access/control.

END OF SUMMARY OF WORK

1 DEFINITIONS

- .1 “**Critical Product**” means a product whose delivery time is critical to the completion of one or more stages of the Work.

2 CONTRACT TIME

- .1 The Construction Schedule and all time limits for performance of the Work stated in the Request for Bids are intended as material considerations of the Contract. The Contractor shall perform the Work expeditiously and with adequate forces to attain completion of each stage of the Work, including Facility Takeover, within the time specified in the Request for Bids.
- .2 Date of commencement of the Contract shall be the date of issue by CFIA of a letter acknowledging acceptance of the Bid, conditional on the bidder executing the required number of copies of the Contract, as completed by CFIA to conform to the Bid, without alteration by the bidder.
- .3 Upon execution of the Contract, as referenced in item 2.2, the Contractor will promptly, and without undue delay, commence Work at the Project.

3 PROGRESS ACCELERATION

- .1 If CFIA decides the progress of any stage of the Work is too slow to ensure attainment of Facility Takeover within the Contract Time, CFIA will issue written notification requiring the Contractor to take special measures deemed necessary by CFIA to accelerate progress sufficiently to regain the Construction Schedule.
- .2 The Contractor is not entitled to extra payment on account of having to take special measures to accelerate progress.

4 PROJECT SCHEDULE

- .1 Provide detailed project schedule within **14 working days** of Award of Contract date showing activity sequencing, interdependencies and duration estimates. Include listed activities as follows:
 - .1 Shop drawings.
 - .2 Samples.
 - .3 Approvals.
 - .4 Procurement.
 - .5 Construction.
 - .6 Installation.
 - .7 Testing.
 - .8 Submission of O&M materials

- .9 Commissioning and acceptance
- .2 Allow 7 working days for review by Owner Representative and Consultant of proposed construction Project Schedule.
- .3 Upon receipt of reviewed Project Schedule make necessary revisions and resubmit to Consultant for review within 2 work days.
- .4 Comply with reviewed Project Schedule.
- .5 Proceed with significant changes and deviations from scheduled sequence of activities that cause delay, only after written receipt of approval by Consultant.
- .6 Identify activities that are behind schedule and causing delay. Provide measures to regain slippage.

5 CONTRACT STAGES, COMPLETION TIMES AND MILESTONES

Stage	Time for Completion	Completion Milestone
Completion of Bid review:	T.B.D	Acceptance by CFIA
Completion of Bid review:	T.B.D	Contract Award
Mobilization:	[Established by the Contractor]	N/A
Project start-up:	T.B.D	Facility Takeover
Preparation and review of submittals related to Critical Products:	T.B.D during project start-up	Acceptance by CFIA
Work related to steam System (including mechanical, electrical and finishing):	T.B.D after review of contractor proposed project working schedule	Acceptance by CFIA
Work related to domestic hot water system (including mechanical, electrical and finishing):	T.B.D after review of contractor proposed project working schedule	Acceptance by CFIA
Performance testing:	No Later Than August 27, 2013	Substantial Performance of the Work
Fine tuning:	No Later Than October 15, 2013	Total Performance of the Work
Warranty:	No later Than August 27, 2014	Total Performance of the Work

END OF CONTRACT TIME AND TIME CONTROL

1 GENERAL COORDINATION

- .1 The Contractor will coordinate all construction activities as required to ensure efficient and orderly installation of each part of the Work.
- .2 If installation of one part of the Work is dependent on installation of other components, the Contractor will coordinate construction activities in the sequence required to obtain the best results.
- .3 If availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair.

2 ADMINISTRATIVE PROCEDURES

- .1 The Contractor will coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work. Administrative activities include, but are not limited to:
 - .1 Preparation of schedules;
 - .2 Installation and removal of temporary facilities;
 - .3 Delivery and processing of submittals;
 - .4 Progress meetings;
 - .5 Contract acceptance procedures; and

3 GENERAL INSTALLATION PROVISIONS

- .1 The Contractor will:
 - .1 require the installer of each major component to inspect both the substrate and conditions under which Work is to be performed, and ensure unsatisfactory conditions have been corrected in an acceptable manner before the Work proceeds;
 - .2 ensure compliance with manufacturer's installation instructions and recommendations, to the extent those instructions and recommendations are more explicit or stringent than requirements contained in the Contract;
 - .3 inspect Materials immediately upon delivery and prior to installation, rejecting damaged and defective items;
 - .4 provide attachment and connection devices and methods necessary for securing the Work, ensuring it is secured true to line and level with allowance for expansion and building movement;

- .5 provide uniform joint widths in exposed Work, arrange joints in exposed Work to obtain the best visual effect and refer questionable choices to the Prime Consultant for final decision;
- .6 install each component during weather conditions and Project status that will ensure the best possible results;
- .7 isolate each part of the completed construction from incompatible material, as necessary to prevent deterioration;
- .8 coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose;
- .9 install individual components at standard mounting heights recognized within the industry for the particular application indicated, unless indicated otherwise in the Drawings, referring questionable mounting height decisions to the Prime Consultant for final decision; and
- .10 supervise construction activities to ensure that no part of the Work, completed or in progress, is subject to harmful, dangerous, damaging or otherwise deleterious exposure during the construction period.

4 OPERATIONS CONTACT

- .1 CFIA will appoint an Operations Contact to be the Contractor's contact regarding all facets of the work which directly or indirectly affect the function of the facility.
- .2 Contractor shall comply with all instructions and directions given by the Operations Contact so as to minimize disruption to the functions of the building.

END OF PROJECT COORDINATION

1 PRE-CONSTRUCTION MEETING

- .1 The Contractor will schedule a pre-construction meeting to take place no more than {15} days after the date of commencement of the Contract and prior to commencement of activities at the Project Site.
- .2 This meeting will be chaired by Prime Consultant.
- .3 The location of the meeting will be at project site.
- .4 Attendees
 - .1 Contractor: Senior management, Project manager, site superintendent, representatives of major Subcontractors, and others as necessary.
 - .2 CFIA and Prime Consultant representatives as determined by CFIA and the Prime Consultant.
- .5 Agenda
 - .1 Introduction of CFIA team, Prime Consultant, and Contractor representatives and a review of their respective assignments.
 - .2 Review of the significant contractual / execution responsibilities and administrative and procedural requirements.
 - .3 Other business.
- .6 Prime Consultant will record minutes and distribute copies to all attendees no more than ten days after the meeting.

2 CONSTRUCTION PROGRESS MEETINGS

- .1 Unless otherwise directed by the Prime Consultant, the Contractor will schedule based on (T.B.D during pre-construction meeting) construction progress meetings during the course of the Work to monitor construction progress and identify problems, and decide actions required for their solution, to expedite the Work.
- .2 This meeting will be chaired by a Prime Consultant representative.
- .3 The location of the meeting will be project site or teleconference, exact time of the meeting and type will be reviewed with contractor at project start-up meeting;
- .4 Attendees
 - .1 Contractor: Project manager, site superintendent and, when requested by Prime Consultant, Subcontractors and other parties involved in the Work, all of whom will be qualified and authorized to act on behalf of the party each represents.

- .2 CFIA and Prime Consultant representatives as determined by CFAI and the Prime Consultant.
- .5 Agenda:
 - .1 Review and approval of minutes of previous meeting.
 - .2 Review of items of significance that could affect progress.
 - .3 Other topics for discussion, as appropriate to the current status of the Work.
- .6 Prime Consultant will record minutes and distribute copies to all attendees no more than ten days after the meeting.

3 WARRANTY MEETINGS

- .1 Warranty meetings will be held on an 'as needed' basis between Substantial Performance of the Work and Total Performance of the Work to bring to Contractor's attention Deficiencies identified during warranty period, determine action required for their correction, and monitor progress of Contract Deficiency correction.
- .2 This meeting will be chaired by a Prime Consultant representative.
- .3 The location of these meetings will be as agreed between the Prime Consultant and the Contractor.
- .4 Attendees
 - .1 Contractor: Project manager, site superintendent and, when requested by Prime Consultant, Subcontractors and other parties involved in the Work, all of whom will be qualified and authorized to act on behalf of the party each represents.
 - .2 CFIA and Prime Consultant representatives as determined by CFIA and the Prime Consultant.
- .5 Agenda
 - .1 Review and approval of minutes of previous meeting.
 - .2 Review of progress of Deficiency correction.
 - .3 Identification of problems impeding Deficiency correction.
 - .4 Review of outstanding Deficiencies.
 - .5 Other business.
- .6 Prime Consultant will record minutes and distribute copies to all attendees no more than ten days after the meeting.

END OF PROJECT MEETINGS

1 WORKERS' COMPENSATION BOARD CERTIFICATE

- .1 Before commencement of activities at the Project Site, the Contractor will obtain and submit to Prime Consultant a certificate of account with the Workers' Compensation Board.

2 CASH FLOW FORECAST

- .1 Before submission of first application for payment, the Contractor will submit a forecast of approximate monthly progress payments for the duration of the Contract to the Prime Consultant for approval.
- .2 This cash flow forecast will be revised by the Contractor as the Work progresses, as required, or when requested by the Prime Consultant.

3 PRODUCT DATA AND SAMPLES

- .1 The Contractor will submit to Prime Consultant all product data and samples called for by the Scope Documents and for any other items the Prime Consultant reasonably requests. The Contractor is not permitted to proceed with the Work until those submissions have been reviewed.
- .2 Product data is standard printed information describing materials, products, equipment and systems; not specially prepared for the Work, and includes manufacturers' standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and descriptive data. Product data will be accepted in lieu of Shop Drawings, provided that:
 - .1 information not applicable to the Work is deleted, and
 - .2 standard information is supplemented with information specifically applicable to the Work, as applicable.

4 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .3 Allow 7 days for Consultant's review of each submission.
- .4 Adjustments made on shop drawings by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.
- .5 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.
- .6 Accompany submissions with transmittal letter, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
- .7 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - Subcontractor.
 - Supplier Manufacture
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .6 Fabrication.
 - Layout, showing dimensions, including identified field dimensions, and clearances.
 - Setting or erection details.
 - Capacities.
 - Performance characteristics.

- Standards.
 - Operating weight.
 - Wiring diagrams.
 - Single line and schematic diagrams.
 - Relationship to adjacent work.
- .8 After Consultant's review, distribute copies.
- .9 Submit 1 stamped electronic non-secure PDF copy of shop drawings and product data sheet for each requirement requested in specification Sections and as requested by Consultant.
- .10 Submit 1 electronic non-secure PDF copy of test reports for requirements requested in specification Sections and as requested by Consultant.
- .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 1 years of date of contract award for project.
- .11 Submit 1 electronic non-secure PDF copy of manufacturers instructions for requirements requested in specification Sections and as requested by Consultant.
- .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .12 Submit 1 electronic non-secure PDF copy of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Consultant. Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .13 Submit 4 prints to facility manger and 1 electronic non-secure PDF copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Consultant.
- .14 Delete information not applicable to project.
- .15 Supplement standard information to provide details applicable to project.
- .16 If upon review by Consultant , no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

END OF SUBMITTAL PROCEDURES

1 INTENT

- .1 Due to the nature of the Project Site, Contractor will ensure the Work is performed in accordance with the listed special procedures, required for the Work.

2 DEFINITIONS

The following definition applies only to this section.

- .1 “**Contractor Personnel**” means all personnel who require access to the Project Site for the purpose of performing part of the Work.

3 MECHANICAL AND ELECTRICAL SERVICE OUTAGES

- .1 The Contractor will coordinate service outages **minimum of 10 days in advance** of and revisions with the Operations Contact, minimizing disruptions to the facility operations and building system functions.

4 CONTRACTOR'S USE OF PROJECT SITE

- .1 The Contractor will have partial use of the Project Site for performance of the Work.
- .2 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .3 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .4 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Consultant.
- .5 At completion of operations condition of existing work: equal to or better than that which existed before new work started.
- .6 The Contractor shall limit its use of the Project Site to the following areas:
 - .1 Existing Boiler Room.
 - .2 Existing Main Electrical Room.
- .7 The Contractor shall limit its use of the Project Site to allow for:
 - .3 Facility O&M team; and
 - .4 The work of other contractors;

5 USER OCCUPANCY

- .1 Users will occupy premises during the Contract Time. The Contractor will cooperate with CFIA and user's representative to minimize conflict and to facilitate usage. Users will temporarily vacate portions of the premises to permit access to those areas for performance of the Work.

6 RESPONSIBILITY FOR EXISTING PROPERTY

- .1 The Contractor shall assume full care, custody and control of premises assigned to him for performance of the Work, including responsibility for making good any damage to existing property attributable to performance of the work.
- .2 Where Work involves breaking into or connecting to existing services, give CFIA Representative 96 hours of advance notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum; carry out interruptions after normal working hours of occupants, preferably on weekends.

7 SPECIAL REQUIREMENTS

- .1 Ensure that Contractor personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .2 Keep within limits of work and avenues of ingress and egress.
- .3 Ingress and egress of Contractor vehicles at site is limited to 1.
- .4 Deliver materials outside of peak traffic hours 6:00-7:00 or 17:00 to 18:00 unless otherwise approved by Owner Representative.
- .5 If Work is required outside normal working hours due to scheduling requirements or interference with facility operations, the Contractor will carry out this Work as directed by the Operations Contact.
- .6 The Contractor will time deliveries and unloading to prevent traffic congestion, and will keep entrances and exits of existing buildings clear at all times.
- .7 Comply with smoking restrictions. Smoking is not allowed.

8 SECURITY CLEARANCES

- .1 Personnel will be checked daily at start of work shift and provided with pass which has to be worn at all times. Pass must be returned at end of work shift and personnel account.

9 IDENTIFICATION BADGES

- .1 The Contractor will obtain identification badges from CFAI for all Contractor Personnel working at the Project Site, which must be worn at all times at the Project Site.
- .2 The Contractor will furnish a directory listing companies and Contractor Personnel employed on the Project Site, including their addresses and telephone numbers.

10 PARKING

- .1 There are **no provisions** for parking on site.

11 ELEVATORS

- .1 Designated permanent service elevators may not be used by Contractor Personnel and for transporting Materials.

12 INDEPENDENT INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies will be engaged by Owner for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by owner.
- .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Consultant at no cost to owner. Pay costs for retesting and re-inspection.

13 INSTALLATION AND REMOVAL

- .1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.
- .2 Identify areas which have to be gravelled to prevent tracking of mud.
- .3 Indicate use of supplemental or other staging area.
- .4 Provide construction facilities in order to execute work expeditiously.
- .5 Remove from site all such work after use.

14 SCAFFOLDING & HOISTING

- .1 Provide and maintain scaffolding, ramps, ladders, platforms.
- .2 Provide, operate and maintain hoists cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.
- .3 Hoists cranes to be operated by qualified operator.

15 PROCEDURES

- .1 Notify appropriate agency, Owner Representative and Consultant at minimum of 7 days in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

16 PRODUCT QUALITY

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

17 STORAGE, HANDLING AND PROTECTION

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

18 MANUFACTURER'S INSTRUCTIONS

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

19 QUALITY OF WORK

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

20 CO-ORDINATION

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.
- .3 Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated without written approval of Consultant.
- .4 Location of equipment and fixtures:

- .1 Location of equipment and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipments and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Owner Representative of impending installation and obtain approval for actual location.

21 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Consultant as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of Consultant it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Consultant.

END OF SPECIAL PROJECT PROCEDURES

1 WORK SITE SAFETY - CONSTRUCTION CONTRACTOR IS PRIME CONTRACTOR FOR SAFETY

- .1 The Prime Contractor for Safety on the Project Site will be the contractor for the following other construction contract, to be performed concurrently with the Work:
- .2 The Contractor will cooperate with, and comply promptly with any directives of, the designated Prime Contractor for Safety on safety related matters.
- .3 The Contractor will comply with the *Occupational Health and Safety Act* (Saskatchewan and National) and its regulations, as required to ensure the health and safety of all persons at the "work site". }

END OF GOVERNMENTAL SAFETY REQUIREMENTS – PRIME CONTRACTOR FOR SAFETY

1 DEFINITIONS

The following definition applies only to this section.

- .1 **“Regulatory Requirements”** means laws, by-laws, ordinances, rules, regulations, codes, and orders of authorities having jurisdiction, and other legally enforceable requirements applicable to the Work and which are in, or come into, force during the Contract Time.

2 GENERAL

- .1 The Contractor will comply with Regulatory Requirements, unless specifically directed otherwise in the Request for Bids.
- .2 Except as otherwise specified, the Contractor will apply for, obtain and pay all fees associated with permits, licenses, certificates and approvals required by Regulatory Requirements and the proposed Contract, based on:
 - .1 Regulatory Requirements and fees in force at Closing; and
 - .2 Any change in Regulatory Requirements or fees scheduled to become effective after Closing and of which public notice has been given before Closing.
- .3 The Contractor shall give all notices required by Regulatory Requirements.
- .4 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .5 CFIA OHS representative or Consultant may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.
- .6 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .7 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.
- .8 Where reference is made to Authority having Jurisdiction, it shall mean all authorities who have within their constituted powers the right to enforce the laws of the place of building.
- .9 Work Stoppage:
 - .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

3 UNFORSEEN HAZARDS

- .1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise CFIA representative and Consultant in writing.

4 CHANGES DUE TO REGULATORY REQUIREMENTS

- .1 Bidders will be responsible for verifying that the Request for Bids complies with Regulatory Requirements. However, if the Request for Bids is at variance with Regulatory Requirements, or if changes are made to Regulatory Requirements after Closing which necessitate modification to the Request for Bids, a bidder will notify the Prime Consultant in writing immediately the variance or change becomes known to him, requesting direction. The Prime Consultant may make changes required to the proposed Contract, and any resulting change in the Contract Price or Contract Time in the Bid will be made in accordance with the procedure described in the Contract.

5 CODE'S

- .1 Perform Work in accordance with National Building Code of Canada 2005 (NBC) and National Fire Code 2005 (NFC) including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 Where edition date is not specified, consider that references to manufacturer's and published codes, standards and specifications are made to the latest edition (revision) approved by the issuing organization, current at the date of the Specifications.
- .3 Reference standard and specifications are quoted in the Specifications to establish minimum standards. Work of quality or of performance characteristics that exceeds these minimum standards will be considered to conform.
- .4 Should the Contract Documents conflict with specified reference standards or specifications, the General Conditions of the Contract shall govern.

6 PERMITS

- .1 Building Permit
 - .1 The Contractor shall apply for, obtain and pay for building permit and other permits required for the Work.
 - .2 The Contractor shall display the building permit, and any other necessary permits, in a conspicuous location at the Project Site.

.2 Occupancy Permits

- .1 Where required by an authority having jurisdiction, the Contractor shall apply for, obtain, and pay for occupancy permits, including partial occupancy permits.
- .2 Where Scope Document deficiencies are required to be corrected to obtain occupancy permits, including partial occupancy permits, the Prime Consultant will issue appropriate instructions to correct the Work.
- .3 The Contractor will turn occupancy permits over to Prime Consultant.

END OF REGULATORY REQUIREMENTS

1 REFERENCE STANDARDS

- .1 Within the text of the Request for Bids, reference may be made to the following standards:
 - .1 ANSI - American National Standards Institute
 - .2 ASTM - American Society for Testing and Materials
 - .3 CGSB - Canadian General Standards Board
 - .4 CSA - Canadian Standards Association
 - .5 CAN - National Standard of Canada (published by CGSB)
 - .6 FM - Factory Mutual Engineering Corporation
 - .7 ULC - Underwriters Laboratories of Canada
 - .8 NBC: National Building Code 2005
 - .9 NFC: National Fire Code 2005;
 - .10 NPC: National Plumbing Code 2010
- .2 The referenced standard, and any amendments in force at Closing, will be applicable to the Work during the duration of the Contract.

END OF REFERENCE STANDARDS

1 INTENT

- .1 The Contractor will provide temporary boilers and controls specified in this section and as otherwise required for performance of the Work.

2 FIELD OFFICES AND SHEDS

- .1 Contractor's Site office: During the entire period of performance of the Work, provide and maintain a suitable office on the Project Site for the Contractor's use, with suitable tables or benches for storage and examination of Project drawings, specifications and other documents, and where all notices and instructions from CFIA may be received and acknowledged.
- .2 Materials storage: There will be no on-site Materials storage on the Project. Contractor will be responsible for the provision of, and payment for, off-site storage. Materials are only to be brought to the Project Site immediately prior to their incorporation into the Work.

3 UTILITIES

- .1 All utility services essential to CFIA continuous occupation and operation of all areas outside the Project Site will be maintained in operation by CFIA, who will have unfettered access to these services where they pass through the Project Site.
- .2 Sanitary Facilities:
 - .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
 - .2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.
- .3 Water Supply: The Contractor will be permitted use of existing water supply for construction purposes, at no cost to the Contractor. Contractor will be responsible for all connections, disconnections, service lines, valves, etc. required to provide water supply service, and their removal on completion of the Work to the satisfaction of CFIA.
- .4 Temporary Light and Power: The Contractor will be permitted use of existing light and power for construction purposes, at no cost to the Contractor. The Contractor will be responsible for all connections, disconnections, switches, service lines, etc., to provide light and power, and their removal on completion of the Work; however, CFIA may discontinue those temporary services without notice, and without acceptance of any liability for damage or delay caused by withdrawal of those temporary services. Contractor will bear costs of all temporary services required for the Project in excess of those supplied by CFIA.

- .5 Temporary Heating (Not Applicable)
- .6 Telephone: Contractor will be permitted use of existing telephone service for emergency purposes only, at no cost to the Contractor.
- .7 Temporary Domestic Hot Water: The Contractor shall have a plan to provide for, and pay for, temporally "Domestic Hot Water (DHW)" system the facility during its erection and until date of system is fully operational. The Contractor will ensure the temporary DHW system will maintain dual temperature of 82°C and 60°C as required by the facility. The cost of temporally DHW system including any equipment (boilers, chimneys, pumps, piping, valves, tanks, etc.) necessary for temporary hook-up, will be included in the Contract Price.

4 TEMPORARY ENCLOSURES

- .1 The Contractor will provide temporary barriers and enclosures, as required to ensure that construction Work may be carried out under temperature controlled conditions and continues unhampered by adverse weather conditions through to completion of the Work.

5 PROTECTION OF THE PUBLIC AND FIRE SAFETY

- .1 Comply with requirements of the National Building Code, Part 8, except as specified otherwise.

6 ACTIVITIES GENERATING VIBRATION, NOISE OR SAFETY CONCERNS

- .1 Operations considered by CFIA to generate vibration, noise or safety concerns include, but are not limited to:
 - .1 Noise generating activities (in excess of 70 db)
 - .2 Jack hammering
 - .3 Shot-blasting
 - .4 Sandblasting
 - .5 Cutting and coring of concrete
 - .6 Use of powder actuated fasteners
- .2 For all such noted activities, the Contractor will:
 - .1 Provide the Operations Contact with a week in advance notice for the planned activity and request approval to carry out this Work, scheduling timing of this Work with the Operations Contact.

- .2 Stop Work generating vibration, noise or safety concerns, when instructed verbally or in writing by CFIA, Prime Consultant or Prime Contractor for Safety. This stopped Work is not permitted to be resumed until authorized by the Operations Contact.

7 ENVIRONMENTAL CONTROLS

- .1 All areas for performance of the Work must be maintained under negative air pressure for the Contract Time.
- .2 The Contractor will provide all necessary dust, noise, fume and odour barriers to adequately protect the existing facilities from environmental effects of the Work.

8 PREVENTING MOULD DURING CONSTRUCTION

- .1 The Contractor will monitor interior relative humidity conditions in relation to surface temperatures to prevent generation of moisture that may contribute to mould growth on the surface of organic construction Materials.
- .2 If using temporary heaters, use a type that exhausts combustion products directly to the exterior of building enclosures. Use of temporary heaters that exhaust combustion products into building enclosures is not permitted.
- .3 Install insulation concurrently with air and vapour retarder.
- .4 Protect all organic construction Materials from the elements, before, during and after their installation.
- .5 Refer to CCA 82 - 2004 "Mould Guidelines for the Canadian Construction Industry", published by the Canadian Construction Association, for additional information about mould, its implications and recommendations on its prevention.
- .6 The Contractor will promptly report to the Prime Consultant any mould growth observed at the Project Site. If CFIA determines that mould growth was caused by the Work, the Contractor shall promptly remove the mould in accordance with procedures prescribed by CFIA, at no cost to CFIA.

9 CLEANING DURING CONSTRUCTION

- .1 The Contractor will:
 - .1 At regular intervals during progress of Work, clean-up the Project Site and dispose of waste material, rubbish, and debris;
 - .2 Do not allow waste material, rubbish and debris to accumulate and become an unsightly or hazardous condition. The Project Site will be maintained in a clean and orderly condition;

- .3 Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces and other closed or remote spaces, prior to enclosing the space;
- .4 Do not allow waste material, rubbish and windblown debris to contaminate adjacent properties; sprinkle dusty debris with water, as required;
- .5 Lower waste material in a controlled manner; not permitting waste material to be dropped or thrown from heights; and
- .6 Clean interior facility areas prior to commencement of painting and finishing operations and continue cleaning on an as-needed basis to eliminate dust until building is ready for occupancy.

10 WASTE DISPOSAL REQUIREMENTS

The Contractor will:

- .1 comply with Laws pertaining to disposal operations;
- .2 provide on-site metal containers with lids for collection and temporary storage of waste material, rubbish and debris;
- .3 dispose of waste material, rubbish and debris at disposal areas away from the Project Site;
- .4 not burn or bury waste material, rubbish or debris at the Project Site, or dispose of wastes into brooks, streams, rivers, waterways, lakes or ponds; and
- .5 not dispose of volatile wastes, such as mineral spirits, oil or paint thinner, in storm or sanitary drains.

11 CLEANING OF STREETS AND SIDEWALKS

- .1 The Contractor will take precautions to prevent depositing of mud or debris on roadways, sidewalks and paved areas, promptly cleaning up any mud or debris so deposited.
- .2 Neglect of these requirements will cause CFIA to have necessary clean-up work carried out and to charge all costs to the Contractor.

END OF TEMPORARY FACILITIES AND CONTROLS

1 RELATED SECTIONS

- .1 This section pertains to final cleaning of the facilities only. Cleaning during construction and waste disposal are described in section 01 50 00 – Temporary Facilities and Controls.

2 DELIVERY, STORAGE AND HANDLING

The Contractor will:

- .1 protect packaging during delivery, storage and handling to prevent development of mould and mildew on packaging and on products.
- .2 request that suppliers provide cleaning materials which minimize packaging and equipment and deliver cleaning materials in recyclable or reusable packaging, such as cardboard, wood paper or reusable blankets, which will be reclaimed by supplier or manufacturer for recycling.

3 CLEANING MATERIALS

- .1 Use only cleaning materials recommended by the manufacturer of the Material to be cleaned.
- .2 Use cleaning materials only on the surfaces recommended by cleaning material manufacturer, following manufacturers' printed instructions and ensuring that cleaning agents and methods do not remove finishes and permanent protective coatings on surfaces being cleaned.

4 FINAL CLEANING

- .1 Perform final cleaning operations prior to request for inspection for Facility Takeover.
- .2 Use a professional cleaning firm for final cleaning operations.
- .3 Remove grease, paint spots, dirt, dust, stains, labels, fingerprints and other foreign matter from interior and exterior surfaces; vacuum and dust behind grilles, electrical outlets and boxes, louvres and screens; wash floor surfaces not otherwise finished; clean metal doors and frames; clean metal work; clean equipment; clean hardware; clean and polish glass on both sides and clean and polish mirrors.
- .4 Repair, patch and touch-up marred surfaces to match adjacent finishes.
- .5 Replace cracked and broken glass.
- .6 Replace all dirty, stained or broken lay-in ceiling tiles.
- .7 Broom clean or remove snow and ice from all exterior paved areas designed for pedestrian or vehicular traffic, including parking areas.

- .8 Thoroughly reclean all affected surfaces during correction of Deficiencies.
- .9 Leave all surfaces in perfectly clean and unsoiled condition to CFIA satisfaction.
- .10 Remove all waste generated during cleaning operations from the project site.

END OF FINAL CLEANING

1 INTENT

- .1 The Contractor shall obtain all specified operation and maintenance data, and using this data, shall prepare and submit three (3) hard copy sets & one (1) digital copy in PDF format on CD of operation and maintenance manuals.

2 DESCRIPTION OF TYPES OF OPERATION AND MAINTENANCE DATA

- .1 Data on Contractor-supplied equipment and systems, including:
 - .1 system design criteria;
 - .2 system and controls descriptions;
 - .3 system and controls schematics; and
 - .4 operating instructions.
- .2 Installation instructions: manufacturer's printed instructions describing manufacturer's recommended installation procedures.
- .3 Operating instructions: manufacturer's printed instructions describing proper operation.
- .4 Equipment identification: name plate information for each piece of equipment.
- .5 Maintenance instructions: manufacturer's printed instructions describing manufacturer's recommended maintenance.
- .6 Spare parts lists: parts lists and manufacturer's recommended spare parts.
- .7 Suppliers and Subcontractors list: list of Subcontractors and suppliers who supplied and installed equipment, systems, Materials or finishes, organized by division and system, and including company name, address and telephone number.
- .8 Tag directories: directory identifying tag number and equipment description and location.
- .9 Drawings list: list of Drawings.
- .10 Shop Drawings: final reviewed/stamped shop drawings.
- .11 Product data: manufacturer's product data for equipment, systems, Materials and finishes.
- .12 Certifications, including:
 - .1 Copies of inspection reports prepared by authorities having jurisdiction;
 - .2 Certified copies of test reports prepared by independent testing agencies; and
 - .3 Any other certificates required by the Contract.

- .13 Warranties and bonds: CFIA copy of manufacturer's warranties, maintenance bonds and service contracts.
- .14 Reports: including, as required by the Contract:
 - .1 Reports documenting system performance testing methods and results; and
 - .2 Documentation of other Materials, equipment or system related information.

3 GENERAL ORGANIZATION OF CONTRACTOR PREPARED OPERATION AND MAINTENANCE MANUALS

- .1 The Contractor will include the following in each volume:
 - .1 Title page.
 - .2 Table of contents. Identify volume number where listed information is located.
 - .3 Ten percent free space for additional data.
- .2 Textual information, schematics and data will be presented on on 21.5cm x 28cm, 75g/m², white bond paper.
- .3 Document Binding Methods:
 - .1 Standard 21.5cm x 28cm sheets: punch sheets to fit binder.
 - .2 Sheets up to 28cm x 41.5cm: punched and neatly folded to allow use without removing from binder.
 - .3 Drawings larger than 28cm x 41.5cm: insert drawings in sturdy vinyl envelopes with reinforced binding holes, open on one side and overall folded size not exceeding 21.5cm x 28cm. Do not punch holes in drawings.
- .4 Binders:
 - .1 Commercial quality, fabric coated, hard covers attached to spine with metal piano hinges, three post, designed to accommodate 21.5cm x 28 cm paper. Maximum 100mm thick.
 - .2 Silk-screen Project title and identification, in white on front cover and spine of binder.
 - .3 Binder fabric and colour:

- Architectural: white
- Mechanical: green
- Electrical: orange

.5 Divider Tabs:

- .1 Light card stock, mylar laminated with tab number and title printed on tab
 - Main divisions: white tabs, labeled with division name, two bank tab length.
 - Sections of a main division: colour coded tabs, labeled with section name, four bank tab length.
 - Subsections: tabs of same colour as section, printed label, eight bank tab length.
- .2 Coordinate tab colour codes and labeling format with CFIA and consultants..

4 MANUAL CONTENTS ORGANIZATION

- .1 For each major equipment, system, Materials or finishes area, organize operation and maintenance data as follows:
 - .1 Operation division: include the following, as applicable:
 - System design criteria.
 - System and controls descriptions.
 - System and controls schematics.
 - All informations realted and associated with technical supports to installed equipments (no latervative will be accepted);
 - Operating instructions.
 - Equipment data.
 - All information reated to technical, troubleshooting and supplier 24/7 oncall support;
 - .2 Maintenance division: include the following, as applicable:
 - Maintenance tasks and schedules.
 - Spare parts.
 - Suppliers and Subcontractors.
 - Tags and directories.
 - .3 Contract division: include the following, as applicable:

- Drawings List.
- Shop Drawings and product data.
- Certifications.
- Warranties and bonds.
- Maintenance brochures.
- Reports.

5 SUBMISSION OF OPERATION AND MAINTENANCE MANUALS

- .1 Prior to Substantial Performance of the Work submit three (3) hard copies of the completed operation and maintenance manuals, and one electronic copy in PDF format, to the Prime Consultant for review. Substantial Performance of the Work will not be ratified until all complete sets of manuals are approved by the Prime Consultant and are ready for submission to CFIA.

END OF OPERATION AND MAINTENANCE DATA AND MANUALS

1 INTENT

- .1 The Contractor shall continuously maintain and update a marked-up, accurate, hard-copy record of:
 - .1 all changes from the initial Drawings made during construction; and
 - .2 the location of concealed systems.

2 DESIGNATION OF PROJECT RECORD DOCUMENTS

- .1 At commencement of the Work, the Contractor will request from the Prime Consultant the following documents, to be designated and retained as the Project record documents:
 - .1 One copy of the Request for Bids;
 - .2 Two complete sets of Drawings; and
 - .3 One set of all Addenda issued.

3 MAINTENANCE OF PROJECT RECORD DOCUMENTS

- .1 Store the Project record documents in the site office apart from sets of documents used for construction.
- .2 Label each document "PROJECT RECORD" in neat, large printed letters.
- .3 Maintain record documents in a clean, dry and legible condition. Do not use record documents for construction purposes.
- .4 Keep record documents continuously available for review by the Prime Consultant or CFIA upon request.

4 RECORDING INFORMATION ON PROJECT RECORD DRAWINGS

- .1 Record changes to, and variations from, the Drawings concurrently with construction process. Do not conceal any construction Work until the required information, including all information contained in Change Orders and all other physical changes to the Work, is recorded.
- .2 Legibly mark one set of the hard-copy Project record drawings to record actual construction, including:
 - .1 measured depths of foundation elements in relation to finished first floor datum;
 - .2 measured horizontal and vertical locations of underground utilities and appurtenances. Reference locations to permanent surface improvements;

- .3 measured locations of internal utilities and appurtenances concealed in construction. Reference to visible and accessible features of construction;
 - .4 field changes of dimension and detail;
 - .5 changes to equipment layout and services, including changes to accommodate substituted equipment; and
 - .6 all items contained in Site Instructions issued during the Work (not just references to Change Orders, etc.).
- .3 Record information as follows:
- .1 Use coloured erasable pencils to record information; and
 - .2 Use a unique colour to record the information pertaining to each major system.

5 RECORD DOCUMENTS REVIEW AT CONSTRUCTION PROGRESS MEETINGS

- .1 The Contractor shall bring the current set of the record drawings to each regular construction progress meeting for review with the Prime Consultant or CFIA representatives at the meeting.

6 SUBMISSION OF PROJECT RECORD DOCUMENTS

- .1 Prior to placing concrete slab, submit one hard-copy set of Project record drawings showing locations of:
 - .1 Existing services; and
 - .2 Existing underslab services, equipment and materials.
- .2 Submit completed Project record documents to the Prime Consultant for review and approval before, or with the, application for Substantial Performance of the Work. Substantial Performance of the Work will not be ratified until documents gain CFIA approval.
- .3 Each submission will include a covering letter, stating:
 - .1 date of submission;
 - .2 Project title, plan no. and centre code;
 - .3 Contractor's name, address and telephone number;
 - .4 number and title of each record document; and
 - .5 Signature & firm stamp of authorized representative of the Contractor.

END OF PROJECT RECORD DOCUMENTS

1. GENERAL

1.1 DESCRIPTION

- .1 Demonstrate operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of substantial performance.
- .2 Owner will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed-upon times.

1.2 QUALITY CONTROL

- .1 When specified in individual Sections require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstration and instructions have been completed.

1.3 SUBMITTALS

- .1 Submittals: in accordance with division 1, 23, 25 & 26.
- .2 Submit schedule of time and date for demonstration of each item of equipment and each system **three (3) weeks** prior to designated dates, for Consultant's approval. Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .3 Give time and date of each demonstration, with list of persons present.

1.4 CONDITIONS FOR DEMONSTRATIONS

- .1 Equipment has been inspected and put into operation in accordance with related Sections.
- .2 Testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and equipment and systems are fully operational.
- .3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.5 PREPARATION

- .1 Verify that conditions for demonstration and instructions comply with requirements.
- .2 Verify that designated personnel are present.

1.6 DEMONSTRATION AND INSTRUCTIONS

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the equipment location.
- .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3 Review contents of manual in detail to explain aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

2. PRODUCTS

2.1 NOT USED

- .1 Not Used.

3. EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.

.2 Acronyms:

- .1 AFD - Alternate Forms of Delivery, service provider.
- .2 BMM - Building Management Manual.
- .3 Cx - Commissioning.
- .4 EMCS - Energy Monitoring and Control Systems.
- .5 O&M - Operation and Maintenance.
- .6 PI - Product Information.
- .7 PV - Performance Verification.
- .8 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:

- .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
- .2 Ensure appropriate documentation is compiled into the BMM.
- .3 Effectively train O&M staff.

- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.

- .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
- .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

- .3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

- .1 Cx to be a line item of Contractor's cost breakdown.
- .2 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .3 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .4 Consultant will issue substantial performance acceptance certificate when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Consultant.
 - .2 Equipment, components and systems have been commissioned.
 - .3 O&M training has been completed.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the un-functional system, including related systems as deemed required by Consultant, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review contract documents, confirm by writing to Consultant.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.
 - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.

- .3 Fully understand Cx requirements and procedures.
- .4 Understand completely design criteria and intent and special features.
- .5 Submit complete start-up documentation to Consultant.
- .6 Have Cx schedules up-to-date.
- .7 Ensure systems have been cleaned thoroughly.
- .8 Complete TAB procedures on systems, submit TAB reports to Consultant for review and approval.
- .9 Ensure "As-Built" system schematics are available.
- .4 Inform Consultant in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

- .1 Report conflicts between requirements of this section and other sections to Consultant before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit no later than 8 weeks after award of Contract:
 - .1 Name of Contractor's Cx agent.
 - .2 Preliminary Cx schedule.
 - .2 Request in writing to Consultant for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to Consultant where not specified and obtain written approval at least 8 weeks prior to start of Cx.
 - .4 Provide additional documentation relating to Cx process required by Consultant.

1.8 COMMISSIONING DOCUMENTATION

- .1 Refer to related division 23, 25 and 26 sections.
- .2 Consultant to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to Consultant.

1.9 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:

- .1 Approval of Cx reports.
- .2 Verification of reported results.
- .3 Repairs, retesting, re-commissioning, re-verification.
- .4 Training.

1.10 COMMISSIONING MEETINGS

- .1 At 80% construction completion stage, consultant to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .2 Meeting will be chaired by Consultant, who will record and distribute minutes.
- .3 Ensure subcontractors and relevant manufacturer representatives are present at 80% and subsequent Cx meetings and as required.

1.11 STARTING AND TESTING

- .1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

1.12 WITNESSING OF STARTING AND TESTING

- .1 Provide 14 days notice prior to commencement.
- .2 Owner to witness of start-up and testing.
- .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.13 MANUFACTURER'S INVOLVEMENT

- .1 Factory testing: manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Provide testing documentation for approval by Consultant.
 - .3 Arrange for Consultant to witness tests.
 - .4 Obtain written approval of test results and documentation from Consultant before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Consultant

- .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
- .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's personnel:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Consultant after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by owner. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
 - .1 Minor equipment/systems: implement corrective measures approved by Consultant.
 - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Consultant.
 - .3 If evaluation report concludes that major damage has occurred, Consultant shall reject equipment.

- .1 Rejected equipment to be remove from site and replace with new.
- .2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to Consultant for approval before commencement of commissioning.
- .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up check lists.
 - .4 Start-up reports,
 - .5 Step-by-step description of complete start-up procedures, to permit Consultant to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit Consultant for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

- .1 Notify Consultant at least 14 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS / EQUIPMENT

- .1 Submit to Consultant for review and approval:

- .1 Complete list of instruments proposed to be used.
- .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
 - .1 2-way radios.
 - .2 Ladders.
 - .3 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
 - .1 Under actual operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for performance verification.

1.21 WITNESSING COMMISSIONING

- .1 Owner Representative to witness activities and verify results.

1.22 AUTHORITIES HAVING JURISDICTION

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to Consultant within 5 days of test and with Cx report.

1.23 SUNDRY CHECKS AND ADJUSTMENTS

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

1.24 DEFICIENCIES, FAULTS, DEFECTS

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Consultant.

- .2 Report problems, faults or defects affecting Cx to Consultant in writing. Stop Cx until problems are rectified. Proceed with written approval from Consultant.

1.25 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Consultant.

1.26 ACTIVITIES UPON COMPLETION OF COMMISSIONING

- .1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

1.27 TRAINING

- .1 In accordance with Section 01 91 41 - Commissioning (Cx) - Training.

1.28 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

- .1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

1.29 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been deposited Consultant.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.30 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 5% of specified values.
- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:

- .1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

1.31 OWNER'S PERFORMANCE TESTING

- .1 Performance testing of equipment or system by Consultant will not relieve Contractor from compliance with specified start-up and testing procedures.

2. PRODUCTS

2.1 NOT USED

- .1 Not Used.

3. EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION GENERAL COMMISSIONING (CX) REQUIREMENTS

1. GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 This Section specifies roles and responsibilities of Commissioning Training.

1.2 TRAINEES

- .1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.
- .2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

- .1 Consultant will provide:
 - .1 Descriptions of systems.
 - .2 Instruction on design philosophy, design criteria, and design intent.
- .2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
 - .1 Start-Up, operation, shut-down of equipment, components and systems.
 - .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
 - .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.

1.4 TRAINING OBJECTIVES

- .1 Training to be detailed and duration to ensure:
 - .1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
 - .2 Effective on-going inspection, measurements of system performance.
 - .3 Proper preventive maintenance, diagnosis and trouble-shooting.
 - .4 Ability to update documentation.
 - .5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.5 TRAINING MATERIALS

- .1 Instructors to be responsible for content and quality.

- .2 Contractor shall provide two (2) hard copy of Training materials which include:
 - .1 "As-Built" Contract Documents.
 - .2 Operating Manual.
 - .3 Maintenance Manual.
 - .4 Management Manual.
 - .5 TAB and PV Reports.
- .3 Consultant and CFIA Project Manager, Commissioning Manager and Facility Manager will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement training materials:
 - .1 Transparencies for overhead projectors.
 - .2 Multimedia presentations.
 - .3 Manufacturer's training videos.
 - .4 Equipment models.

1.6 SCHEDULING

- .1 Deliver training during regular working hours, training sessions to be 3 hours in length.
- .2 Training to be completed prior to acceptance of facility.

1.7 RESPONSIBILITIES

- .1 Be responsible for:
 - .1 Implementation of training activities,
 - .2 Coordination among instructors,
 - .3 Quality of training, training materials,
- .2 Consultant will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Facility manager.

1.8 TRAINING CONTENT

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:
 - .1 Review of facility and occupancy profile.

- .2 Functional requirements.
- .3 System philosophy, limitations of systems and emergency procedures.
- .4 Review of system layout, equipment, components and controls.
- .5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
- .6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
- .7 Maintenance and servicing.
- .8 Trouble-shooting diagnosis.
- .9 Inter-Action among systems during integrated operation.
- .10 Review of O&M documentation.
- .3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

2. PRODUCTS

2.1 NOT USED

- .1 Not Used.

3. EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION COMMISSIONING: TRAINING

1. GENERAL

1.1 SUMMARY

- .1 Related Sections.
 - .1 Division 1 all sections.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .3 Carry out demolition work in accordance with CSA S350-M1980 (R2003), Code of Practice for Safety in Demolition of Structures and the National and Alberta Building Code.

1.2 DEFINITIONS

- .1 Demolition: rapid destruction of building following removal of hazardous materials.
- .2 Hazardous Materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, may include but not limited to: asbestos PCB's, CFC's, HCFC's poisons, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or other material that can endanger human health or well being or environment if handled improperly.

1.3 SITE CONDITIONS

- .1 Visit and examine the site and note all conditions affecting this work.
- .2 Work shall be performed in phases as outlined in General Conditions.
- .3 Verify which services are to be disconnected and which are to remain and be kept operational.
- .4 Owner may disconnect and remove some items prior to commencement of demolition work.

1.4 SCHEDULING

- .1 Employ necessary means to meet project time lines without compromising specified minimum rates of material diversion.
 - .1 Notify Departmental Representative and Consultant in writing when unforeseen delays occur.

1.5 PROTECTION

- .1 Prevent movement, settlement or any other damage to adjacent work. Provide shoring and bracing and be responsible for safety and support of work. Structural shoring shall be designed and installation reviewed by a Professional Engineer registered in Saskatchewan.
- .2 Seal all vents, louvres and ducts to prevent movement of dust.
- .3 Ensure continuous safe passage of building occupants around areas of demolition.
- .4 Erect and maintain dustproof hoarding at limits of demolition work to prevent migration of dust, fumes, etc created by demolition work. At completion, remove and make-good.
- .5 Provide all hoarding at building exterior and interior as required to prevent damage due to weather and dust.

1.6 HAZARDOUS MATERIALS

- .1 Be responsible for the identification of all hazardous materials.
- .2 Immediately upon identification of hazardous materials, stop work and notify owner. Comply with Owner's directions.
- .3 Comply with all current legal requirements for removal and disposal of various types of hazardous materials.

2. PRODUCTS

2.1 EQUIPMENT

- .1 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

2.2 SALVAGEABLE MATERIALS

- .1 All surplus materials shall become Contractor's property, except materials to be reused and the following, which are to be turned over to the Owner at the site:
 - .1 All items as identified on the drawings.
- .2 Contractor is encouraged to recycle and use non-profit agencies wherever possible to reduce quantity of material for landfill.

2.3 ITEMS TO BE REUSED

- .1 Carefully remove, clean, store, modify, refurbish and re-use items as noted on the drawings.

3. EXECUTION

3.1 EXISTING SERVICES

- .1 Disconnect services as identified in the areas to be demolished. Post warning signs on all electrical lines and equipment which must remain energized to serve other areas during period of demolition. Disconnection of services in demolition areas must be performed to the requirements of Authority having Jurisdiction.
- .2 Maintain all essential services to all occupied areas. Refer also to Owner's "Work Authorization Permit Rules and Regulations".
- .3 Notify Owner in advance and obtain approval where required, before commencing with the work on services.

3.2 REMOVAL OPERATIONS

- .1 Remove items as indicated.
- .2 Do not disturb items designated to remain in place.
- .3 Removal of Curbs:
 - .1 Square up adjacent surfaces to remain in place by saw cutting or other method approved by Departmental Representative.
 - .2 Protect adjacent joints and load transfer devices.
 - .3 Protect underlying and adjacent granular materials.
- .4 Provide all temporary supports and falsework as required to support existing structure to remain during demolition.
- .5 Carry out demolition in a manner to minimize inconvenience to occupied spaces.
- .6 Carry out demolition in an orderly and careful manner.
- .7 Carefully remove, refurbish as necessary and store all materials and items to be reused.
- .8 Lower waste materials in a controlled manner; do not drop or throw materials from heights.
- .9 Burning of materials on site is not permitted.

3.3 RESTORATION

- .1 Restore areas and existing works outside areas of demolition to conditions that existed prior to beginning of Work and to match condition of adjacent, undisturbed areas.

3.4 CLEANING

- .1 Remove debris, trim surfaces and leave work site clean, upon completion of Work
- .2 Use cleaning solutions and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

END OF SECTION SELECTIVE SITE DEMOLITION

1. GENERAL

1.1 RELATED WORK

- .1 Fire stopping and smoke seals within mechanical assemblies (i.e inside ducts, dampers) and electrical assemblies (i.e. inside cable trays) are specified in Division 21, 22, 23, 25 and 26 respectively.
- .2 Provide labelled fire-stopping to all openings in fire rated walls, floors and ceilings and slab edges to maintain the integrity of the fire rating of the assembly. Work shall include new construction, new openings in existing structure and where rating is required between new construction and existing building.
- .3 During the course of construction, where unprotected openings are discovered in existing fire rated walls, floors, and ceilings install fire-stopping material to maintain the integrity of the fire rating of the assembly.
- .4 Seal the perimeter of all fire rated and non-rated fire partitions with labelled sealant where gypsum board, concrete block or other rated construction does not meet the structure to allow for movement, expansion and contraction.

1.2 REFERENCES

- .1 Underwriter=s Laboratories of Canada (ULC)
 - .1 ULC-S115-05, Fire Tests of Firestop Systems.

1.3 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit duplicate 12" x 12" samples showing actual firestop material proposed for project.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.

1.5 PRODUCT DATA

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

- .2 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site. Include manufacturer's printed instructions for installation.

1.6 INSTALLER QUALIFICATIONS

- .1 Subcontractor performing the work of this Section shall have been regularly engaged in installation of firestopping materials for the last five (5) years minimum. Provide proof of qualifications upon request from the Consultant.
- .2 Subcontractor's workers shall have received training from at least one manufacturer in installation of all types of firestopping materials. Provide proof of such training, refer to Submittals below.

1.7 QUALITY ASSURANCE

- .1 Firestopping material manufacturer's trained technical representative, shall make onsite inspections of this project as follows:
 - .1 Prior to initial installation of firestopping materials to verify that subcontractor has ordered correct materials and assemblies for application to ensure all fire ratings are maintained and to verify substrate preparation procedures.
 - .2 During the initial installation of firestopping materials. Representative shall review site conditions, firestopping materials for compliance with "best before" date and storage conditions as well as substrate preparation and installation compliance with manufacturer's installation instructions and with requirements for labelled assemblies. Provide additional training for subcontractor's employees as required.

1.8 PERFORMANCE REQUIREMENTS

- .1 Firestopping shall provide a rating, when tested to ULC-S115, for a rating period applicable to the fire separation.
- .2 Provide F, FT and combination rated assemblies as required by Building Code for each application.
- .3 Firestopping used to fill voids in floors having openings 4" in diameter or larger, and which are accessible shall support floor design loading.

1.9 COORDINATION AND SEQUENCING

- .1 Coordinate the work of this Section with construction of fire separations and penetrations through fire separations.
- .2 Ensure penetrations have been completed prior to installing firestopping.

1.10 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

2. PRODUCTS

2.1 MATERIALS

- .1 Fire stopping and smoke seal systems: in accordance with ULC-S115.
 - .1 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC-S115 and not to exceed opening sizes for which they are intended .
- .2 Service penetration firestop components: certified by ULC in accordance with ULC-S115 and listed in ULC Guide No.40 U19.13 and ULC Guide No.40 U19.15 under the Label Service of ULC.
- .3 Firestopping systems shall be as certified by an agency acceptable to the Authority
- .4 having Jurisdiction.
- .5 Firestopping materials, in addition to complying with the requirements of .1 above shall
 - .1 be compatible with substrates,
 - .2 allow for movement caused by thermal cycles
 - .3 prevent the transmission of vibrations from pipe, conduit or duct to structure and structure to pipe, conduit or duct.
- .6 .When more than one product is required for an assembly all products shall be compatible and from the same manufacturer.
- .7 Firestopping sealants and coatings shall be silicone based, guaranteed not to reemulsify if subject to wetting or standing water, acrylic based coatings and sealants are not acceptable.
- .8 Provided that all other specified requirements can be met, use any of the following products, either singly or in combination:
 - .1 Elastomeric sealant.
 - .2 Elastomeric coating.
 - .3 Mineral fibre.
 - .4 Rated Mortar.
 - .5 Intumescent putty.
 - .6 Firestop putty pads, similar to Hilti "CP 617".
 - .7 Poured-in-place silicone foam.

- .8 Manufactured collars for plastic pipe and conduits through walls.
- .9 Concrete floor slab cast-in fire-stop pipe collars, similar to Hilti "CP 680".
- .10 Multi-cable transit system.
- .11 Any other product which meets all other specified requirements.
- .9 Primer: as recommended by firestopping manufacturer for applicable substrate.
- .10 Smoke sealing assemblies: shall be as certified by an agency acceptable to the Authority having Jurisdiction, shall be installed to locations noted and for wall-metal deck locations consist of mineral wool and sealant in a labelled assembly.
- .11 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .12 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .13 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .14 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .15 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

3. EXECUTION

3.1 PREPARATION

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials. Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.2 INSTALLATION

- .1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.

- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to a neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

3.3 INSPECTION

- .1 Notify Consultant when ready for inspection and prior to concealing or enclosing firestopping materials and service penetration assemblies.

3.4 SCHEDULE

- .1 Firestop and smoke seal at:
 - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
 - .2 Edge of floor slabs at curtain wall and precast concrete panels.
 - .3 Top of fire-resistance rated masonry and gypsum board partitions.
 - .4 Intersection of fire-resistance rated masonry and gypsum board partitions.
 - .5 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
 - .6 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
 - .7 Openings and sleeves installed for future use through fire separations.
 - .8 Around mechanical and electrical assemblies penetrating fire separations.
 - .9 Rigid ducts: greater than 14 sq.in: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

3.5 CLEAN UP

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application.
- .2 Remove temporary dams after initial set of fire stopping and smoke seal materials.

END OF SECTION FIRESTOPPING

1. GENERAL

1.1 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM C919-02, Standard Practice for Use of Sealants in Acoustical Applications.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 19-GP-5M-Latest Edition, Sealing Compound, One Component, Acrylic Base, Solvent Curing (Issue of 1976 reaffirmed, incorporating Amendment No. 1).
 - .2 CAN/CGSB-19.13-Latest Edition, Sealing Compound, One-component, Elastomeric, Chemical Curing.
 - .3 CGSB 19-GP-14M-Latest Edition, Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing (Reaffirmation of April 1976).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 QUALITY ASSURANCE

- .1 Sealant work shall be performed by a Trade Contractor with five (5) or more years successful experience in work of similar size and complexity.
- .2 Before performing work of this Section, submit the names of proposed materials for review by the Consultant.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Manufacturer's product to describe.
 - .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
- .3 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Submit duplicate samples of each type of material and colour.
- .5 Cured samples of exposed sealants for each color where required to match adjacent material.

- .6 Submit manufacturer's instructions in accordance with Section 01 33 00 - Submittal Procedures.

- .1 Instructions to include installation instructions for each product used.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver containers labeled and sealed, complete with written application and maintenance instructions.
- .2 Comply with all WHMIS and Dangerous Goods Transportation and Handling Act requirements
- .3 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor and in accordance with manufacturer's instructions

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper, plastic, corrugated cardboard, packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.
- .3 Divert unused metal materials from landfill to metal recycling facility approved by city of Saskatoon.
- .4 Divert unused adhesive materials from landfill to official hazardous material collections site approved by city of Saskatoon.
- .5 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

1.6 PROJECT CONDITIONS

- .1 Environmental Limitations:
 - .1 Do not proceed with installation of joint sealants under following conditions:
 - .1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 42°F.
 - .2 When joint substrates are wet.
- .2 Joint-Width Conditions:

- .1 Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
 - .1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 ENVIRONMENTAL REQUIREMENTS

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.
- .2 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .3 Ventilate area of work as directed by Consultant by use of approved portable supply and exhaust fans without disturbing the operation of the laboratory air system, under no circumstance the building air pressurization shall be in jeopardy, contractor is fully responsible to monitor this issue at all time.

2. PRODUCTS

2.1 SEALANT MATERIALS

- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
- .2 When low toxicity caulks are not possible, confine usage to areas which off gas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off gas time.
- .3 Where sealants are qualified with primers use only these primers
- .4 General Construction silicone sealant, conforming to CAN/CGSB-19.13 M87; CGE Silpruf or Dow Corning 790.
- .5 Horizontal joint sealant: Multi-component, self levelling, conforming to ASTM C920-79, Sikaflex 2c SL.
- .6 General Construction polyurethane sealant: One component, non-sag, for general construction, conforming to CAN/CGSB-19.13-M87; Sikaflex 1-A.
- .7 Sanitary sealant: silicone, GE "Sanitary 1700", Dow Corning "786 Mildew Resistant".

2.2 ACCESSORIES

- .1 Backer Rod: Non-staining, non-absorbent, closed cell polyethylene foam rod, round shape; 30% -50% oversized. Use high density rod in floor joints.
- .2 Primer: Non-staining type as recommended by sealant manufacturer.
- .3 Joint Cleaner: Non-corrosive solvent type recommended by sealant manufacturer for applicable substrate materials.

2.3 COLOURS

- .1 Colours: To match adjacent materials.
- .2 Verify all sealant colours with the Consultant prior to ordering materials.

2.4 SELECTION OF SEALANT TYPES

- .1 Make sealant selections consistent with manufacturer's recommendations.
- .2 Use General Construction silicone sealant or polyurethane sealant for all joints where no other specific sealant type is specified. Do not use on horizontal traffic joints or where immersed in water.
- .3 Use Horizontal joint sealant for floor control joints where no mechanical joint is scheduled.

3. EXECUTION

3.1 PROTECTION

- .1 Protect installed Work of other trades from staining or contamination.

3.2 SURFACE PREPARATION

- .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .4 Ensure joint surfaces are dry and frost free.
- .5 Prepare surfaces in accordance with manufacturer's directions.

3.3 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 BACKUP MATERIAL

- .1 Apply bond breaker tape where required to manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.5 MIXING

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.6 APPLICATION

- .1 Sealant.
 - .1 Apply sealant in accordance with manufacturer's written instructions.
 - .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - .3 Apply sealant in continuous beads.
 - .4 Apply sealant using gun with proper size nozzle.
 - .5 Use sufficient pressure to fill voids and joints solid.
 - .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
 - .8 Form surface of sealant smooth, free from ridges, wrinkles, sags, or air pockets and imbedded impurities. Neatly tool surface to a slight concave appearance.
 - .9 Remove excess compound promptly as work progresses and upon completion.
- .2 Cleanup.
 - .1 Clean adjacent surfaces immediately and leave Work neat and clean.
 - .2 Remove excess and droppings, using recommended cleaners as work progresses.
 - .3 Remove masking tape after initial set of sealant.

END OF SECTION JOINT SEALING

1. GENERAL

1.1 APPLICABLE STANDARDS

- .1 ASTM C413-01: Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes.
- .2 ASTM C531-00: Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- .3 ASTM C579-01: Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes.
- .4 ASTM D523-89 (1999): Standard Test Method for Specular Gloss.
- .5 ASTM D695-02a: Standard Test Method for Compressive Properties of Rigid Plastics.
- .6 ASTM D790-03: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- .7 ASTM D1864-89(2002): Standard Test Method for Moisture in Mineral aggregate Used on Built-Up Roofs.
- .8 ASTM D2240-02b Standard Test Method for Rubber Property - Durometer Hardness.
- .9 ASTM D4060-01: Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- .10 ASTM D 4263-83 (1999): Standard Test Method for Indicating Moisture in Concrete by Plastic Sheet.
- .11 ASTM D4258-83(1999): Standard Practice for Surface Cleaning Concrete for Coating.
- .12 ASTM D4259-88(1999): Standard Practice for Abrading Concrete.
- .13 ASTM D4260-88(1999): Standard Practice for Acid Etching Concrete.
- .14 ASTM D4262-83(1999): Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
- .15 CAN/ULC-S102-03: Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 SUBMITTALS

- .1 Submit product data and manufacturer's installation/application instructions for each paint and coating product to be used in accordance with the requirements of Section 01 33 00 - Submittal Procedures.
- .2 Submit Manufacturer's Material Safety Data Sheets (MSDS) acceptable to Labour Canada and Health and Welfare Canada and "Canadian Food Inspection Agency" for use as epoxy flooring.
- .3 Submit 300 mm x 300 mm representative sample of flooring in selected colour. Identify sample by project name including material and colour identification.

1.3 DELIVERY

- .1 Deliver materials undamaged, in original containers, with manufacturer's labels and seals intact.

1.4 ENVIRONMENTAL CONDITIONS

- .1 For interior coatings: Ensure minimum surface temperature 10°C, 24 hours before, during and 96 hours after application or until cured.
- .2 Maximum moisture content of substrate: 12%.
- .3 Alkali: Ensure negative alkalinity of substrate before application of coating.
- .4 Ventilation: provide continuous ventilation during and after coating application to control dangerous vapour build-up, odours and fumes.
- .5 Provide uniform and sufficient lighting in areas of installation.
- .6 Post and enforce **"No smoking or open flame"** signs until flooring has cured. Eliminate all spark producing devices (furnaces, all pilot lights, spark-producing switches etc.) in or near the work area.
- .7 Do not begin flooring installation until all other work which would cause damage, dirt dust or interruption of normal installation pace has been completed.

1.5 PRODUCT HANDLING

- .1 Deliver and store materials undamaged, in original containers, with manufacturer's seals and labels intact.
- .2 Designate a room for storage of flooring materials and equipment. Keep room neat and clean at all times, under lock and key, and surrounding surfaces protected from damage. Keep material temperatures at 16°C minimum.

1.6 PROTECTION

- .1 Mask and protect adjacent surfaces and materials from damage. Make good any damage so caused, to the satisfaction of the Consultant.
- .2 Keep all traffic out of all areas receiving flooring until it has been completed and cured.
- .3 Apply temporary protection until floor is fully cured.

1.7 QUALIFICATIONS

- .1 The work of this Section shall be applied only by experienced applicators of the specified products.
- .2 Apply epoxy flooring in accordance with the most recent installation instructions of the manufacturer.

1.8 MAINTENANCE

- .1 Provide maintenance data for epoxy flooring for incorporation into maintenance manual as specified in division 01.

1.9 SCHEDULING OF WORK

- .1 Submit work schedule for various stages of painting to Owner for approval. Submit schedule a minimum of 72 hours in advance of proposed operations.
- .2 Obtain written authorization from Owner for changes in work schedule.
- .3 Schedule repainting operations to prevent disruption by other trades if applicable and by occupants in and about the building.

1.10 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2 Paint, stain and wood preservative finishes and related materials (thinners, solvents, etc.) are hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.
- .3 Materials that cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- .4 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.

2. PRODUCTS

2.1 MATERIALS

- .1 Epoxy Flooring: self-levelling, heavy duty, solid glossy coloured (approved by facility manager), three-component, water dispersed polyurethane-based/cement and aggregate screed, low viscosity, non odour, glossy, slip resistance finish, nominal 4 mm thick, epoxy floor coating system, chemical resistant.
- .2 Joint and crack sealant: manufacturer's standard.
- .3 Surface conditioner: to manufacturer's standard.
- .4 Epoxy aggregate flooring, thermo-setting, 100% solids, and meeting following requirements:

Property	Test Method	Requirement
Compressive Strength	ASTM C-579	37 MPa after 7 days
Abrasion resistance	ASTM D1044-08 CS 17 wheels with 2 kg load 5 000 cycles	0.3 g loss max
Coefficient of linear Expansion	ASTM D696-08	$165.6 \times 10^{-7}/^{\circ}\text{C}$
Flammability	ASTM E84-09	Non-burning
Freeze-thaw resistance	ASTM D2337-01(2005)	Unaffected
Hardness	Barcol	55
Impact Resistance	Falling ball method, 50.8 mm in diameter weighing 535 g Gardner Impact Tester (Masonry Backing)	Energy required to cause failure: 12.9 J 9 J: no loss of adhesion
Resistance to burning cigarette		Very slight Discoloration
Resistance to cleaning agents, hydroxides and salts	ASTM D1308-02(2007)	Unaffected by common household cleaning agents, hydroxides and salts
Shear bond strength	ASTM D905-08e1	2 MPa to concrete
Surface stain	ASTM C126-99(2005)	Unaffected
Tensile strength (binder only)	ASTM D638-08	23 MPa
Toxicity	CFIA	Approved non-toxic
Wash-ability	Gardner straight line method 5000cycles	No visual effect
Water absorption	ASTM D570-98(2005)	0.1% by mass

- .5 Custom colour as selected by the Departmental Representative.

3. EXECUTION

3.1 INSPECTION

- .1 Inspect existing epoxy flooring and bases.
- .2 Ensure that all surfaces are clean and dry.

3.2 PREPARATION OF SURFACES

- .1 Protect adjacent surfaces and equipment from damage by overspray, fall-out and dusting.
- .2 Ensure surfaces are clean, sound and dry; in all cases requiring some form of preparation. Prepare existing epoxy flooring surface in accordance with manufacturer's printed instructions.
- .3 Effectively remove concrete laitance by steel shot blasting, grit blasting or method approved by manufacturer.
- .4 Prefill surface irregularities, holes and cracks in accordance with manufacturer's recommendations.
- .5 Before commencement of application of flooring, ensure that concrete floors are acceptable in accordance with manufacturer's recommendations.
- .6 Commencement of work implies acceptance of surfaces and working conditions.

3.3 APPLICATION/EPOXY FLOORING

- .1 Ensure that floors have been prepared in accordance with manufacturer's instructions prior to application of epoxy flooring.
- .2 Install cove and base including top cap in accordance with manufacturer's instructions. Ensure top of base is level, and true to line.
- .3 Prime entire surface with recommended primer.
- .4 Apply flooring in accordance with manufacturer's instructions to the proper thickness.
- .5 Apply top coats at recommended coverage, to provide a uniform, dense surface.
- .6 Finish flooring uniformly, free from surface imperfections, and to match the accepted sample in the Consultant's office.
- .7 Allow proper cure time for each installation procedure.
- .8 Apply flooring up adjoining concrete walls to form 100 mm high base to flooring. Top of base to be level, true, and even.

- .9 Flash pipes, conduits and other penetrations to manufacturer's standards.

3.4 CLEAN-UP

- .1 Upon completion of work of this Section clean area up of debris, remove flooring material from adjacent surfaces where splattered and leave area in clean, tidy condition acceptable to the owner and consultant.

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Division 1 all sections.

1.2 REFERENCES

- .1 Maintenance Repainting Manual by the Master Painters Institute (MPI), including Identifiers, Evaluation, Systems, Preparation and Approved Product List.
- .2 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings) of the Environmental Protection Agency (EPA).
- .3 Alberta Fire Code of Canada Latest edition.

1.3 QUALITY ASSURANCE

- .1 Conform to latest MPI requirements for interior repainting work including cleaning, preparation and priming.
- .2 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) shall be in accordance with the latest edition of the MPI Approved Product List and shall be from a single manufacturer for each system used.
- .3 Paint materials such as linseed oil, shellac, turpentine, etc. shall be the highest quality product of an approved manufacturer listed in MPI Maintenance Repainting Manual and shall be compatible with other coating materials as required.
- .4 Standard of Acceptance: When viewed using final lighting source surfaces shall indicate the following:
 - .1 Walls: No defects visible from a distance of 6'-0" at 90° to surface.
 - .2 Ceilings: No defects visible from floor at 45° to surface.
 - .3 Final coat to exhibit uniformity of colour and sheen across full surface area.

1.4 SCHEDULING OF WORK

- .1 Submit work schedule for various stages of painting to Owner for approval. Submit schedule a minimum of 7 days in advance of proposed operations.
- .2 Paint occupied facilities in accordance with approved schedule. Schedule operations to approval of Owner such that painted surfaces will have dried and cured sufficiently before occupants are affected.
- .3 Obtain written authorization from Owner for changes in work schedule.

- .4 Schedule repainting operations to prevent disruption by other trades if applicable and by occupants in and about the building.

1.5 SUBMITTALS

- .1 Submit product data and manufacturer's installation/application instructions for each paint and coating product to be used in accordance with the requirements of Section 01 33 00 - Submittal Procedures.
- .2 Submit full range colour sample chips for review and selection. Indicate where colour availability is restricted.
- .3 Upon completion, submit records of products used. List products in relation to finish system and include the following:
 - .1 Product name, type and use (i.e. materials and location).
 - .2 Manufacturer's product number.
 - .3 Colour code numbers.
 - .4 MPI Environmentally Friendly classification system rating.
 - .5 Manufacturer's Material Safety Data Sheets (MSDS).

1.6 DELIVERY, HANDLING AND STORAGE

- .1 Deliver, store and handle materials in accordance with division 1 requirements.
- .2 Deliver and store materials in original containers, sealed, with labels intact.
- .3 Labels shall clearly indicate:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
- .4 Remove damaged, opened and rejected materials from site.
- .5 Observe manufacturer's recommendations for storage and handling.
- .6 Store materials and equipment in a secure, dry, well-ventilated area with temperature range between 7°C to 30°C. Store materials and supplies away from heat generating devices and sensitive products above minimum temperature as recommended by manufacturer.
- .7 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Consultant. After completion of operations, return areas to clean condition to approval of owner.
- .8 Remove paint materials from storage in quantities required for same day use.

.9 Fire Safety Requirements:

- .1 Provide one 20 lb Type ABC fire extinguisher adjacent to storage area.
- .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
- .3 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with division 1 requirements.
- .2 Paint, stain and wood preservative finishes and related materials (thinners, solvents, etc.) are hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.
- .3 Materials that cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- .4 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
- .5 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground the following procedures shall be strictly adhered to:
 - .1 Retain cleaning water for water-based materials to allow sediments to be filtered out. In no case shall equipment be cleaned using free draining water.
 - .2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - .3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - .4 Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.
 - .5 Empty paint cans are to be dry prior to disposal or recycling (where available).
 - .6 Close and seal tightly partly used cans of materials including sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.
- .6 Where paint recycling is available, collect waste materials by type and provide for delivery to recycling or collection facility.

1.8 EXTRA MATERIALS

- .1 Submit maintenance materials in accordance with division 1 requirements.
- .2 Provide 1/2 gallon can of each type and colour of Identify type and colour in relation to established colour schedule and finish system.
- .3 Deliver to Contractor and store where directed.

2. PRODUCTS

2.1 MATERIALS

- .1 Paint materials listed in the latest edition of the MPI Approved Product List (APL) are acceptable for use on this project.
- .2 Where required by authorities having jurisdiction, paints and coatings shall provide a fire resistant rating.
- .3 Paint materials for repaint systems shall be products of a single manufacturer.
- .4 Paints and coatings must be manufactured and transported in a manner that steps of processes, including disposal of waste products arising therefrom, will meet requirements of applicable governmental acts, by-laws and regulations including, for facilities located in Canada, Fisheries Act and Canadian Environmental Protection Act (CEPA).
- .5 Paints and coatings must not be formulated or manufactured with formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

2.2 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials is not allowed.
- .2 Paste, powder or catalyzed paint mixes shall be mixed in strict accordance with manufacturer's written instructions.
- .3 Where thinner is used, addition shall not exceed paint manufacturer's recommendations. Do not use kerosene or such organic solvents to thin water-based paints.
- .4 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

3. EXECUTION

3.1 GENERAL

- .1 Perform preparation and operations for interior painting in accordance with MPI Maintenance Repainting Manual requirements except where otherwise specified.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.2 EXISTING CONDITIONS

- .1 Prior to commencing work, thoroughly examine site conditions and existing interior substrates to be repainted. Report in writing to Owner and Consultant damages, defects, or unsatisfactory or unfavourable conditions or surfaces that will adversely affect this work.

3.3 PROTECTION

- .1 Protect existing surfaces and adjacent fixtures and furnishings from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Owner.
- .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
- .3 Protect factory finished products and equipment.
- .4 Protect general public and building occupants in and about the building.
- .5 Removal of electrical cover plates, light fixtures, surface hardware on doors, bath accessories and surface mounted equipment, fittings and fastenings shall be done prior to undertaking re-painting operations by General Contractor. Items shall be securely stored and re-installed by General Contractor after painting is completed.
- .6 Move and cover furniture and portable equipment as necessary to carry out repainting operations. Replace as painting operations progress.
- .7 As repainting operations progress, place "WET PAINT" signs in occupied areas to approval of owner.

3.4 CLEANING AND PREPARATION

- .1 Clean and prepare interior surfaces to be repainted in accordance with MPI Maintenance Repainting Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and surface debris by vacuuming, wiping with dry, clean cloths.

- .2 Wash surfaces with a biodegradable detergent and clean warm water using a stiff bristle brush to remove dirt, oil and surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and to dry thoroughly. Allow sufficient drying time and test surfaces using an electronic moisture meter before commencing work.
 - .5 Use water-based cleaners in place of organic solvents where surfaces will be repainted using water based paints.
 - .6 Many water-based paints cannot be removed with water once dried. Minimize the use of kerosene or such organic solvents to clean up water-based paints.
- .2 Clean metal surfaces to be repainted by removing rust, dirt, oil, grease and foreign substances in accordance with MPI requirements. Remove such contaminants from surfaces, pockets and corners to be repainted by brushing with clean brushes, blowing with clean dry compressed air, or brushing/vacuum cleaning as required.
 - .3 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before priming and between applications of remaining coats. Touch-up, spot prime, and apply primer, paint, or pre-treatment as soon as possible after cleaning and before deterioration occurs.

3.5 APPLICATION

- .1 Apply paint by method that is best suited for substrate being repainted using brush, and roller. Conform to manufacturer's application instructions unless specified otherwise.
- .2 Brush and Roller Application:
 - .1 Apply paint in a uniform layer using brush and/or roller of types suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces shall be free of roller tracking and heavy stipple unless approved by [Consultant] [Engineer].
 - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray Application (**Not Permitted in This Project**):
- .4 Use dipping, sheepskins or daubers when no other method is practical in places of difficult access and when specifically authorized by owner .

- .5 Apply paint coats in a continuous manner and allow surfaces to dry and properly cure between coats for minimum time period as recommended by manufacturer. Minimum dry film thickness of coats shall not be less than that recommended by the manufacturer. Repaint thin spots or bare areas before next coat of paint is applied.
- .6 Sand and dust between coats to remove visible defects.
- .7 Repaint surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.

3.6 MECHANICAL / ELECTRICAL EQUIPMENT

- .1 Unless otherwise noted, repainting shall also include exposed to view / previously painted mechanical and electrical equipment and components (panels, conduits, piping, hangers, ductwork, etc.).
- .2 Touch up scratches and marks and repaint such mechanical and electrical equipment and components with colour, and sheen finish to match existing unless otherwise noted or scheduled.
- .3 Do not paint over name plates or instruction labels.
- .4 Leave unfinished exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish.
- .5 Keep sprinkler heads free of paint.
- .6 Do not paint interior transformers and substation equipment.

3.7 CLEAN-UP

- .1 Remove paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
- .2 Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials and debris.
- .3 Remove combustible rubbish materials and empty paint cans each day and safely dispose of same in accordance with requirements of authorities having jurisdiction.
- .4 Clean equipment and dispose of wash water used for water borne materials, solvents used for oil based materials as well as other cleaning and protective materials (e.g. rags, drop cloths, masking papers, etc.), paints, thinners, paint removers/strippers in accordance with the safety requirements of authorities having jurisdiction and as noted herein.
- .5 Painting equipment shall be cleaned in leak-proof containers that will permit particulate matter to settle out and be collected. Sediment remaining from

cleaning operations shall be recycled or disposed of in a manner acceptable to authorities having jurisdiction.

- .6 Paint and coatings in excess of repainting requirements shall be recycled as noted herein.

3.8 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on affected exposed surfaces. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of owner. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by owner.

END OF SECTION INTERIOR RE-PAINTING

1. GENERAL

1.1 SCOPE

- .1 This section shall be used as a guideline for any additional sprinkler heads require to meet NFPA-13-2010 and as result of new Mechanical equipments and ductworks; additional sprinkler heads to meet the existing system classification (ONLY).

1.2 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for wet pipe fire protection and sprinkler systems for heated areas.

1.3 REFERENCES

- .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA):
 - .1 ANSI/NFPA 13-2010, Installation of Sprinkler Systems.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN4 S543-M1984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

1.4 DESIGN REQUIREMENTS

- .1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13, as following:
 - .1 Ordinary hazard group 1 occupancy: Mechanical room.
- .2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.
- .3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings. Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.
- .4 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.
- .5 Location of Sprinkler Heads:

- .1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13.
- .2 Uniformly space sprinklers on branch.
- .6 Provide sprinklers for areas as indicated and required, including specialized rooms. Run new piping concealed above furred ceilings and in joists to minimize obstructions. Expose only heads. Furnish additional heads which may be required for coordinated ceiling pattern without added cost, even though number of heads may exceed minimum code requirements.
- .7 Water Distribution:
 - .1 Make distribution uniform throughout the area in which sprinkler heads will open.

1.5 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
 - .2 Indicate:
 - .1 Materials.
 - .2 Finishes.
 - .3 Method of anchorage
 - .4 Number of anchors.
 - .5 Supports.
 - .6 Reinforcement.
 - .7 Assembly details.
 - .8 Accessories.
- .3 Closeout Submittals:
 - .1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 23 & 39 - Closeout Submittals.
 - .2 Manufacturer's Catalog Data, including specific model, type, and size for:
 - .1 Pipe and fittings.
 - .2 Alarm valves.
 - .3 Valves, including gate, check, and globe.

- .4 Water motor alarms.
- .5 Sprinkler heads.
- .6 Pipe hangers and supports.
- .7 Pressure or flow switch.
- .8 Fire department connections.
- .9 Excess pressure pump.
- .10 Mechanical couplings.
- .3 Drawings:
 - .1 Sprinkler heads and piping system layout.
 - .1 Prepare detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".
 - .2 Show data essential for proper installation of each system.
 - .3 Show details, plan view, elevations, and sections of systems supply and piping.
 - .4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.
 - .2 Electrical wiring diagrams.
- .4 Design Data:
 - .1 Calculations of sprinkler system design.
 - .2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months.
- .5 Field Test Reports: preliminary tests on piping system.
- .6 Records:
 - .1 As-built drawings of each system.
 - .1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.
 - .2 Submit drawings on reproducible Mylar film with title block similar to full size contract drawings.
- .7 Operation and Maintenance Manuals:
 - .1 Provide maintenance data for incorporation into manual specified in division 1 requirements.
 - .2 Provide detailed hydraulic calculations including summary sheet, and Material and Test Certificate for aboveground piping and other documentation for incorporation into manual specified in division 1 requirement in accordance with ANSI/NFPA 13.

1.6 QUALITY ASSURANCE

- .1 Qualifications:

- .1 Installer: company or person specializing in wet sprinkler systems with documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Storage and Protection:
 - .1 Store materials in dry location.
 - .2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

2. PRODUCTS

2.1 PIPE, FITTINGS AND VALVES

- .1 Pipe:
 - .1 Ferrous: to ANSI/NFPA 13.
 - .2 Copper tube: to ANSI/NFPA 13.
 - .3 Grooved piping is not acceptable.
- .2 Fittings and joints to ANSI/NFPA 13:
 - .1 Ferrous: screwed, welded, flanged or roll grooved.
 - .2 Copper tube: screwed, soldered, brazed.
 - .3 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.
 - .4 Rubber gasketed grooved-end pipe and fittings with mechanical couplings are not permitted.
 - .5 Fittings: ULC approved for use in wet pipe sprinkler systems.
 - .6 Side outlet tees using rubber gasketed fittings are not permitted.
 - .7 Sprinkler pipe and fittings: metal.
- .3 Pipe hangers:
 - .1 ULC listed for fire protection services in accordance with NFPA.

2.2 SPRINKLER HEADS

- .1 General: to ANSI/NFPA 13 and ULC listed for fire services.
- .2 Sprinkler Head shall meet the existing rating and type

2.3 PIPE SLEEVES

- .1 Provide pipe sleeves where piping passes through walls and floors.
- .2 Secure sleeves in position and location during construction.
- .3 Provide sleeves of sufficient length to pass through entire thickness of walls and floors.
- .4 Provide 1" inch minimum clearance between exterior of piping and interior of sleeve or core-drilled hole.
 - .1 Firmly pack space with mineral wool insulation.
 - .2 Seal space at both ends of sleeve or core-drilled hole with provide mechanically adjustable segmented elastomeric seal.
 - .3 In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with ULC listed fill, void, or cavity material.
- .5 Sleeves in Masonry and Concrete Walls, Floors, and Roofs:
 - .1 Provide ductile-iron sleeves.
 - .2 Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in core-drilled hole are completely grouted smooth.
- .6 Sleeves in other than "Masonry and Concrete Walls, Floors, and Roofs":
 - .1 Provide gauge 22 thick galvanized steel sheet.

2.4 SIGNS

- .1 Attach properly lettered and approved metal signs to each valve and alarm device to ANSI/NFPA 13.
- .2 Permanently fix hydraulic design data nameplates to riser of each system.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install, inspect and test to acceptance in accordance with ANSI/NFPA 13.

3.3 PIPE INSTALLATION

- .1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.
- .2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.
- .3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.
- .4 Inspect piping before placing into position.

3.4 DISINFECTION

- .1 Disinfect new piping and existing piping.
- .2 Fill piping systems with solution containing minimum of 50 parts per million of chlorine and allow solution to stand for minimum of 24 hours.
- .3 Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2 part per million or residual chlorine content of domestic water supply.
- .4 Obtain at least two consecutive satisfactory bacteriological samples from piping, analyzed by certified laboratory, and submit results prior to piping being placed into service.

3.5 CONNECTIONS TO EXISTING SYSTEMS

- .1 Notify Facility Manager in writing at least 21 days prior to connection date.
- .2 Use valve and mechanical joint type sleeves for connections to be made under pressure.
- .3 Bolt sleeves around main piping.
- .4 Bolt valve to branch connection. Open valve, attach drilling machine, make tap, close valve, and remove drilling machine, without interruption of service.
- .5 Furnish materials required to make connections into existing water supply systems, and perform excavating, backfilling, and other incidental labour as required.

3.6 FIELD PAINTING

- .1 Clean, pre-treat, prime, and paint new systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.
- .2 Apply coatings to clean, dry surfaces, using clean brushes.

- .3 Clean surfaces to remove dust, dirt, rust, and loose mill scale.
- .4 Immediately after cleaning, provide metal surfaces with 1 coat of pre-treatment primer applied to minimum dry film thickness of 0.3 ml, and one coat of zinc chromate primer applied to minimum dry film thickness of 1.0 ml.
- .5 Shield sprinkler heads with protective covering while painting is in progress.
- .6 Upon completion of painting, remove protective covering from sprinkler heads.
- .7 Remove sprinkler heads which have been painted and replace with new sprinkler heads. Provide primed surfaces with following:

3.7 FIELD QUALITY CONTROL

- .1 Site Test, Inspection:
 - .1 Perform test to determine compliance with specified requirements in presence of Departmental Representative.
 - .2 Test, inspect, and approve piping before covering or concealing.
 - .3 Preliminary Tests:
 - .1 Hydrostatically test each system at 200 PSI for a 4 hour period with no leakage or reduction in pressure.
 - .2 Flush piping with potable water in accordance with NFPA 13.
 - .3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.
 - .4 Test alarms and other devices.
 - .5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.
 - .4 Formal Tests and Inspections:
 - .1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.
 - .2 Submit written request for formal inspection at least 21 days prior to inspection date.
 - .3 Repeat required tests as directed.
 - .4 Correct defects and make additional tests until systems comply with contract requirements.
 - .5 Authority of Jurisdiction shall witness formal tests and approve systems before they are accepted.
- .2 Proceed in accordance with Section 01 74 23 – Final Cleaning.
- .3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION WET PIPE SPRINKLER SYSTEMS

1. GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for copper domestic water service used in the following:
 - .1 Hard drawn copper domestic hot and cold water services inside building.
 - .2 Soft copper tubing inside building.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 23 & 39 - Closeout Submittals.
- .3 Section 23 05 00 - Common Work Results - Mechanical.
- .4 Section 23 05 05 - Installation of Pipework.
- .5 Section 23 05 22 - Valves - Bronze.
- .6 Section 23 05 23 Valves - Cast Iron: Gate, Globe, Check.
- .7 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).
 - .1 ANSI/ASME B16.15-02, Cast Bronze Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22-01, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24-01, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A307-04, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B88M-05, Standard Specification for Seamless Copper Water Tube (Metric).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Research Council (NRC)/Institute for Research in Construction.

- .1 NRCC 38728, National Plumbing Code of Canada (NPC) - 2005.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data for following: valves.
- .3 Provide maintenance data for incorporation into manual specified in Section 01 78 23 or 39- Closeout Submittals.

1.5 STORAGE AND HANDLING

- .1 Store and manage hazardous materials in accordance with manufacture requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Fold up metal banding, flatten and place in designated area for recycling.

2. PRODUCTS

2.1 PIPING

- .1 Within building: Copper hard drawn, **Type K**: to ASTM B88M for:
 - .1 Above ground Domestic Water;
 - .2 Above ground or Buried for Drainage or Vent.

2.2 FITTINGS

- .1 Bronze pipe flanges and flanged fittings, Class 150 to ANSI/ASME B16.24.
- .2 Cast bronze threaded fittings, Class 125: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI/ASME B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.

2.3 JOINTS

- .1 Solder: 95/5.
- .2 Teflon tape: for threaded joints.

2.4 VALVES

- .1 See related sections: 23 05 22, 23 05 23 and 23 05 26.

3. EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with NPC Plumbing Code and local authority having jurisdiction.
- .2 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.
- .3 Assemble piping using fittings manufactured to ANSI standards.
- .4 Install DCW piping below and away from DHW and DHWR and other hot piping so as to maintain temperature of cold water as low as possible.
- .5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

3.2 VALVES

- .1 Isolate equipment, fixtures and branches with globe valves.
- .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.3 PRESSURE TESTS

- .1 Conform to requirements of Section 23 05 00 - Common Work Results - Mechanical.
- .2 Test pressure: greater of 1.5 times maximum system operating pressure or minimum of 1034 KPa water pressure.

3.4 FLUSHING AND CLEANING

- .1 Flush entire added new system for 8 h. Let stand for 24 h, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean copper to Federal potable water guidelines. Let system flush for additional 2 h, then draw off another sample for testing.
- .2 All flushing of the new systems shall be taking place during off hours of the facility with minimum 7 days written advance notice to facility O&M;
- .3 Contractor to ensure that existing systems are fully isolated;
- .4 Contractor shall discuss flushing procedure with O&M team prior to taking place.

3.5 PRE-START-UP INSPECTIONS

- .1 Systems to be complete, prior to flushing, testing and start-up.

- .2 Verify that system can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.
- .4 Ensure that air chambers, expansion compensators are installed properly.

3.6 DISINFECTION

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction approval of Departmental Representative.

3.7 START-UP

- .1 Timing: Start up after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Certificate of static completion has been issued.
- .2 Provide continuous supervision during start-up.
- .3 Start-up procedures:
 - .1 Establish circulation and ensure that air is eliminated.
 - .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
 - .3 Bring DHW storage tank up to design temperature slowly.
 - .4 Monitor piping DHW and DHWR piping systems for freedom of movement, pipe expansion as designed.
 - .5 Check control, limit, safety devices for normal and safe operation.
- .4 Rectify start-up deficiencies.

3.8 PERFORMANCE VERIFICATION

- .1 Timing:
 - .1 After pressure and leakage tests and disinfection completed, and certificate of completion has been issued by authority having jurisdiction.
- .2 Procedures:
 - .1 Verify that flow rate and pressure meet Design Criteria.
 - .2 TAB DHW and DHWR in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
 - .4 Verify performance of temperature controls.
 - .5 Verify compliance with safety and health requirements.

- .6 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
- .7 Confirm water quality consistent with supply standards, verifying that no residuals remain as a result of flushing and/or cleaning.
- .3 Reports:
 - .1 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

END OF SECTION DOMESTIC WATER PIPING COPPER

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 The installation of drainage waste and venting piping - PVC.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 23 & 39 - Closeout Submittals.
- .3 Section 23 05 00 - Common Work Results - Mechanical.
- .4 Section 23 05 05 - Installation of Pipework.
- .5 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.3 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM D2564-02, Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2 Canadian Standards Association (CSA International).
 - .1 CSA-Series B1800-02, Plastic Nonpressure Pipe Compendium.
 - .2 CSA-B181.2-02, PVC Drain, Waste and Vent Pipe and Pipe Fittings.
 - .3 CSA-B182.1-02, Plastic Drain and Sewer Pipe and Pipe Fittings.

1.4 DELIVERY STORAGE AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper, plastic, corrugated cardboard, packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.
- .3 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

2. PRODUCTS

2.1 PIPING AND FITTINGS

.1 For buried and above ground DWV piping to:

- .1 CSA-B181.1.
- .2 CSA-B181.2.
- .3 CSA-B182.1.

2.2 JOINTS

.1 Solvent weld for PVC: to ASTM D2564.

3. EXECUTION

3.1 INSTALLATION

.1 Install in accordance with Canadian Plumbing Code and local authority having jurisdiction.

3.2 TESTING

- .1 Pressure test buried systems before backfilling.
- .2 Hydraulically test to verify grades and freedom from obstructions.
- .3 Drainage systems: test by filling with water to produce water pressure of 70 KPa minimum and 210 KPa maximum. Use ball test to check for proper grade and that system is free of obstructions.

3.3 PERFORMANCE VERIFICATION

- .1 Cleanouts:
 - .1 Ensure accessible and that access doors are correctly located.
 - .2 Open, cover with linseed oil and re-seal.
 - .3 Verify cleanout rods can probe as far as the next cleanout, at least.

END OF SECTION DRAINAGE WASTE AND VENT PIPING - PVC

1. GENERAL

1.1 REFERENCES

- .1 American National Standards Institute/Canadian Standards Association (ANSI/CSA)
 - .1 ANSI Z21.10.3A-2007/CSA 4.3-07, Gas Water Heaters - Volume III - Storage Water Heaters, with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B51-03(R2007), Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CAN/CSA-B149.1-05, Natural Gas and Propane Installation Code.
 - .3 CAN/CSA-C309-M90(R2003), Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Division 1 Requirements.
- .2 Product Data:
- .3 Shop Drawings:
 - .1 Indicate:
 - .1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and engineering data for incorporation into manual specified in Division 1 Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

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

2. PRODUCTS

2.1 DHW HEATER AND STORAGE TANK (DHWT-1 & 2)

- .1 General: packaged unit to ASME standards, stamped for 1100 kPa WP. Provide CGA certification.
- .2 The heaters shall be advanced commercial water heaters, design takes performance to its highest level with thermal efficiency of 96%, complete with conventional power-vent, Low-NOx emissions.

- .3 Unit shall be complete with seamless glass-lined steel tank construction, with glass lining applied to all water-side surfaces after the tank has been assembled and welded, also heater shall be supplied with maintenance-free powered anode;
- .4 Unit shall be complete with down fired pre-mix burner provides optimum efficiency and quiet operation;
- .5 Complete with and a CSA/ ASME rated T&P relief valve;
- .6 Complete with vent package supplied by manufacture;
- .7 Complete with down-fired power burner designed for precise mixing of air and gas for optimum efficiency, requiring no special calibration on start-up;
- .8 Unit shall be approved for 0 mm (0 inch) clearance to combustibles;
- .9 Unit shall be complete with factory supplied intake and exhausts pipes as per Canadian installation code and ULC S636 suitable for venting;
- .10 Thermal insulation: Foam insulation Meets or exceed thermal efficiency of ASHRAE 90.1-2010;
- .11 Complete 15-year warranty, no exception will be accepted;
- .12 The control shall be suitable to work with existing building BMS system and remote monitoring, leak detection and fault alert.
 - .1 Control system shall monitor temperature and ignition device with integral diagnostics, graphic user interface, fault history display and digital temperature readout.

3. EXECUTION

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations, associated codes and authority having jurisdiction.
- .2 Provide insulation between tank and supports.

3.3 CLEANING

- .1 Clean in accordance with Division 1 Requirements.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .5 Closeout / Substantial Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Division 1 requirements.
 - .2 Prior to requesting an inspection for **Substantial Performance**, provide a complete list of items which are deficient; certificate of Substantial Performance will not be granted unless the following items are completed:
 - .1 Heating, plumbing and fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation;
 - .2 Fire stopping for pipe are completed at all fire penetrations;
 - .3 Thermometers and pressure gauges in place and readable;
 - .4 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval;
 - .5 Water systems have been balanced with draft report is submitted to Engineer;
 - .6 Painting, identification and valve tagging completed; touch up of equipment;
 - .7 Letter of completion from the Control Sub-trade forwarded and all tests completed;

- .8 Systems have been chemically cleaned. Flush and initiate water treatment.
- .9 Provide report from manufacturer's representative to confirm status of treatment.
- .10 Draft Operating/Maintenance Manuals have been submitted.
- .11 Operating and Maintenance demonstrations have been provided to the Owner.
- .12 Written inspection report by manufacturer's representative has been submitted for noise and vibration control devices and flexible connections.
- .13 Warranty forms and letters forwarded and extended Warranty items identified;
- .14 Record drawings have been submitted.
- .15 All previously identified deficiencies have been corrected.
- .3 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:
 - .1 Submit final water balance reports.
 - .2 Submit final operating and maintenance manuals.
 - .3 Complete final calibration.
- .4 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .1 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .2 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .3 Performance data to include:

- .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
- .2 Equipment performance verification test results.
- .3 Special performance data as specified.
- .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .4 Approvals:
 - .1 Submit 1 copies of draft Operation and Maintenance Manual to Engineer for approval. Submission of individual data will not be accepted.
 - .2 Make changes as required and re-submit as directed by Engineer.
- .5 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .5 Site records:
 - .1 Consultant will provide 1set of reproducible mechanical drawings. Provide sets of red prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information monthly to re-producibles, revising re-producibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .6 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 1/2 inch high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Engineer for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .7 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 MAINTENANCE

- .1 Furnish spare parts in accordance with Division 1 requirements as follows:
 - .1 One (1) set of packing for each pump.
 - .2 One (1) set of belt for each belt driven equipments;
 - .3 One (1) casing joint gasket for each size pump.
 - .4 Two (2) head gasket set for each heat exchanger.
 - .5 Two (2) glass for each gauge glass.
 - .6 Valves:
 - .1 Washers- one (1) for each size valve and type;
 - .2 Seats- one (1) for each size valve and type
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Division 1 requirements.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with City of Saskatoon and CFIA requirements.

2. PRODUCTS

2.1 NOT USED

3. EXECUTION

3.1 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.2 CLEANING

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Division 1 requirements and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 DEMONSTRATION

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.

3.5 PROTECTION

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

END OF SECTION COMMON WORK RESULTS FOR HVAC

1. GENERAL

1.1 USE OF SYSTEM

- .1 Use of new or existing permanent “Domestic Hot Water (DHW), Steam or Heating ” systems for supplying temporary DHW or building heating is permitted only under the following conditions:
 - .1 Entire system is complete, pressure tested, cleaned, flushed out.
 - .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .3 There is no possibility of damage from any cause.
 - .4 All systems will be:
 - .1 operated as per manufacturer's recommendations or instructions.
 - .2 operated by Contractor.
 - .3 monitored continuously by Contractor.
 - .5 Warranties and guarantees are not thereby relaxed.
 - .6 Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Engineer.
 - .7 Before static completion, entire system to be refurbished, cleaned internally and externally, restored to "as- new" condition, filters in air systems replaced.

2. PRODUCTS

2.1 NOT USED

3. EXECUTION

3.1 NOT USED

END OF SECTION

1. GENERAL

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-1999, Ready-Mixed Organic Zinc-Rich Coating.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 Collect, separate and place in designated containers for recycling Metal and Plastic in accordance with Waste Management Plan.
- .3 Unused sealant materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

2. PRODUCTS

2.1 NOT USED

- .1 Not Used.

3. EXECUTION

3.1 CONNECTIONS TO EQUIPMENT

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

3.2 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

3.3 DRAINS

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

3.4 AIR VENTS

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

3.5 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Uses of press fitting pipe system components are not acceptable on this project.
- .4 Uses of mechanical grooved couplings or fittings are not acceptable on this project.
- .5 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .6 Assemble piping using fittings manufactured to ANSI standards.
- .7 Steel Piping systems- Teeing off Main Line:
 - .1 Use reducing Tee (T), Sockolet (S) or Weldolet (W) type connection as per following schedule:

Branch (N.P.S)													
Header (NPS)		1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10
	1/2	T											
	3/4	T	T										
	1	T	T	T									
	1 1/4	T	T	T	T								
	1 1/2	T	T	T	T	T							
	2	S	S	S	T	T	T						
	2 1/2	S	S	S	S	T	T	T					
	3	S	S	S	S	S	T	T	T				
	4	S	S	S	S	S	T	T	T	T			
	6	S	S	S	S	S	W	T	T	T	T		
	8	S	S	S	S	S	W	W	W	T	T	T	
	10	S	S	S	S	S	W	W	W	W	T	T	T

- .8 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .9 Install concealed pipe work to minimize furring space, maximize headroom, conserve space.
- .10 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .11 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .12 Group piping wherever possible or as indicated.
- .13 Ream pipes, remove scale and other foreign material before assembly.

- .14 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .15 Provide for thermal expansion as indicated.
- .16 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use gate or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Install ball valves for glycol service.
 - .9 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .17 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.

3.6 PIPEWORK INSTALLATION_ STEAM:

- .1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
- .2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.
- .3 Install piping material specified as inside the building to 2500 mm outside of building.
- .4 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.
- .5 Slope steam piping 0.5% in direction of flow and condensate return piping 0.7%. Provide drip trap assembly at all low points and in front of control valves. Run condensate lines from traps to nearest condensate receiver. Where condensate lines form a trap, provide vent loop over the trapped section.

- .6 Make reductions in steam pipes with eccentric reducing fittings installed to provide drainage and venting, bottom flat for steam.
- .7 Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blow-downs, water columns and overflows to the nearest blow-down tank.

3.7 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 1/4 inch minimum clearance between sleeve and un-insulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
 - .2 Other floors: Terminate 125 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: Provide space for fire stopping. Maintain fire rating integrity.
 - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.8 ESCUTCHEONS

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

3.9 PREPARATION FOR FIRESTOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 – Fire stopping.
- .2 Un-insulated unheated pipes not subject to movement: No special preparation.
- .3 Un-insulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging fire stopping material or installation.
- .4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.10 FLUSHING OUT OF PIPING SYSTEMS

- .1 For the new pipes in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of existing of reused piping systems in accordance with requirements of division 1 requirements.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Engineer minimum 5 working days prior to performance of pressure tests.
- .2 Verify that:
 - .1 All valves are accessible.
 - .2 Instrument tappings are accessible, and adequate clearance has been provided to attach instruments.
 - .3 Major pieces of equipment are serviceable and connected to system with flanges or unions, etc.
 - .4 All pipe expansion has been allowed for.
- .3 Pipework: Test as follows:
 - .1 Heating water/glycol system: test to minimum of 1.5 times maximum working pressure or 1054 KPa water pressure at lowest point of system/section being tested.
 - .2 Domestic water system: test to minimum of 1.5 times maximum working pressure or 1054 KPa water pressure at lowest point of system/section being tested.
 - .3 Gas piping: test as required by authorities having jurisdiction.
 - .4 Sprinkler system: test as required by authorities having jurisdiction.

- .5 Low pressure steam and condensate system: test to 860 KPa hydrostatic pressure.
- .4 Maintain specified test pressure without loss for 12 hours minimum unless specified for longer period of time.
- .5 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .6 Pay costs for repairs or replacement, retesting, and making good. Engineer to determine whether repair or replacement is appropriate.
- .7 Conduct tests in presence of Building owner representative.
- .8 Pay costs for repairs or replacement, retesting, and making good to determine whether repair or replacement is appropriate.
- .9 Insulate or conceal work only after approval and certification of tests by Consultant.
- .10 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, and re-making joints in copper lines. Do not caulk.
- .11 For glycol systems, retest after cleaning. Repair leaking joints, fittings or valves.

3.12 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Engineer.
- .2 Request written approval **21 working days minimum**, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Ensure daily clean-up of existing areas.

3.13 PIPING SCHEDULE

System	Pipe	Fitting	Joint
Equipment drains and overflows	Copper water tube, type "K" Hard drawn	Wrought copper	Soldered, Lead-Free
Domestic water pipe above grade	Copper water tube, type "K" hard temper.	Wrought copper	Soldered, Lead-Free
DWV	DWV copper (above grade only)	Cast bonze	Soldered 50- 50 tin-lead
		Wrought copper	Soldered 50- 50 tin-lead
Hydronic Heating and 1035 KPa (Glycol Mix)	Black steel Schedule 40, 50 mm or less	Threaded	Screwed
		Welding	Welded
	Black steel Schedule 40, Greater than 50 mm	Welding	Welded
Low Pressure Steam (supply) up to 350 KPa	Black steel schedule 40	Welding	Welded
Steam Condensate (return) up to 175 KPa	Black steel schedule 80	Welding	Welded
Natural gas low pressure less than 175 KPa, Inside building	Black steel, Schedule 40 50 mm or less	Threaded	Screwed
		Welding	Welded
	Black steel, Schedule 40 greater than 50 mm		
		Welding	Welded

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Electrical motors, drives and guards for mechanical equipment and systems.
- .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
- .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22, 23 and 25. Refer to Division 26 for quality of materials and workmanship.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-2006, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .3 Quality Control: in accordance with Division 1 Requirements.
 - .1 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Division 1 Requirements.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial regulations.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

2. PRODUCTS

2.1 GENERAL

- .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1-2010.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 3/4 HP : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 3/4 HP and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees °C, 3 phase, 575 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Engineer for temporary use only. Work will only be accepted when specified motor is installed.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Fasten securely in place.

- .2 Make removable for servicing, easily returned into, and positively in position.

3.3 CLEANING

- .1 Proceed in accordance with Division 1 Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for flexible connections, expansion joints, anchors and guides for building services piping.

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A53/A53M-2002, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A105/A105M-2003, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and indicate for items as applicable:
 - .1 Manufacturer, model number, line contents, pressure and temperature rating.
 - .2 Movement handled, axial, lateral, angular and the amounts of each.
 - .3 Nominal size and dimensions including details of construction and assembly.
- .3 Submit maintenance data in accordance with Division 1 Requirements
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Unused sealant materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

2. PRODUCTS

2.1 SLIP TYPE EXPANSION JOINTS

- .1 Application: for axial pipe movement, as indicated.
- .2 Repacking: under full line pressure.

- .3 Body and packing housings: Class 150 carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe with slip-on] or weld neck flanges to match pipe .
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.
- .8 Packing rings: graphite impregnated non-asbestos.
- .9 Thermal plastic packing: graphite impregnated non-asbestos slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
 - .1 Plunger body: heavy wall carbon steel welded to body.
 - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.
- .14 Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug.

2.2 BELLOWS TYPE EXPANSION JOINTS

- .1 For axial, lateral or angular movements, as indicated.
- .2 Maximum operating pressure: 1054 KPa.
- .3 Maximum operating temperature: 120 degrees C.
- .4 Type A: free flexing, factory tested to 1 1/2 times maximum working pressure. Furnish test certificates.
- .5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1 1/2 times maximum working pressure. Furnish test certificates.
- .6 Bellows:

- .1 Multiple bellows, hydraulically formed, single ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.
- .7 Reinforcing or control rings:
 - .1 2 piece nickel iron.
- .8 Ends:
 - .1 For butt welding weld neck flanges to match pipe.
- .9 Liner:
 - .1 Austenitic stainless steel in direction of flow.
- .10 Shroud:
 - .1 Carbon steel, painted.

2.3 FLEXIBLE CONNECTION

- .1 Application: to suit motion as indicated.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: stainless steel corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: as per pipe size.
- .6 Operating conditions:
 - .1 Working pressure: 1054 KPa.
 - .2 Working temperature: 150 degrees C.
 - .3 To match system requirements.

2.4 ANCHORS AND GUIDES

- .1 Anchors:
 - .1 Provide as indicated or required.
- .2 Alignment guides:
 - .1 By conduit manufacturer.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers, jackets to remain uninterrupted.

3. EXECUTION

3.1 INSTALLATION

- .1 Provide flexible pipe connectors on pipes connected to equipment supported by vibration isolation where indicated on the drawing.
- .2 Install expansion joints with cold setting, as indicated. Make record of cold settings.
- .3 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .4 Install pipe anchors and guides as indicated. Anchors to withstand 150 % of axial thrust.

3.2 CLEANING AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

END OF SECTION EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

1. GENERAL

1.1 RELATED SECTIONS

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2001, Power Piping.
 - .2 ANSI/ASME Boiler and Pressure Vessel Code-2007:
 - .1 Section I: Power Boilers.
 - .2 Section V: Nondestructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-1997, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1-2000, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-1999, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook..
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-48.2-1992, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA B51-2003, Boiler, Pressure Vessel and Pressure Piping Code.
 - .2 CSA-W117.2-2006, Safety in Welding, Cutting and Allied Processes.

1.3 QUALIFICATIONS

- .1 Welders
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use only 15 years experienced qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Furnish welder's certifications and qualifications to Owner prior to commence the work.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.

1.4 QUALITY ASSURANCE

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures available for inspection.
- .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

2. PRODUCTS

2.1 ELECTRODES

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

3. EXECUTION

3.1 WORKMANSHIP

- .1 Welding: in accordance with ANSI/ASME B31.1, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1 and applicable requirements of provincial authority having jurisdiction.
- .2 The Contractor is to ensure that for any pipe welding that occurs within the interior of the laboratory facility, proper ventilation for the welding system is in place, and under no circumstances shall the welding fumes be transferred to the any area of CFIA building; Contractor is fully responsible to monitor & maintain facility pressurization as per original design

3.2 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.

3.3 SPECIALIST EXAMINATIONS AND TESTS

- .1 General
 - .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Consultant.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .2 Hydrostatically test welds to requirements of ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Engineer of total of up to 25% of welds, selected at random by particle tests.
- .5 Full radiographic tests for piping systems.
 - .1 Spot radiography to CAN/CGSB-48.2.
 - .1 Conduct spot radiographic tests of up to 25% of welds, selected at random by Consultant from welds which would be most difficult to repair in event of failure after system is operational.
 - .2 Radiographic film:
 - .1 Identify each radiographic film with date, location, name of welder, and submit to Consultant. Replace film if rejected because of poor quality.
 - .3 Interpretation of radiographic films:
 - .1 By qualified radiographer.
 - .4 Failure of radiographic tests:
 - .1 Extend tests to welds by welder responsible when those welds fails tests.

3.4 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

3.5 REPAIR OF WELDS WHICH FAILED TESTS

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

END OF SECTION PIPE WELDING

1. GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for thermometers and pressure gauges in piping systems.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 23 05 54 - Mechanical Identification.

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-2001, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data.
- .3 Submit manufacturer's product data for following items:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Stop cocks.
 - .4 Syphons.
 - .5 Wells.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 Collect, separate and place in designated containers for recycling Metal and Plastic in accordance with Waste Management Plan.

2. PRODUCTS

2.1 GENERAL

- .1 Design point to be at mid point of scale or range.
- .2 Ranges: as indicated.

2.2 THERMOMETER

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: stainless steel.
- .3 Stem Type Thermometer: to CGSB 14-GP-2a and as follows:
 - .1 Type: Type C - any angle, adjustable.
 - .2 Class: Class 2 - fixed calibration.
 - .3 Case Material: steel, protected against corrosion and painted black.
 - .4 Crystal: shatterproof glass.
 - .5 Case Length: 225 mm
 - .6 Capillary Tube: Liquid in glass "Red Fluid", mercury free;
 - .7 Graduations: °C.
 - .8 Scale Range:
 - .1 Hot Water Heating: 0-110°C.
 - .2 Condenser Water: 0-50°C.
 - .3 Domestic Hot Water: 0-110°C.
 - .4 Domestic Cold Water: 0-50°C.
- .4 Thermometer Wells: to CAN/CGSB 14.5-M88 and as follows:
 - .1 Construction: one piece brass construction.
 - .2 Diameter: 6 mm
 - .3 Depth: to suit thermometer stem.

2.3 POSITIVE PRESSURE GAUGES

- .1 Type: liquid fill.
- .2 Accuracy: accurate within $\pm 1\%$.
- .3 Gauge Size: 125 mm diameter.
- .4 Case Material: steel, protected against corrosion and painted black.
- .5 Crystal: shatterproof glass.
- .6 Mounting: stem mounting at bottom of case.

- .7 Bourdon Tube Material: phosphor bronze.
- .8 Dial Graduations: PSI.
- .9 Scale Range:
 - .1 Hydronic Systems: 0-900 KPa
 - .2 Steam Systems: 0-350 KPa
 - .3 Domestic Water Systems: 0-600 KPa
- .10 Stop: bourdon tube and stop.
- .11 Movement: stainless steel or non-ferrous metal.
- .12 Calibrator: set screw.

2.4 COMPOUND PRESSURE GAUGE:

- .1 Type: compound pressure
- .2 Accuracy: accurate within $\pm 1\%$
- .3 Gauge Size: 100 mm diameter
- .4 Case Material: steel, protected against corrosion and painted black
- .5 Crystal: shatterproof glass
- .6 Mounting: stem mounting at bottom of case
- .7 Bourdon Tube Material: phosphor bronze
- .8 Low Pressure Steam:
 - .1 Vacuum: 0-400 KPa
 - .2 Pressure: 0-400 KPa
- .9 Hydronic Systems:
 - .1 Vacuum: 0-200 KPa
 - .2 Pressure: 0-800 KPa
- .10 Domestic Water Systems:
 - .1 Vacuum: 0-1200 KPa
 - .2 Pressure: 0-800 KPa

2.5 PITOT FLOW FITTINGS

- .1 Flow Element: Averaging pitot-type of 316 stainless steel.
- .2 Flow Sensor: Consisting of three basic flow sensing chambers.

- .1 Upstream high pressure chamber.
- .2 High pressure interpolating tube.
- .3 Low pressure tube located on the pipe centreline.
- .3 Flow Element Design Criteria:
 - .1 Temperature: Serviceable to 150°C.
 - .2 Pressure: Serviceable to 1725 KPa.
- .4 Accuracy: $\pm 2\%$.
- .5 Flow Element Mounting: Pipe Diameters up to 6" inch; Welded fitting with flow element supported at one end.
- .6 Flow Element Accessories:
 - .1 Brass shut-off valves on each fitting.
 - .2 Quick disconnect gauge fitting.
 - .3 Metal identification tag attached with a chain. Include following information on tag:
 - .1 Design flow rates.
 - .2 Meter readings for design flow rates.
 - .3 Metered fluid name.
 - .4 Line size.
 - .5 Tag number.
 - .6 Station or location number.

2.6 POSITIVE DISPLACEMENT FLUID METERS

- .1 Positive Displacement Fluid Meters:
 - .1 Type: Designed to be used with the fluid being metered.
 - .2 Case: Bronze construction with cast iron frost-proof, breakaway bottom cap.
 - .3 Register: Hermetically sealed.

2.7 PRESSURE/TEMPERATURE TAPS

- .1 Fitting to allow a 1/4" inch O.D. plug in gauge to measure temperature or pressure.
- .2 Maximum pressure: 3450 KPa
- .3 Maximum temperature: 150°C.
- .4 Fitting constructed of:
 - .1 1/2" inch NPT brass body with hex head screw cap and gasket;

- .2 Protective sercew cap to have retaining strap;
- .3 Two self-closing valves constructed of nordel.
- .5 Test kit including the following:
 - .1 One 65 mm diameter compound pressure gauge with 1/8" O.D. plug-in stem
 - .2 One 125 mm diameter temperature gauge with 1/8" O.D. plug in stem, range 0 – 110 °C
 - .3 One 125 mm diameter temperature gauge with 1/8" O.D plug in stem, range 0 – 80°C; and
 - .4 All above in protective carrying case with operating instructions.

3. EXECUTION

3.1 GENERAL

- .1 Provide one pressure gauge per pump. Install taps on pump suction, pump discharge and before strainer. Pipe to gauge with needle valve on each tap.
- .2 For gauges on liquid service, provide tee in piping with bronze pulsation damper and needle valve.
- .3 For steam service, provide a pigtail siphon and needle valve.
- .4 Install positive displacement fluid meters with isolating valves and unions.
- .5 Install pitot flow meters according to manufacturer's installation instructions.

3.2 PRESSURE/TEMPERATURE TAPS

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.
- .3 Provide one pressure/temperature taps test kit.
- .4 Install pressure/temperature taps in the following locations:
 - .1 Both sides of two-way control valves;
 - .2 All lines to three-way control valves;
 - .3 Heat exchanger: at inlet and outlet;
 - .4 All control sensor.

3.3 THERMOMETERS

- .1 Install in wells on piping. Provide heat conductive material inside well.

- .2 Install wells for balancing purposes.
- .3 Use extensions where thermometers are installed through insulation.
- .4 Stem Type Thermometers:
 - .1 Heat exchangers at inlet and outlet.
 - .2 Boilers at inlet and outlet.
 - .3 All lines to three way control valves.
 - .4 Inlets/ outlet of three way mixing valve
 - .5 Inlet/ outlet to domestic hot water heater/tanks; and
 - .6 All locations as indicated on drawings.

3.4 METER:

- .1 Positive Displacement Fluid Meter:
 - .1 Provide positive displacement meters in the following systems at locations indicated on the drawings:
 - .1 Condensate return.
 - .2 Expansion tank make-up.
- .2 Pitot Flow Fittings:
 - .1 Provide pitot type flow fittings in the following systems at locations indicated on drawings:
 - .1 Heating water system.
 - .2 Condenser water system
 - .3 Steam system
 - .2 Install elements a minimum of ten straight pipe diameters upstream, and three diameters downstream of any elbows. Where flow fittings are installed closer than ten pipe diameters upstream of any elbow, provide straightening vanes. Install straightening vanes in accordance with manufacturer's instruction.

3.5 PRESSURE GAUGES

- .1 Positive Pressure Gauges:
 - .1 Expansion tanks.
 - .2 Domestic cold water supply to the systems
 - .3 Boilers at inlet and outlets.
 - .4 Heat exchangers at inlet and outlet.
 - .5 Upstream and downstream of PRV's
 - .6 Inlet and outlet of liquid side of heat exchangers.
- .2 Compound Pressure Gauges:

- .1 Suction and discharge of pumps.
- .2 Steam header
- .3 Condensate header
- .3 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .4 Use extensions where pressure gauges are installed through insulation.

3.6 NAMEPLATES

- .1 Install engraved lamicaid nameplates as specified in Section 23 05 54 - Mechanical Identification, identifying medium.

END OF SECTION METERS AND GAUGES PIPING SYSTEMS

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Bronze - valves.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).

- .1 ANSI/ASME B1.20.1-2001 Pipe Threads, General Purpose (Inch).
- .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.

.2 American Society for Testing and Materials International, (ASTM).

- .1 ASTM A276-2004, Specification for Stainless Steel Bars and Shapes.
- .2 ASTM B62-2002, Specification for Composition Bronze or Ounce Metal Castings.
- .3 ASTM B283-1999, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
- .4 ASTM B505/B505M-2002, Specification for Copper-Base Alloy Continuous Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

- .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
- .2 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.
- .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

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

- .1 Submit data for valves specified in this section.

.2 Closeout Submittals:

- .1 Submit maintenance data for incorporation into manual specified in division 1 requirements.

1.4 MAINTENANCE

.1 Furnish following spare parts:

- .1 Valve seats: one for every 10 valves each size, minimum 2.
- .2 Discs: one for every 10 valves, each size. minimum 2.
- .3 Stem packing: one for every 10 valves, each size. minimum 1.
- .4 Valve handles: 2 of each size.
- .5 Gaskets for flanges: one for every 10 flanged joints.

2. PRODUCTS

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 All products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: Solder ends to ANSI/ASME B16.18.
- .3 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc , regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .3 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: Handwheel
 - .4 Use for 'Throttling Service'.
 - .4 Angle valve, NPS 2 and under, composition disc, Class 150:

- .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .3 Operator: Handwheel.
- .4 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
- .5 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class125.
 - .3 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.
- .6 DRAIN VALVES
 - .1 NPS 2 and under:
 - .1 Globe Type Drain Valves:
 - .1 Body: bronze.
 - .2 Disc: compression stop.
 - .3 Ends: nipple and cap or hose.
 - .2 Ball Type Drain Valves:
 - .1 Body: bronze.
 - .2 Ends: cap and chain.

.7 CIRCUIT BALANCING VALVES

.1 NPS 2 and under:

- .1** Body Design: suitable for throttling.
- .2** Construction: all metal parts non-ferrous, pressure die cast, non-porous copper alloy.
- .3** Installation: designed to be installed in any direction without affecting flow measurement.
- .4** Functions:
 - .1** Precise flow measurement $\pm 2\%$.
 - .2** Precision flow balancing.
 - .3** Positive shut-off with no drip seat and teflon disc.
 - .4** Drain connections with protective cap.
 - .5** Balancing Connection: "hidden memory" feature to program valve with precision tamper-proof balancing setting.
 - .6** Meter Connection: fittings for connecting a portable differential pressure meter and positive shut-off cocks for each meter connection.
- .5** Balancing Connection: "hidden memory" feature to program valve with precision tamper-proof balancing setting.

3. EXECUTION

3.1 INSTALLATION

- .1** Install rising stem valves in upright position with stem above horizontal.
- .2** Remove internal parts before soldering.
- .3** Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
- .4** Provide valves as indicated on drawings and following schedule:
 - .1** Globe and Angle Globe Valves:
 - .1** Throttling service.
 - .2** Control device.
 - .2** Ball and Quick Opening Valves:
 - .1** Branch take-offs.
 - .2** Shut-off.
 - .3** Isolating Service - Isolate equipments.
 - .4** Chemical pot feeders.
 - .3** Swing Check Valves:

- .1 Discharge or pumps.
- .2 Backflow prevention.
- .4 Circuit Balancing Valves:
 - .1 Pumps discharge.
 - .2 Branch pipe take-offs from main and sub-mains.
 - .3 As Indicated on Drawings
- .5 Drain Valves:
 - .1 Near main shut-off valves.
 - .2 Low points in piping systems.
 - .3 At equipment.

END OF SECTION VALVES - BRONZE

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Valves, gate, globe, and check.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).

- .1 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.

.2 American Society for Testing and Materials International (ASTM).

- .1 ASTM A49-2006, Specification for Heat-Treated Carbon Steel Joint Bars.
- .2 ASTM A126-2001, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- .3 ASTM B61-1993, Specification for Steam or Valve Bronze Castings.
- .4 ASTM B62-1993, Specification for Composition Bronze or Ounce Metal Castings.
- .5 ASTM B85-2003, Specification for Aluminum-Alloy Die Castings.
- .6 ASTM B209-2004, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

- .1 MSS SP-70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
- .2 MSS SP-71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
- .3 MSS SP-82-1992, Valve Pressure Testing Methods.
- .4 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

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

- .1 Submit data for valves specified in this section.

.2 Closeout Submittals:

- .1 Submit maintenance data for incorporation into manual specified in division 1 requirements.

1.4 MAINTENANCE

- .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.

2. PRODUCTS

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
 - .1 Gate valves: MSS SP-70.
 - .2 Globe valves: MSS SP-85.
 - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Body, bonnet: cast iron to ASTM B209 Class B.
 - .2 Connections: flanged ends plain face to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: Die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
 - .9 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have CRN registration numbers.

2.2 GATE VALVES

- .1 NPS 2 ½ to 8, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.

- .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
- .3 Seat rings: renewable bronze screwed into body.
- .4 Stem: nickel-plated steel.
- .5 Pressure-lubricated operating mechanism.
- .6 Operator: Handwheel.

2.3 GLOBE VALVES

- .1 NPS 2 1/2 to 10, OSY:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 125 PSI steam, 200 PSI CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - .5 Seat ring: renewable, regrindable, screwed into body.
 - .6 Stem: bronze to ASTM B62.
 - .7 Operator: Handwheel.

2.4 VALVE OPERATORS

- .1 Install valve operators as follows:
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 6'-0" above floor in boiler rooms and mechanical equipment rooms.

2.5 CHECK VALVES

- .1 Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron to ASTM A126 Class B.
 - .2 Ratings:
 - .1 NPS 2 1/2 - 12: 125 PSI steam, 200 PSI CWP.
 - .3 Disc: rotating for extended life.
 - .1 Up to NPS 6: bronze to ASTM B 62.
 - .2 NPS 8 and over: bronze-faced cast iron.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Hinge pin, bushings: renewable bronze to ASTM B62.
 - .6 Identification tag: fastened to cover.
 - .7 Hinge: galvanized malleable iron.

3. EXECUTION

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Provide valves as indicated on drawings and following schedule:
 - .1 Gate Valves:
 - .1 Shut-off.
 - .2 Isolating Service - Isolate equipment and vertical risers.
 - .3 Branch take-offs.
 - .2 Globe Valves:
 - .1 Throttling service.
 - .2 Control device.
 - .3 Low water cut-offs.
 - .4 Chemical pot feeders.
 - .3 Swing Check Valves:
 - .1 Discharge or pumps.
 - .2 Backflow prevention.

END OF SECTION VALVES - CAST IRON

1. GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
 - .3 ANSI/ASME B16.5-2003, Pipe Flanges and Flanged Fittings.
 - .4 ANSI/ASME B16.11-2001, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-1997, Buttwelding Ends.
 - .6 ANSI/ASME B16.34-1996, Valves - Flanged, Threaded and Welding Ends.
- .2 American National Standards Institute (ANSI)/American Petroleum Institute (API).
 - .1 ANSI/API 609-1997, Lug- and Water-Type Butterfly Valves.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A126-2001, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM B62-2002, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B209M-2004, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-67-2002, Butterfly Valves.

1.2 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit data for valves specified this section.
- .2 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Division 1 Requirements.

1.3 MAINTENANCE

- .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size, minimum 1.
 - .3 Stem packing: one for every 10 valves, each size, minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.

2. PRODUCTS

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSIG

- .1 Except to specialty valves, to be of single manufacturer.
- .2 To be suitable for dead-end service.
- .3 CRN registration number required for products.
- .4 Sizes: Wafer type: NPS 2 to 30.
- .5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - .1 NPS 2 to 12: 1378 KPa.
- .6 Minimum seat temperature ratings to 275 degrees C.
- .7 Application: on-off operation.
- .8 Full lug body (threaded).
- .9 Operators:
 - .1 NPS 2 - 6: Handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.
- .10 Designed to comply with MSS SP-67 and API 609.
- .11 Compatible with ANSI Class 125/Class 150 flanges.
- .12 Construction:
 - .1 Body ductile iron.
 - .2 Disc: 316 SS.
 - .3 Seat: EPDM.
 - .4 Shaft: 316 stainless steel.

- .5 Taper pin: 316 SS.
- .6 Key: stainless.
- .7 O-Ring: Buna-N.
- .8 Bushings: Teflon.

2.2 MOUNTING FLANGES

- .1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges.

3. EXECUTION

3.1 PREPARATION

- .1 Valve and mating flange preparation.
 - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
 - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
 - .3 Install butterfly valves with disc in almost closed position.
 - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

- .1 Air hoses or electrical connections to be made by actuator manufacturer.

- .2 Cycle valve operation from fully closed to fully open then back to fully closed.
- .3 At same time, check travel stop settings for proper disc alignment.

END OF SECTION BUTTERFLY VALVES

1. GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2004, Power Piping.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A125-2007, Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-2004, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-2004, Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 Underwriter's Laboratories of Canada (ULC)

1.3 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
 - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
 - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Division 1 Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

2. PRODUCTS

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.
- .3 Obtain approval from the Engineer prior to drilling for inserts and supports for piping systems.
- .4 Obtain approval from the Engineer prior to using percussion type fastenings.
- .5 Use of piping or equipment for hanger supports is not permitted.
- .6 Use of perforated band iron, wire or chain as hangers is not permitted.
- .7 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the Engineer.

- .8 Where deemed necessary by the engineer the contractor shall, at his own cost, employ a structural consultant to design equipment supports and/or pipe anchors.

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized painted with zinc-rich paint] after manufacture.
 - .2 Use hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 3/8" inch UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 1/4" inch minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate to MSS SP69.
- .5 Do not use shop and field-fabricated assemblies.
- .6 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 7/8" inch or 1 1/8" inch rod.
- .7 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel black.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP69, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

- .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: black, with formed portion epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.3 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 305 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.4 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10 % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.5 VARIABLE SUPPORT SPRING HANGERS

- .1 Vertical movement: 13mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops.

- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.6 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements Structural Steel for Buildings.

2.7 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

- .1 Provide templates to ensure accurate location of anchor bolts.

2.8 HOUSE-KEEPING PADS

- .1 Provide high concrete housekeeping pads for base-mounted equipment; size pads as indicated on drawings and as per shown structural detail.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, and as indicated.
- .3 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .5 Use approved constant support type hangers where:
 - .1 vertical movement of pipework is 13 mm or more,
 - .2 transfer of load to adjacent hangers or connected equipment is not permitted.
- .6 Use variable support spring hangers where:
 - .1 transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to National Plumbing Code and authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1800 mm.
- .4 Copper piping: up to NPS 1/2: every 1500 mm.
- .5 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1m	1.8m
1-1/2	2.7m	2.4m
2	3.0m	2.7m
2-1/2	3.6m	3.0m
3		
3-1/2	3.9m	3.3m
4	4.2m	3.6m
5	5.1m	Do Not Use
6		
8		
10		
12		

- .7 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FLASHING

- .1 Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.
- .2 Flash floor drains over finished areas with lead minimum 250 mm clear on sides. Fasten flashing to drain clamp device.
- .3 Provide curbs for mechanical roof installations.
- .4 Attach counterflashings to mechanical equipment and lap base flashings on roof curbs.
- .5 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Use storm collars above all roof jacks.

3.7 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

END OF SECTION HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Vibration isolation materials and components, seismic control measures and their installation.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 13-2010, Standard for the Installation of Sprinkler Systems.
- .3 National Building Code of Canada (NBC) - 2005

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Provide separate shop drawings for each isolated system complete with performance and product data.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

2. PRODUCTS

2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 ELASTOMERIC PADS

- .1 Type EP1 - neoprene-steel-neoprene; 12mm minimum thick neoprene bonded to 1/4" inch steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 75 PSI.

2.3 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.
- .2 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .3 Performance: as indicated.

2.4 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .2 Ensure piping and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

- .1 Up to NPS4: first 3 points of support.
- .2 NPS5 to NPS8: first 4 points of support.
- .3 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 Upon completion of installation.
 - .3 Submit manufacturer's reports to Engineer within 7 days of manufacturer representative's review.
 - .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
 - .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC system[s] after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .2 Provide Departmental Representative with notice 96 h in advance of commencement of tests.
 - .3 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
 - .4 Submit complete report of test results including sound curves.

3.4 CLEANING

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

3.5 ISOLATION SCHEDULES

Isolated Equipment		Type of	Static
No.	Description	Isolation	Min. Deflection (inch)
B-4 to 6	Boilers	EP-1	-
Vertical In-Line Pumps	General	H-2	3/4

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Materials and requirements for the identification of piping systems, valves and controllers, including the installation and location of identification systems.

1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-1.60-1997, Interior Alkyd Gloss Enamel.
- .2 CAN/CGSB-24.3-1992, Identification of Piping Systems.

.2 National Fire Protection Association (NFPA)

- .1 NFPA 13-2010, Standard for the Installation of Sprinkler Systems.

1.3 SUBMITTALS

.1 Product Data: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product data to include paint colour chips, other products specified in this section.

.3 Samples:

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

- .1 Do not dispose of unused paint, coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

2. PRODUCTS

2.1 EXISTING IDENTIFICATION SYSTEMS

- .1 Where existing identification system does not cover for new work, use identification system specified this section.
- .2 Before starting work, obtain written approval of identification system from Departmental Representative.

2.2 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.3 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

Size #	Sizes (inch)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3		2	3
4	20 x 100	1	8
5		2	5
6	20 x 200	1	8
7	25 x 125	1	12
8		2	8
9	35 x 200	1	20

- .2 Use maximum of 25 letters/numbers per line.
- .4 Identification for:
 - .1 Equipment in Mechanical Room:
 - .1 Main identifier: size #9.
 - .2 Source and Destination identifiers: size #6.
 - .3 Terminal cabinets, control panels: size #5.
 - .2 Equipment elsewhere: sizes as appropriate.

2.4 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Sprinklers: to NFPA 13.
 - .2 Natural gas: to CSA/CGA B149.1-2005.

2.5 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than NPS 75mm long x 50 mm high
 - .2 Outside diameter of pipe or insulation NPS 3 and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 3/4" and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

- .2 Other pipes: pressure sensitive plastic-coated cloth with protective over-coating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 120°C and intermittent temperature of 180°C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Engineer.
 - .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

- .3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Treated water	Green	TREATED WATER
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Steam ___ KPa	Yellow	___ PSI STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Domestic hot water supply	Green	DOM. HW SUPPLY
Domestic cold water supply	Green	DOM. CWS
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Sprinklers	Red	SPRINKLERS
Natural gas	As per Natural Gas code CSA B149.1-05	

2.6 VALVES, CONTROLLERS

- .1 Brass tags with 1/2" stamped identification data filled with black paint.

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

2.7 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

- .1 Identification in English.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

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

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC or CSA registration plates as required by respective agency.

3.4 NAMEPLATES

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
 - .1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 30'-0" intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 On both sides of visual obstruction or where run is difficult to follow.
- .4 On both sides of separations such as walls, floors, partitions.
- .5 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .6 At beginning and end points of each run and at each piece of equipment in run.
- .7 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .8 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative and provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.7 CLEANING

- .1 Proceed in accordance with Division 1 Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 SUMMARY

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Engineer within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and

recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Engineer adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Engineer in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB and as required by Departmental Representative and Engineer for verification of TAB reports.

1.9 START OF TAB

- .1 Notify and coordinate with Departmental Representative **15 working days** prior to start of TAB.
- .2 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Hydronic systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 **Hydronic systems: +/- 5 %.**

1.11 ACCURACY TOLERANCES

- .1 Measured values accurate to within plus or minus 5% of actual values.

1.12 INSTRUMENTS

- .1 Prior to TAB, submit to Engineer list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 1 month of TAB. Provide certificate of calibration to Engineer.

1.13 SUBMITTALS

- .1 Submit, prior to commencement of TAB:

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

1.14 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Engineer, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.

1.15 TAB REPORT

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 5 copies of TAB Report to Engineer for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 SETTINGS

- .1 After TAB is completed to satisfaction of Engineer, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.17 COMPLETION OF TAB

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

1.18 HYDRONIC SYSTEMS

- .1 Definitions: for purposes of this section, to include low pressure hot water heating, chilled water, condenser water, glycol systems.
- .2 Standard: TAB to be to most stringent of this section or TAB standards of AABC.
- .3 Do TAB of following systems, equipment, components, controls:
 - .1 Balance all flows at all pumps. Provide PV data for all pumps.

- .2 Provide recommendations on impeller trimming for all pumps, remeasure pump performance after impeller trimming is complete.
- .3 Provide PV measurements for heat exchangers, preheat coil, heating coil.
- .4 Adjust flow of water through heat exchanger.
- .5 Check and record leaving water temperatures and return water temperatures, and pressure drop through heat exchangers. Reset to design temperatures.
- .6 Check and record water temperature at inlet side of coils. Note rise or drop of temperatures from source.
- .7 Position and mark all automatic valves, hand valves, and balancing cocks for design flow through all coils, connectors and all items in the system requiring circulation of chilled water, hot water or glycol.
- .8 Ensure all bypass valves are tightly closed.
- .4 Qualifications: personnel performing TAB to be qualified to standards of AABC or NEBB.
- .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of primary and secondary loops (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water.

1.19 DOMESTIC SYSTEMS

- .1 Meet requirements as specified for hydronic systems.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate: Inlet and outlet of heaters, tank, pump, circulator, at controllers, controlled device.

1.20 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for hydronic systems specified this section.
 - .2 Quality assurance: as for hydronic systems specified this section.
- .2 Laboratories fume hoods:
 - .1 Standard: Canada Labour Code or Territorial standard.
 - .2 TAB procedures: as described in standard.

- .3 Measurement of noise and vibration from equipment specified in Division 23.

2. PRODUCTS

2.1 NOT USED

- .1 Not used.

3. EXECUTION

3.1 NOT USED

- .1 Not used.

END OF SECTION

1. GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-2010, SI; Energy Standard for Buildings except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M-2002, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric)
 - .2 ASTM C335-2005, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-1997, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-2000, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement
 - .5 ASTM C547-2000, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-2000, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 - .7 ASTM C612-2000, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795-2003, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921-2003, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-1995, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation
- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards 2005.
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-2000 Surface Burning Characteristics of Building Materials and Assemblies
 - .2 CAN/ULC-S701-2001, Thermal Insulation Polyotrene, Boards and Pipe Covering

1.2 DEFINITIONS

.1 For purposes of this section:

- .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
- .2 "EXPOSED" - will mean "not concealed" as defined herein.
- .3 Insulation systems - insulation material, fasteners, jackets, and other accessories

.2 TIAC Codes:

- .1 CRD: Code Round Ductwork,
- .2 CRF: Code Rectangular Finish.

1.3 SUBMITTALS

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

.2 Product Data:

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

.3 Shop Drawings:

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

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

1.4 QUALITY ASSURANCE

.1 Qualifications:

- .2 Installer: specialist in performing work of this Section, and have at least 15 years successful experience in this size and type of project, qualified to standards of TIAC.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.

2. PRODUCTS

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed 0.035 W/m.C at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 Services Temperatures:
 - .1 Cold Ducts: -45°C to 50°C, all Outdoor air and Combustion air ducts will be consider "Cold Ducts".
- .4 **Type C-1:** Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section), maximum "K" value 0.035 W/m.C at 24°C.
- .5 **Type C-2:** Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section), maximum "K" value 0.035 W/m.C at 24°C.
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.
- .6 **Breeching Insulation:** Semi-rigid mineral fibre with glass mat, "k" Value: Maximum 0.035 W/m.C at 24°C mean temperature and service Temperature of 70°C to 480°C.

2.3 JACKETS

- .1 Use of Canvas is not allowed.

- .2 Aluminum:
 - .1 To ASTM B209 with and without moisture barrier as scheduled in PART 3 of this section
 - .2 Thickness: 0.5 mm sheet.
 - .3 Finish: Smooth.
 - .4 Jacket banding and mechanical seals: 12 mm thick stainless steel.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation
- .3 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m²
- .4 Tape: self-adhesive, aluminum, plain 3" wide minimum.
- .5 Contact adhesive: quick-setting
- .6 Canvas adhesive: washable.
- .7 Tie wire: 1.52 mm stainless steel.
- .8 Banding: 19 mm wide, 0.5 mm thick stainless steel
- .9 Fasteners: 0.50 mm diameter pins with 40 mm diameter clips, length to suit thickness of insulation with 32 mm square nylon retaining clips;
- .10 Finishing Cement: to CAN/CGSB-51.12-95, Type 1 - mineral fibre hydraulic setting thermal insulating and finishing cement for use up to 480°C.

3. Execution

3.1 PRE-INSTALLATION REQUIREMENTS

- .1 Dimensions shown are clear inside free area measurement regardless of insulation placement. Fabricate ducts accordingly.
- .2 Apply insulation after required duct system tests have been completed and inspected by the Minister.

- .3 Ensure duct surfaces are clean and dry before installing insulation.
- .4 Install insulation over entire surface of duct, for full length of duct run including portions of duct passing penetrations through walls and floors.
- .5 Install insulation in a manner to insure hangers and standing duct seams do not penetrate insulation.
- .6 Locate finished seams in least visible location.
- .7 Do not insulate ductwork with external thermal insulation where acoustic duct insulation has been specified.
- .8 Install insulation at ambient temperatures within acceptable ratings for tapes, sealants and adhesives.

3.2 INSTALLATION

- .1 Install in accordance with TIAC National Standards section 6.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 3".
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm o.c in horizontal and vertical directions, minimum two rows each side.
- .7 Exposed Ducts
 - .1 Finish exposed ducts with canvas jacket suitable for paint finish; only in areas that duct will be painted.
 - .2 Finish ducts exposed to outdoors with aluminum jacket. Caulk all joints on jacket for weather-tight finish. Locate longitudinal joints in least weather exposed position.

3.3 BREECHING INSULATION APPLICATION

- .1 Face breeching with 10 mm rib lath turn out to provide 12 mm space between insulation and hot surface and 12 mm mesh expanded lath on the outside.

- .2 Butt insulation firmly together and secure with 1.5 mm galvanized wire.
- .3 Lace metal mesh together. Coat with 12 mm thick finishing cement. Finish with a final 12 mm coat of finishing cement with 25% by weight of Portland cement. Trowel to a smooth hard finish.

3.4 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thicknesses: Conform to following table:

	Code/ Service Temperature	Vapour Retarder	Thickness (mm)
Outside air ducts to mixing plenum	C-1/ Cold Duct	Yes	50
Boiler (B-1S)	Breeching	N/A	25

3.5 CLEANING

- .1 Clean in accordance with division 1 requirement.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 REFERENCES

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

- .1 ASHRAE Standard 90.1-10, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

.2 American Society for Testing and Materials International (ASTM)

- .1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
- .2 ASTM C335-05, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C533-04, Calcium Silicate Block and Pipe Thermal Insulation.
- .6 ASTM C547-06, Mineral Fiber Pipe Insulation.
- .7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

- .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts

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

- .1 Material Safety Data Sheets (MSDS).

.5 Manufacturer's Trade Associations

- .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards- 04.
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-97, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC Codes:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.5 QUALITY ASSURANCE

- .1 Qualifications:

- .2 Installer: specialist in performing work of this Section, and have at least 15 years successful experience in this size and type of project, qualified to standards of TIAC.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.

2. PRODUCTS

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102.
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 All Insulation products shall be **“Mold Resistant”** no alternative will be accepted, contractor shall supply written confirmation accompany with the shop drawings.
- .2 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .3 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .4 Type 1: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51.9.
 - .3 Maximum "k" factor: to 0.035 W/m.C and to CAN/ULC-S702.
 - .4 Services Temperature: up to 160°C
- .5 Type 6: Flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.

- .3 Maximum "k" factor: .035 W/m.C.
- .4 Service Temperature: -4°C to 100°C
- .5 To be certified by manufacturer to be free of potential stress corrosion cracking corrodants.

2.3 INSULATION SECUREMENT

- .1 All Adhesive shall meet the environmental choice guideline CCD-046 or the California south coast air quality management Rule No. 1168 .
 - .1 Tape: self-adhesive, aluminium, plain, 50 mm wide minimum.
 - .2 Contact adhesive: quick setting.
 - .3 Tie wire: 1.5 mm diameter stainless steel.
 - .4 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Air drying on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 JACKETS

- .1 Use of Canvas is not allowed.
- .2 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint by Architect.
 - .3 Minimum service temperatures: -40 degrees C;
 - .4 Maximum service temperature: 200 degrees C;
 - .5 Moisture vapour transmission: 0.02 perm
 - .6 Thickness: 0.5 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.

- .3 Aluminum:
 - .1 To ASTM B209
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: smooth.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps
 - .5 Fittings: 0.50 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.50 mm thick at 300 mm spacing.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at valves, expansion joints, flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: aluminum or high temperature fabric.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 Type A:
 - .1 Type 1 insulation without factory applied vapour retarder.
 - .2 Securements: SS wire at 300 mm on centre. Pipe insulation with integral jacket shall be held in place by stapling the flaps on 75mm centres. Pipe insulation with integral self-sealing jacket will not require additional fastening.
 - .3 Seals: not required.
 - .4 Fittings: miter pipe insulation to fit tightly, or insulating cement, or with tightly placed flexible insulation covered with reinforcing membrane stapled in place. Alternately insulate fitting with tightly placed flexible insulation and apply aluminium fitting covers.
 - .5 Valves, Strainers: where indicated on the particular product schedule, insulate valve bodes and strainers with insulating cement or fitted pipe insulation segments or mitred blocks al to thickness of adjacent pipe insulation or insulate with tightly placed flexible insulation covered with reinforcing membrane stapled in place. Drains, blow-off plugs and caps shall be left uncovered. Alternately insulate with tightly placed insulation and apply aluminium fitting covers.
 - .6 Flanges: where indicted insulate flanges with oversized pipe covering or mitred blocks to and applied in accordance with the manufacturers directions. Alternately insulate with tightly placed flexible insulation and apply aluminium fitting covers.

- .7 Insulation termination points: terminate insulation 75 mm from fittings to provide working clearance and bevel insulation at 45 degree angle.
- .8 Installation: TIAC Code: 1501-H.
- .3 Type B:
 - .1 Type 6 insulation.
 - .2 Insulation securements: glue all joints in accordance with manufacturers instructions.
 - .3 Seals: lap seal adhesive, lagging adhesive.
 - .4 Installation: TIAC Code: 1501-CA.
- .4 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 12'-0" long.

Application	Temp °C	Code	NPS Pipe sizes (Ø) and insulation thickness (mm)					
			Run out	Up to 1”	11/4”to 2”	21/2”to 4”	5” & 6”	8”& over
Domestic DHW/ DHWR with or without vapour retarder	60–94	A	25	40		50		
Heating Glycol (Supply / Return)	60–94	A	25	40		50		
Heating Steam, Saturated and Super heated From Boilers plant	up to 175	A	40	50	65	75	100	
Condensate Return to Boilers Plant	60 to 94	A	25	40				
Domestic DCW with or without vapour retarder	2 to 10	B	25					

- .5 Finishes:
 - .1 Exposed indoors: PVC jacket or aluminum unless otherwise specified.

- .2 Exposed in mechanical rooms: PVC jacket or aluminum unless otherwise specified
- .3 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
- .4 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 CLEANING

- .1 Proceed in accordance with division 1 requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-04-SI, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials (ASTM International)
 - .1 ASTM B209M-06, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C335-05, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-05, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-01, Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-06, Specification for Mineral Fiber Pipe Insulation.
 - .7 ASTM C553-02, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .8 ASTM C612-04, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .9 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .10 ASTM C921-03a, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CGSB 51-GP-53M-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Thermal Insulation Association of Canada (TIAC)
 - .1 National Insulation Standards-04.
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.

1.2 PRODUCT DATA

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

1.3 QUALIFICATIONS

- .1 Installer to be specialist in performing work of this section, and have at least 15 years successful experience in this size and type of project, qualified to standards of TIAC.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions recommended by manufacturer.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper, plastic, corrugated cardboard, packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.
- .3 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

2. PRODUCTS

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 All Insulation products shall be **"Mold Resistant"** no alternative will be accepted, contractor shall supply written confirmation accompany with the shop drawings.
- .2 Mineral fibre: includes glass fibre, rock wool, slag wool.
- .3 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .4 **Type A:** Rigid mineral fibre blanket to CAN/CGSB-51.11 and suitable for curved surfaces

- .1 Insulation: ASTM C533.
- .2 Maximum "k" factor: maximum 0.035 W/hr.ft².F and as per ASTM C533.
- .3 Hot Equipment Service Temperature: 20°C to 160°C.

2.3 CEMENT

- .1 Thermal insulating and finish
 - .1 To: ASTM C449/C449M.
 - .2 Air drying on mineral wool, to ASTM C449.

2.4 JACKETS

- .1 Use of Canvas is not allowed.
- .2 Aluminum:
 - .1 To ASTM B209
 - .2 Thickness: 0.02" Sheet.
 - .3 Finish: smooth.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps
 - .5 Fittings: 0.02" thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

- .1 Tape: Self-adhesive, aluminum, reinforced, 50 mm inch wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Tie wire: 1.5 mm diameter stainless steel.
- .4 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.
- .5 Facing: 25 mm galvanized steel hexagonal wire mesh on both faces of insulation.
- .6 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

3. EXECUTION

3.1 PRE- INSTALLATION REQUIREMENTS

- .1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

- .1 Install in accordance with TIAC National Standards

- .1 Hot equipment: To TIAC code 1503-H.
- .2 Provide vapour retarder as recommended by manufacturer
- .3 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- .4 Cover insulation with 25 mm galvanized hexagonal mesh and 12 mm coat of insulating cement. Finish with a final 12 mm coat of finishing cement and recover with canvas.
- .5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports outside vapour retarder jacket.
- .7 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.3 EQUIPMENT INSULATION SCHEDULES

- .1 Heat Exchangers:
 - .1 Type A: un-faced with wire or bands and 13 mm cement precede by one layer of reinforcing mesh.
 - .2 Thickness: 50 mm.
- .2 Finishes:
 - .1 Equipment in mechanical rooms: TIAC code CEF/1 with aluminum jacket.

3.4 CLEANING

- .1 Proceed in accordance with Section Division 1 Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Related Sections:

- .1 Section 23 05 93: Testing, Adjusting and Balancing (TAB).

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

- .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

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

.2 When systems are operational, perform following tests:

- .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 72 hours to demonstrate compliance with design criteria.
- .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pumps operation.
 - .2 Boilers Operations and failure,
 - .3 Pressure bypass open/closed.
 - .4 Control pressure failure.
 - .5 Maximum heating demand.
 - .6 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

- .1 TAB has been completed
- .2 Verification of operating, limit, safety controls.

- .3 Verification of primary and secondary pump flow rates.
- .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .1 Test procedures:
 - .1 Open fully heat exchanger, heating coil and radiation control valves.
 - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
 - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

1.6 GLYCOL SYSTEMS

- .1 Test to prove concentration will prevent freezing to minus 35°C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

1.7 POTABLE WATER SYSTEMS

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
 - .2 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.8 STEAM SYSTEMS

- .1 Performance verification:
 - .1 When systems are operational, perform relevant tests of steam and condensate return piping systems as specified under hydronic systems.
 - .2 Verify operation of components of steam system including:
 - .1 Steam traps by:
 - .1 Measuring temperature of condensate return and/or
 - .2 Using audio-sensing devices.
 - .3 Use of other approved methods.

- .2 Flash tanks.
 - .3 Thermostatic vents.
 - .3 Verify performance of condensation units, including:
 - .1 Pump capacity at design temperature.
 - .2 Controls.
 - .4 Verify performance of condensate return system to ensure return of maximum quantity of condensate return water at with minimum temperature drop.
 - .5 Adjust piping system as required to eliminate water hammer.
- .2 Monitor system continuously until acceptance for proper operation of components including steam traps, thermostatic vents, flash tanks and condensate pumping units.

1.9 REPORTS

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

2. PRODUCTS

2.1 Not Used.

3. EXECUTION

3.1 Not Used

END OF SECTION

1. GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-2000, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

2. PRODUCTS

2.1 CLEANING SOLUTIONS

- .1 Currently facility only use chemical product supplied "Nalco" contractor shall contact and use only similar product no other alternative will be accepted.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING HYDRONIC AND STEAM SYSTEMS

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

- .2 Cleaning Agency:
 - .1 Retain only approved CFIA facility water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete .
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
 - .1 As per current standard practice of the facility, coordinate with facility O&M team.
 - .2 Establish circulation, raise temperature slowly to maximum design Circulate for 12h ensuring flow in all circuits; drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

3.3 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

- .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
- .5 Clean out strainers repeatedly until system is clean.
- .6 Commission water treatment systems as specified in Section 23 25 00- HVAC Water Treatment Systems.
- .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
- .8 Repeat with water at design temperature.
- .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
- .10 Bring system up to design temperature and pressure slowly over a 48 hour period.
- .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for Mechanical System .
- .12 Adjust pipe supports, hangers, springs as necessary.
- .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .15 Check operation of drain valves.
- .16 Adjust valve stem packings as systems settle down.
- .17 Fully open balancing valves (except those that are factory-set).
- .18 Check operation of over-temperature protection devices on circulating pumps.
- .19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

- .1 Proceed in accordance with division 1 requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME-2004, Boiler and Pressure Vessel Code.
- .2 American Society for Testing and Materials, (ASTM).
 - .1 ASTM A47/A47M-2004, Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278M-2006, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (345 degrees C).
 - .3 ASTM A516/A516M-1999, Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536-2003, Specification for Ductile Iron Castings.
 - .5 ASTM B62-1993, Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International).
 - .1 CSA B51-2003, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Indicate on product data expansion tanks, air vents, air-separators, valves, strainers.
- .2 Closeout Submittals:
 - .1 Submit maintenance data in accordance with Section 01 78 23 & 39 - Closeout Submittals.

2. PRODUCTS

2.1 MATERIAL

2.2 DIAPHRAGM TYPE EXPANSION TANK

- .1 Vertical steel pressurized diaphragm type expansion tank.
- .2 Diaphragm sealed in EPDM suitable for 115°C operating temperature.
- .3 Working pressure: 860 KPa with ASME stamp and certification.
- .4 Air pre-charged to 84 KPa (initial fill pressure of system).
- .5 Base mount for vertical installation.
- .6 Supports: provide supports with hold down bolts and installation templates.

2.3 AUTOMATIC AIR VENT

- .1 Provide automatic float type with isolating valve, semi-steel body, copper float, stainless steel valve and valve seat, suitable for system operating temperature and pressure.
- .2 Float: solid material shall be suitable for maximum working pressure of 150 PSI and 300°F working temperature.
- .3 All air vents in concealed spaces: Provide vent tubing to nearest drain.

2.4 AIR SEPARATOR - EXPANSION TANK FITTING

- .1 Cast iron body and cover, stainless steel bolts and nuts, bronze pilot mechanism.
- .2 Complete with adjustable vent tube and built-in manual vent valve.
- .3 Working pressure: 860 KPa.

2.5 AIR SEPARATOR - IN-LINE

- .1 Provide centrifugal type with 860 KPa WSP/ 115°C OPT steel tank, galvanized steel 5 mm perforated strainer, perforated stainless steel air collector tube and drain connection.
- .2 Size: as indicated.

2.6 COMBINATION CHECK AND SHUT-OFF VALVE (TRIPLE-DUTY VALVE)

- .1 Provide angle or straight type with screwed or flanged cast iron body, and bronze disc, Stainless steel stem spring, EPDM seat & O-ring, Brass port fitting.
- .2 Size: as indicated.

2.7 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 NPS 2 1/2 to 10: cast steel body to ASTM A278M, Class 30, flanged connections.
- .3 Blow-down connection: NPS 1.
- .4 Screen: stainless steel with 1.3 mm perforations.
- .5 Working pressure: 860 KPa.

2.8 SUCTION DIFFUSER

- .1 Body: flanged connections, strainer: with built-in stainless steel disposable 3 mm perforations, fine Galvanized steel mesh, cast iron guide vane, low pressure drop screen.
- .2 Size: as indicated.

2.9 RELIEF VALVES

- .1 Provide ASME rated direct spring loaded type, lever operated non-adjustable factory set discharge pressure as indicated.

2.10 COMBINATION SEPARATORS/STRAINERS

- .1 Steel, tested and stamped in accordance with ANSI/ASME BPVC, for 125 PSI operating pressure, with galvanized steel integral strainer with 0.2" perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.11 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

- .1 Adjustable pressure setting: 206 KPa relief, 55 to 180 KPa reducing.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.

2.12 FLEXIBLE CONNECTORS

- .1 Flexible connectors shall consist of close pitch corrugated bronze hose with single layer of exterior braiding to provide additional strength and prevent elongation of corrugated section.
- .2 Connectors shall be minimum 8" long and provided with bronze fittings to facilitate connection to equipment.

3. EXECUTION

3.1 GENERAL

- .1 Install as indicated and to manufacturer's recommendations.
- .2 Run drain lines and blow off connections to terminate above nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .5 Check shop drawings for conformance of all tappings for ancillaries and for equipment operating weights.

3.2 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump if suction diffuser is not being used or shown.

3.3 AIR VENTS

- .1 Install at high points of systems.

- .2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain.
- .3 Use automatic float type at system high points not readily accessible for servicing.
- .4 Where large air quantities can accumulate, provide enlarged air collection standpipes.
- .5 For float type air vents provide vent tubing to nearest drain.

3.4 EXPANSION TANKS

- .1 Adjust expansion tank pressure to suit design criteria.

3.5 PRESSURE SAFETY RELIEF VALVES

- .1 Provide relief valves on pressure tanks, low pressure side of reducing valves, heating convertors, expansion tanks and where indicated.
- .2 Drain relief valve to nearest floor drain.
- .3 System relief valve capacity shall equal make-up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.
- .4 Where one line vents several relief valves, cross sectional area shall equal sum of individual vent areas.

3.6 SUCTION DIFFUSERS

- .1 Install on inlet to pumps having suction size greater than 50Ø mm.
- .2 Support fitting with floor mounted pipe and flange support to eliminate undue stress on pump suction connection

3.7 COMBINATION CHECK AND SHUT-OFF VALVE

- .1 Provide on discharge side of base in-line vertical pumps and where indicated.

3.8 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems, supplemented as specified herein.

END OF SECTION

1. GENERAL

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-1998, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-2003, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-2001, Factory-Made Wrought Butt welding Fittings.
 - .5 ASME B18.2.1-2003, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-1999, Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M-2004, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-2002, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-1999, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-2002, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-2002, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-2000, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111-2000, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242-2005, Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48-2006, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

1.2 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals.
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 23 & 39 - Closeout Submittals and include following:

- .1 Special servicing requirements.

2. PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, as follows:
 - .1 NPS 2 and under, continuous weld, **Sch. 40 or 80**, standard weight and as indicated.
 - .2 NPS 2 1/2 and over, Grade B, electric resistance weld, **Sch. 40 or 80**, standard weight and as indicated.

2.2 PIPE JOINTS

- .1 NPS2 and under: screwed fittings with teflon tape or pulverized lead paste.
- .2 NPS2-1/2 and over: welding fittings and flanges to CSA W47.1 and CSA W47.1S1.
- .3 Flanges: plain weld neck.
- .4 Flange gaskets: to ANSI/AWWA C111/A21.11.
- .5 Pipe thread: taper.
- .6 Bolts and nuts: to ANSI/ASME B18.2.1 and ANSI/ASME B8.2.2.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ANSI/ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ANSI/ASME B16.1, Class 150.
 - .2 Steel: to ANSI/ASME B16.5.
- .3 Butt-welding fittings: steel, to ANSI/ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M and ANSI/ASME B16.3.
- .5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M or ductile iron to ASTM A536.

2.4 VALVES

- .1 See related sections: 23 05 22, 23 05 23 and 23 05 26.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work.

3.3 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.4 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

3.5 TESTING

- .1 Test system in accordance with Section 23 05 05 – Installation of Pipework.

3.6 BALANCING

- .1 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for Mechanical System for applicable procedures.

3.7 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping.

3.8 CLEANING

- .1 Proceed in accordance with division 1 requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 SECTION INCLUDES

- .1 Materials, equipment selection, installation and start up for hydronic system pumps.

1.2 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE).
 - .1 Standard 90.1-2010 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC).
- .3 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-B214-2001, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers Association (NEMA).
 - .1 NEMA MG 1-2003, Motors and Generators.

1.3 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
- .3 Submit product data of pump curves for review showing point of operation.
- .4 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.
- .5 Provide maintenance data for incorporation into manual specified in Section 01 78 23 & 39 - Closeout Submittals.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 23 & 39 - Closeout Submittals.

2. PRODUCTS

2.1 IN-LINE CIRCULATORS

- .1 All Bronze fitted/body pump, with screwed or flanged design suction and discharge connections.
- .2 Impeller: bronze-cast.
- .3 Shaft: alloy steel-copper with oil lubricated bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: Mechanical seal, inside unbalanced type, long life carbon rotating face, ceramic stationary seat and for service to 240 deg F.
- .5 Coupling: flexible, spacer type.
- .6 Motor: resilient mounted, sleeve bearing, 1,800 r/min or 3,600 r/min, kW (HP) as indicated.
- .7 Design pressure: 150 PSI maximum working pressure.
- .8 Capacity: as indicated on the schedule.

2.2 VERTICAL IN-LINE CIRCULATORS

- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.
- .2 Impeller: bronze, fully enclosed type impeller shall be dynamically balanced.
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: shall be single spring inside type with carbon against o-ring mounted Ni resist faces. EPDM elastomer with stainless steel spring and hardware shall be provided.
- .5 Seal vent line shall be factory installed and shall be piped from seal area to the pump suction.
- .6 Bearings: oil lubricated ball or roller and thrust bearings with oil reservoir, oil seals with integral dirt and water seals at each end of reservoir; rated for minimum life of 10,000 hours.
- .7 Coupling: rigid self-aligning.
- .8 Motor: resilient mounted, sleeve bearing, 1,800 r/min, kW (HP) as indicated.
- .9 Design pressure: 1000 kPa maximum working pressure.
- .10 Capacity: as indicated on the schedule.

3. EXECUTION

3.1 INSTALLATION

- .1 Provide drains for bases and stuffing boxes, piped to and discharging into floor drains.
- .2 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible.
- .3 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
- .4 Support "in-line" circulators directly from inlet and discharge pipe. Do not use flexible connections.
- .5 Install volute venting pet cock in accessible location.
- .6 Check rotation prior to start-up.
- .7 Install pressure gauge test cocks.

3.2 START-UP

- .1 General
 - .1 In accordance with manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
 - .4 Check base for free-floating, no obstructions under base.
 - .5 Run-in pumps for 12 continuous hours.
 - .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.

3.3 PERFORMANCE VERIFICATION (PV)

- .1 Exclusions:
 - .1 This paragraph does not apply to small in-line circulators.
- .2 Assumptions: these PV procedures assume that:
 - .1 Manufacturer's performance curves are accurate.
 - .2 Valves on pump suction and discharge provide tight shut-off.
- .3 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 and await instructions.
- .4 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.

3.4 OPERATION REQUIREMENTS

- .1 Operational requirements in accordance with Division 1.

END OF SECTION

1. GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation of steel piping valves, fittings for steam and condensate building services piping.

1.2 REFERENCES

- .1 American Society for Mechanical Engineers (ASME International).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A126-Latest Edition, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM A167-Latest Edition, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - .3 ASTM A216/A216M-Latest Edition, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.
 - .4 ASTM A240/A240M-Latest Edition, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .5 ASTM A276-Latest Edition, Standard Specification for Stainless Steel Bars and Shapes.
 - .6 ASTM A278/A278M-Latest edition, Standard Specification for Gray Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 degrees C).
 - .7 ASTM A351/A351M-latest Edition, Standard Specification for Steel Castings, Austenitic, Austenitic- Ferritic (Duplex) for Pressure-Containing Parts.
 - .8 ASTM A564/A564M-Latest Edition, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data and include manufacturer's literature indicating Canadian Registration Number (CRN): Steam traps, Vacuum breakers, Pressure reducing valves, Air Vents and Safety relief valves.
- .3 Provide maintenance data for incorporation into manual specified in Section 01 78 23 & 39- Closeout Submittals:

1.4 Quality Assurance

- .1 Low pressure steam is steam at 10 PSI or less.
- .2 Comply with Federal and Provincial Regulations and have CSA approval.

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with division 1 requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

2. PRODUCTS

2.1 MATERIALS

- .1 Cast steel: to ASTM A216/A216M.
- .2 Cast iron: to ASTM A278, Class 300.
- .3 Bronze: to ASTM B62.
- .4 Stainless steel: to ASTM A351/A351M.

2.2 FLOAT AND THERMOSTATIC STEAM TRAPS 0-110 KPA

- .1 Provide fully modulating type suitable for continuous operation with semi-steel body and cover.
- .2 Materials: body - - stainless steel ; valve - stainless steel with stainless steel seat; float and mechanisms - stainless steel; air vent - stainless steel thermostatic type.

2.3 INVERTED BUCKET STEAM TRAP 0-125 PSI

- .1 Application: for non-modulating steam services on end of line drips, humidifiers and as indicated.
- .2 Materials: body - cast-steel; valve - stainless steel; bucket-stainless steel, with bimetal air vent.
- .3 Capacity: as indicated.
- .4 Provide inverted bucket type suitable for intermittent operation with semi-steel body and cover.

- .5 Construct bucket, seat, head, operating mechanism and strainer of stainless steel.

2.4 VACUUM BREAKERS

- .1 All brass constructed vacuum breaker with stainless steel spring, 19 mm connection 1035 KPa operating pressure and adjustable operating set point from 0.850 KPa to 70 KPa vacuum.
- .2 Application: on inlets to steam coils, heat exchangers and as indicated.
- .3 Materials: body and cap - stainless steel, spring - stainless steel; stem and seat - stainless steel.

2.5 STEAM AIR VENTS

- .1 Provide automatic steam air vents of the thermostatic balanced pressure type, with brass or semi-steel body, renewable stainless steel head and seat.
- .2 Fabricate thermostatic liquid filled bellows or phosphor bronze.

2.6 PRESSURE REDUCING VALVE -EXTERNAL PILOT OPERATED

- .1 Location: as indicated.
- .2 Self operating, external pilot, single seat, diaphragm operated, dead end shutoff, enclosed spring chamber main and pilot valve.
- .3 Connections:
 - .1 Under NPS 2: screwed ends.
 - .2 NPS 2-1/2 and over: flanged ends.
- .4 Main valve:
 - .1 Body: cast iron to ASTM A126, Class B .
 - .2 Diaphragm: stainless steel to ASTM A240/A240M.
 - .3 Seat rings: stainless steel to ASTM A276.
 - .4 Disc: stainless steel to ASTM A276.
 - .5 Stem: stainless steel to ASTM A276.
 - .6 Spring: carbon steel.
 - .7 Bolting: carbon steel.
- .5 Pilot valve:
 - .1 Body: cast iron to ASTM A126, Class B.
 - .2 Diaphragm: stainless steel to ASTM A240/A240M.

2.7 SAFETY AND RELIEF VALVES

- .1 Spring loaded type of bronze with high capacity and full nozzle and to ASME code.
- .2 Material: body -cast iron; valve - housing malleable iron; spring - steel, cadmium plated; bronze/brass trim.

2.8 DRIP PAN ELBOWS

- .1 Application: on discharge of steam safety relief valves as indicated.
- .2 Cast iron or steel with screwed or flanged inlet and threaded drain connections.

2.9 PIPE LINE STRAINERS UP TO NPS 2

- .1 Application: ahead of steam traps, control valves and elsewhere as indicated.
- .2 Working pressure: 150 PSI.
- .3 Body: cast iron.
- .4 Connections: screwed.
- .5 Screen: stainless steel with 0.03" inch perforations.

2.10 PIPE LINE STRAINERS NPS 2-1/2 AND OVER

- .1 Application: ahead of steam traps and control valves and elsewhere as indicated.
- .2 Working pressure: 1035 KPa.
- .3 Body: cast iron.
- .4 Connections: flanged.
- .5 Blowdown connection: NPS 1-1/4 complete with gate valve and cap.
- .6 Screen: stainless steel with 3.5 mm perforations.

3. EXECUTION

3.1 GENERAL

- .1 Install in accordance with manufacturers' recommendations.
- .2 Maintain proper clearance around equipment to permit maintenance.

3.2 STRAINERS

- .1 Install as indicated.
- .2 Ensure clearance for removal of basket.
- .3 Install valved blow-down as indicated.

3.3 SAFETY RELIEF VALVE

- .1 Pipe to atmosphere independent of other vents and in accordance with applicable code.
- .2 Support discharge pipe against reaction forces and to take up thermal movement.
- .3 Drain pipe from drip pan elbow to terminate over floor drain.

3.4 STEAM TRAPS

- .1 Install unions on inlet and outlet.
- .2 Provide gate valve and strainer at inlet, gate valve and check valve at discharge.
- .3 Provide minimum 250 mm long dirt pocket of same pipe size as apparatus return connection.
- .4 Do not use thermostatic elements in traps until system has been operated and dirt pockets cleared of sediment and scale. Provide temporary covers for use prior to this time.

3.5 VACUUM BREAKER

- .1 Install on condensate leg of all steam fired equipment.

3.6 STRAINERS

- .1 Provide all strainers with drain valves.

3.7 PRESSURE REDUCING VALVES

- .1 Install on 3-valve bypass with strainer on inlet.
- .2 Pipe as indicated. Follow manufacturer's installation instructions.
- .3 Pressure reduction shall be one or two stages as required to produce flat reduced pressure curve for all ranges of capacity.
- .4 Pilot operator control line shall connect downstream far enough to ensure true pressure.

- .5 Rate relief valves for the station upstream steam pressure. Size for full installed capacity of reducing station. Set valve to relieve at not more than 20% above reduced pressure.

3.8 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

END OF SECTION STEAM SPECIALTIES

1. General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories
 - .2 Sustainable requirements for construction and verification

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A480/A480M-2003, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
 - .2 ASTM A635/A635M-2002, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M-2003, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS)
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-2010, Standard for the Installation of Air-Conditioning and Ventilating Systems
 - .2 NFPA 90B-2010, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems
 - .3 NFPA 96-2010, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition

1.3 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

- .1 Sealants
- .2 Tape
- .3 Proprietary Joints

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

2. Products

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure	Outdoor Intake
Concealed Ducts in the other areas ceiling space	A

- .2 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made air-tight with use of both sealant and tape.

2.2 SEALANT

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 50°C to plus 60°C.

2.3 TAPE

- .1 Tape: polyvinyl treated, open weave fiber-glass tape, 75 mm wide.

2.4 DUCT LEAKAGE

- .1 For class "A" seal classification, the air leakage shall be 0%, no alternative will be accepted.

2.5 DUCTWORK

- .1 Material:
 - .1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M.
 - .2 Thickness: to SMACNA.
- .2 Construction – Oval or Round
 - .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.
 - .2 Transverse joints up to 900 mm: slip type with tape and sealants.
 - .3 Transverse joints over 900 mm: Vanstone.
- .3 Construction - rectangular:
 - .1 Ducts: to SMACNA.
 - .2 Transverse joints: SMACNA seal Class A.

2.6 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows. (Low Pressure up to 500 Pa):
 - .1 Rectangular: Standard or Centreline radius: 1.5 times width of duct.
 - .2 Round or Oval: smooth radius Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular (Low Pressure up to 500 Pa):
 - .1 To 600 mm: with single thickness turning vanes.
- .4 Branches (Low Pressure up to 500 Pa):
 - .1 Rectangular main and branch: with radius on branch 45 degrees entry on branch.
 - .2 Round /Oval main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions (Low Pressure up to 500 Pa):
 - .1 Diverging: 20° maximum included angle.
 - .2 Converging: 30° maximum included angle.
- .6 Obstruction deflectors: maintain full cross sectional area.
 - .1 Maximum included angles: as for transitions.

2.7 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation
- .2 Firestopping material and installation must not distort duct

2.8 HANGERS AND SUPPORTS

- .1 Hangers and Supports: [in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 500 mm.
 - .2 Hanger configuration: to ASHRAE and SMACNA.
 - .3 Hangers: galvanized steel angle with black steel rods to as following table:

Duct Size	Angle Size	Rod Size
(mm)	(mm)	(mm)
up to 750	25 x 25 x 3	6.35
750 to 1050	40 x 40 x 3	

- .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps.

3. Execution

3.1 GENERAL

- .1 Fabricate ductwork from field measurements and not from plans and shop drawings exclusively. Failure to do so will not constitute an extra to the Contract.
- .2 Complete metal ducts within themselves with no single partition between ducts, where width of duct exceeds 18". Cross-brace for rigidity, Open corners are not acceptable.
- .3 Do work in accordance with: NFPA 90A, NFPA 90B, NFPA-96 and SMACNA and as indicated.
- .4 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate strap hangers 100 mm beyond insulated duct and ensure diffuser is fully seated.
- .5 Support risers in accordance with SMACNA.

- .6 Increase duct sizes gradually, not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream
- .7 Locate ducts with sufficient space around equipment to allow normal operation and maintenance activities.
- .8 Shield ductwork from dust and construction material during construction. Clean any ductwork found to be dirty at no extra cost to the Contract.
- .9 Protect steel ductwork exposed to weather by painting or coating with suitable weather resistant material (inside and out).
- .10 Do not use flexible duct to change direction.
- .11 Prove that ductwork is substantially air tight before covering or concealing.
- .12 Clean duct systems and force air at high velocity through duct to remove accumulated dust. Protect equipment which may be harmed by excessive dirt with filters or bypass during cleaning.

3.2 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Fit base of riser with 150 mm deep drain sump and 32Ø drain connected, with deep seal trap and valve and discharging to open funnel drain.
- .4 Slope horizontal branch ductwork down towards fume hoods served.
 - .1 Slope header ducts down toward risers.

3.4 SEALING AND TAPING

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.5 LEAKAGE TESTS

- .1 In accordance with owner requirements and SMACNA HVAC Duct Leakage Test Manual, perform leakage tests in sections.
- .2 Make trial leakage tests as instructed to demonstrate workmanship.
- .3 Do not install additional ductwork until trial test has been passed.

END OF SECTION METAL DUCTS

1. GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials, accessories and installation for breechings, chimneys and stacks.

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .2 Underwriters' Laboratories of Canada (ULC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate following:
 - .1 Methods of sealing sections.
 - .2 Methods of expansion.
 - .3 Details of thimbles.
 - .4 Bases/Foundations.
 - .5 Supports.
 - .6 Guy details.
 - .7 Rain caps.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .3 Closeout Submittals
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEAA and applicable Provincial regulations.

.2 Certificates:

- .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's written instructions requirements.

2. PRODUCTS

2.1 BREECHINGS

- .1 Shop fabricated 3.5 mm thick mild steel welded, with sweep bends from boiler outlet to thimble or chimney as indicated.

2.2 TYPE B GAS VENT (Only Boiler B1S)

- .1 ULC labelled, 300° C rating maximum, atmospheric gas vent only.
- .2 Sectional, prefabricated, double wall with 12 mm air space. Aluminum inner wall. Galvanized steel outer wall. Mated fittings and couplings.

2.3 ACCESSORIES

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA).
- .3 Expansion sleeves with heat resistant caulking, held in place as indicated.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION - GENERAL

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.

- .2 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .3 Install cleanouts prior to connecting to the existing system.

3.3 CLEANING

- .1 Proceed in accordance with division 1 requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 REFERENCES

- .1 American Boiler Manufacturer's Association (ABMA)
- .2 American National Standards Institute (ANSI)
 - .1 ANSI Z21.13-2004/CSA 4.9-2004, Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .3 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2004.
- .4 Canadian Gas Association (CGA)
 - .1 CAN1-3.1-77(R2001), Industrial and Commercial Gas-Fired Package Boilers.
 - .2 CAN/CSA-B149.1-2005, Natural Gas and Propane Installation Code.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA B51-2003, Boiler, Pressure Vessel, and Pressure Piping Code.
- .6 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 SUBMITTALS

- .1 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00.
 - .2 Indicate the following:
 - .1 General arrangement showing terminal points, instrumentation test connections.
 - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
 - .3 Foundations with loadings, anchor bolt arrangements.
 - .4 Piping hook-ups.
 - .5 Equipment electrical drawings.
 - .6 Burners and controls.
 - .7 All miscellaneous equipment.
 - .8 Flame safety control system.
 - .9 Breeching and stack configuration.

- .10 Stack emission continuous monitoring system to measure CO, O₂, NO_x, SO₂, stack temperature and smoke density of flue gases.
- .3 Engineering data to include:
 - .1 Boiler efficiency at 25%, 50%, 75%, 100%, of design capacity.
 - .2 Radiant heat loss at 100% design capacity.
- .2 Quality assurance submittals: submit following in accordance with Section 01 00 01 – General Requirements.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals:
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 23 & 39- Closeout Requirements.

1.3 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA and applicable local regulations.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Division 01 Requirements.
- .2 Waste Management and Disposal:
 - .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.5 MAINTENANCE

- .1 Extra materials:
 - .1 Special tools for burners, manholes, handholes and Operation and Maintenance.
 - .2 Spare parts for 1 year of operation.
 - .3 Spare gaskets.
 - .4 Spare gauge glass inserts.
 - .5 Probes and sealants for electronic indication.
 - .6 Spare burner tips.
 - .7 Spare burner gun.
 - .8 Safety valve test gauge.

2. PRODUCTS

2.1 GENERAL

- .1 Packaged boiler:
 - .1 Complete with burner and necessary accessories and controls.
 - .2 Ready for attachment to piping, electrical power, controls, flue gases exhaust.
 - .3 Designed and constructed to ANSI/ASME Boiler and Pressure vessel Code.
 - .4 CRN (Canadian Registration Number), to CSA B51.
 - .5 Boiler/burner package to bear ULC and CGA labels.
- .2 Electrical:
 - .1 Electrical components: CSA approved.
- .3 Mounting:
 - .1 Structural steel base, lifting lugs.
- .4 Start-up, instruction, on-site performance tests: 2 full days .

2.2 TUBE STEAM BOILER & BURNER (B1S)

- .1 The boiler shall be constructed and assembled as a completely packaged unit ready for field connections to the steam supply, return connection, electrical power supply, fuel supply(s), relief valve discharge, building management controls and flue-gas vent.
- .2 The boiler shall be manufactured in strict accordance with the ASME Low Pressure Boiler Heating Code, Section IV, and shall bear the ASME "H" stamp for a low-pressure steam system.
- .3 The boiler shall be constructed on a heavy steel frame. The boiler pressure vessel shall be provided with adequately sized upper drum, water legs and tube header.
- .4 Packaged, water tube design, with multi-pass flue gas passes separated with water wall tubes and a drum.
- .5 Boiler tubes: 25 Ø mm (out-side), easily removed and replaced at attachment to drums without requiring welding or expanding.
- .6 Equip with minimum of two down/comers to ensure internal natural circulation and temperature equalization steam water separators in upper drum.
- .7 Water side interior of upper and lower drums accessible via front and rear openings.
- .8 Fire side interior accessible for service and inspection.

- .9 The boiler shall have no less than 0.465 square meter of heating surface per boiler horsepower.
- .10 The boiler shall be complete with a metal jacket, 16 gauge, zinc-coated rust resistant steel casing, finished with a suitable heat resisting paint and shall be constructed on a structural steel frame suitable to withstand 1040°C.
- .11 Insulate boiler with 40Ø mm thick fibreglass and jacketed with baked enamel coated plates, easily removable and replaceable.
- .12 Warranty: The boiler vessel shall be warranted for 25 years against thermal shock on a non-pro-rated basis, no alternative will be accepted.
- .13 Boiler manufacture shall provide and furnish the boiler with:
 - .1 Steam pressure gauge
 - .2 Steam pressure control operator
 - .3 High limit safety control
 - .4 Water gauge glass
 - .5 Low water cut-off and feeder controller interlock with feed system
 - .6 Auxiliary low water cut-off – probe type M/R
 - .7 Gauge cocks
 - .8 ASME safety relief valve(s)
 - .9 Internal control system compatible working with existing Johnson building management system.
- .14 Boiler shall be furnished with a ULC listed forced draft flame retention natural gas burner. Burner shall be complete with integral motor and blower for supplying sufficient combustion air with normal vent conditions; the following trim and controls shall be furnished:
 - .1 Two stage burner (Natural Gas) with proven LFS controls
 - .2 Main manual gas shutoff valve
 - .3 Combination pressure regulating automatic gas valve operator and aux. safety shutoff gas valve
 - .4 Gas pilot shutoff and solenoid valves
 - .5 Gas pilot ignition assembly with ignition transformer
 - .6 Pilot and main gas pressure regulators
 - .7 Air safety switch and combustion safety control.
- .15 The boilers shall be controlled by Div 25 boilers shall utilize a 24 VAC control circuit and components to meet existing “BACnet or LON” controller; boiler manufacture shall review the option with contractor prior to shipping the boilers.
- .16 Capacity: as indicated on the schedule.

2.3 MODULAR HEATING BOILER, NATURAL GAS CONDENSING TYPE (B-2W & 4W)

- .1 Furnish and install as shown on AERCO International plans and operation and maintenance manuals, with all applicable codes and authorities having local, state and federal jurisdiction, Benchmark Series with all standard features.
 - .1 Alternative boilers type or manufacture maybe accepted if alternative propose boilers meet the performance data and be able to maintain same clearances as shown on current floor plan layout.
- .2 Boiler Flue Venting (Shall be Supplied by Boiler Manufacture with all required installation kit no alternative will be accepted). Venting shall be BH type accomplished with a stainless steel, double-wall, vent piping installed in accordance with applicable national and local codes.
- .3 Boiler Controller:
 - .1 The boilers shall be monitor by Div 25 (Existing Building BMS System), AERCO boiler shall supply "Boiler Management Controller" boiler manufacture shall review the option with existing BMS system for type of g "BACnet or LON" controller prior to shipping the boilers.
- .4 Boilers shall be complete with:
 - .1 Low water cut-off valve, to automatically prevent burner operation when boiler water falls below safe level;
 - .2 Factory supplied CSA approved neutralization tank (one per boiler).
- .5 Warranty:
 - .1 The pressure vessel, tubes and tube sheets (heat exchanger) shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 10 years. The condensate collection box shall be guaranteed for 20 years. The burner cylinder shall be warranted for a period of 5 years.
 - .2 All parts not covered by the above warranties shall carry a 5 year warranty from start-up, or 3 years from shipment, whichever occurs first. This shall include all electrical components and burner components.
- .6 Capacity & Model: as indicated on the schedule.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 Mount unit level using specified vibration isolation in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .5 Pipe boilers (B-2W to 4W) relief valves full size to nearest floor drain.
- .6 Pipe steam relief valve (B-1S) through with drip pan elbow piped to Blow down tank.
- .7 Pipe blow down/drain to blow down tank/floor drain.
- .8 Natural gas fired installations - in accordance with CAN/CSA-B149.1.

3.3 MOUNTINGS AND ACCESSORIES

- .1 Safety valves and relief valves:
 - .1 Run separate discharge from each valve.
 - .2 Terminate discharge pipe as indicated.
 - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.
- .2 Blowdown valves:
 - .1 Run discharge to terminate as indicated.

3.4 FIELD QUALITY CONTROL

- .1 Manufacturer to:
 - .1 Certify installation.
 - .2 Start up and commission installation.
 - .3 Carry out on-site performance verification tests.
 - .4 Demonstrate operation and maintenance.
- .2 Provide CFIA at least Fourteen (14) days notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.5 CLEANING

- .1 Proceed in accordance with division 1 requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION BOILERS

1. GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for piping and fittings used in HVAC heat exchangers.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code.
 - .1 BPVC-VIII B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 1.
 - .2 BPVC-VIII-2 B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 2 - Alternative Rules.
 - .3 BPVC-VIII-3 B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 3 - Alternative Rules High Press Vessels.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for heat exchangers.
 - .2 for adhesive and solvents during application and curing.
- .2 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout including layout, dimensions of heat exchangers and system. Indicate following information:
 - .1 Manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools.
 - .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Instructions: submit manufacturer's installation instructions.
- .5 Manufacturer's Field Reports: manufacturer's field reports specified.
- .6 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in division 1 requirements.

1.4 MAINTENANCE

- .1 Supply following spare parts:
 - .1 Head gaskets.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

2. PRODUCTS

2.1 PLATE HEAT EXCHANGER

- .1 General:
 - .1 50% propylene glycol to 50% propylene glycol.
 - .2 Designed, constructed and tested in with accordance ASME Boiler and pressure Vessel Code, Section VIII, CSA B51 and provincial pressure vessel regulations.
- .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
- .3 Plates: type 304 stainless steel, minimum thickness 10mm.
- .4 Tie Rods: Zn coated steel.
- .5 Shroud: Aluminum.
- .6 Gaskets: as recommended by manufacturer to suit fluid temperature.
- .7 Nozzles: as indicated on drawings
- .8 Supports: as indicated on drawings
- .9 Piping connections: as indicated on drawings

- .10 Design to operate at 690 kPa and rated for 900 kPa with and maximum operating temperature of 100°C.
- .11 Capacity: as indicated on the equipment schedule.

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 General: install level and firmly anchored to supports in accordance with manufacturer's recommendations.
- .2 Plate heat exchangers: arrange piping so that exchanger can be removed after disconnecting two unions or flanges adjacent to head and without disturbing other equipment and systems.

3.3 APPURTENANCES

- .1 Install with safety relief valve piped to drain, vacuum breaker, steam trap.
- .2 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.
- .3 Install pressure gauge on steam inlet.

3.4 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its product[s], and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - .2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
- .2 Upon completion of work, after cleaning is carried out.
- .3 Obtain reports within 3 days of review and submit immediately to Engineer.
- .4 Start-up:

- .1 General: perform start-up operations in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
- .2 Check heater for cleanliness on primary and secondary sides.
- .3 Check water treatment system is complete, operational and correct treatment is being applied.
- .4 Check installation, settings, operation of relief valves and safety valves.
- .5 Check installation, location, settings and operation of operating, limit and safety controls.
- .6 Check supports, seismic restraint systems.
- .5 Performance Verification:
 - .1 General: perform performance verification in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.
 - .2 Timing: only after TAB of hydronic systems have been successfully completed.
 - .3 Primary side:
 - .1 Measure flow rate, pressure drop, and either steam pressure and temperature at heater inlet and water temperature at heater inlet and outlet.
 - .2 Verify operation of steam traps. Measure temperature of condensate return at trap outlet.
 - .4 Control valve: verify proper operation without binding, slack in components. Measure either steam pressure and temperature at control valve inlet.
 - .5 Simulate heating water temperature schedule and repeat above procedures.
 - .6 Verify settings, operation, safe discharge from safety valves and relief valves.
 - .7 Verify settings, operation of operating, limit and safety controls and alarms.
 - .8 Reports:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

3.5 CLEANING

- .1 Perform cleaning operations as specified in division 1 requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 PRODUCT DATA

- .1 Product Data: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data to include:
 - .1 Replacement data for motor element, thermostat and switch.
 - .2 Mounting methods.
 - .3 kW rating, voltage, phase.
 - .4 Cabinet material thicknesses.
 - .5 Physical size.
 - .6 Finish.
 - .7 Thermostat, transformer, controls where integral.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

2. Products

2.1 UNIT HEATERS VERTICAL

- .1 Casing: 1.2 mm thick cold rolled steel with electrostatically applied epoxy powder coat prime finish with 4 integral 10 mm threaded connections for hanger rods.
- .2 Coils: seamless 16 mm copper tubing, silver brazed to steel headers and with evenly spaced aluminum fins mechanically bonded to tubing. Headers include steel MPT pipe connections located on top and below unit. Hydrostatically test to 1 MPa.
- .3 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish.
- .4 Motor: speed as indicated, continuous duty, ball bearing motor with built-in overload protection, and resilient motor supports.
- .5 Air outlet: Louvre cone diffuser with finish to match casing.
- .6 Capacity: as indicated on the schedule.

2.2 UNIT HEATERS HORIZONTAL

- .1 Casing: 1.2 mm thick cold rolled steel with electrostatically applied epoxy powder coat prime finish with 4 integral 10 mm threaded connections for hanger rods.

- .2 Coils: seamless 16 mm copper tubing, silver brazed to steel headers and with evenly spaced aluminum fins mechanically bonded to tubing. Headers include steel MPT pipe connections located on top and below unit. Hydrostatically test to 1 MPa.
- .3 Fan: direct drive aluminum blade type, factory balanced, with anti-corrosive finish and fan guard.
- .4 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor supports.
- .5 Air outlet: four-way adjustable louvres.
- .6 Capacity: as indicated on the schedule.

3. EXECUTION

3.1 INSTALLATION

- .1 Install heaters in accordance with manufacturer's instructions.
- .2 Make power and control connections.
- .3 Check final location with Engineer if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .4 Hot water units: for each unit, install gate valve on inlet and calibrated balancing valve on outlet of each unit. Install drain valve at low point. Install manual air vent at high point.
- .5 Provide supplementary suspension steel as required.
- .6 Before acceptance, set discharge patterns and fan speeds to suit requirements.

END OF SECTION

1. GENERAL

1.1 INTENT

- .1 This Section specifies mechanical requirements relating to the commissioning of components, systems and integrated systems and applies to all sections in Division 21, 22 and 23.
- .2 Related Sections:
 - .1 Section 01 91 00's – Commissioning - General
- .3 Commissioning of building components and systems is of the utmost importance to ensure the successful operation of this building. The building will not be considered complete until all systems have been demonstrated to work precisely in accordance with the Contract requirements.
- .4 Responsibility for the satisfactory completion of the building and demonstration that the requirements of the commissioning are satisfied rests with the Contractor, who will employ and pay for any specialist supervision, inspection and testing as required to complete the work described.
- .5 The commissioning process consists of:
 - .1 Component verifications per this Section.
 - .2 System Performance Verification Testing and Demonstration per this Section
 - .3 Integrated System Performance Verification Testing and Demonstration per Section 01 91 00's.
- .6 Read this Section in conjunction with related Sections, which specify specific portions of mechanical starting and testing work. Refer also to Division 1.
- .7 Except where otherwise specified, arrange and pay for the testing and related requirements specified in this and related Sections.
- .8 If test results do not conform with applicable requirements, repair, replace or adjust or balance components and systems Repeat testing as necessary until results acceptable to the Engineer are achieved.

1.2 VERIFICATION AND REPORTING

- .1 General:
 - .1 Component and system Performance Verification Testing shall be conducted per this Section
 - .2 Integrated system Performance Verification Testing shall be conducted as outlined in Section 01 91 00's.

- .3 Submit completed verification and test reports immediately after inspections and/or tests are performed.
- .4 Record all data gathered on site on approved verification forms with completed shop drawing data.
- .5 Provide the Engineer with original of each completed verification form.
- .6 Maintain one photocopy on site of all data taken during commissioning.
- .7 Maintain one copy of all final starting, testing, balancing and adjusting reports on site up to interim acceptance of the work for reference purposes.
- .8 All final verification forms are to be typewritten.
- .9 Submit to engineer for approval.
- .10 Make corrections and re-submit as requested by Consultant.

1.3 SCHEDULE

- .1 Prior to starting and testing of components, and systems prepare a schedule for the required testing.
- .2 Provide sufficient notice minimum 14 calendar days prior to commencing tests.
- .3 Consultant may witness all or any portion of the component testing.
- .4 The Consultant will witness all System and Integrated System tests performed by the Contractor.
- .5 Contractor to be present for and participate in all tests.
- .6 Unless otherwise specified in writing by the Consultant all testing and related requirements specified herein will be performed prior to the issue of the Interim Certificate of Completion.

1.4 COORDINATION

- .1 Coordinate all sub-trades, manufacturers, suppliers and other specialists as required to ensure all phases of work shall be properly organized prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.
- .2 Where any components or systems require testing prior to starting, ensure that such work has been completed and approved prior to starting of these components and systems. In particular, the Building Management system requirements specified on drawings and the balancing requirements in Section 23 05 93 shall be coordinated by the Contractor to complete the commissioning requirements

1.5 COMMISSIONING MEETINGS

- .1 Provide the appropriate representation at the scheduled commissioning meetings as outline in Section 01 91 00's.

1.6 PRESIDING AUTHORITIES

- .1 Starting procedures defined in this section may duplicate verification conducted by presiding authorities. To facilitate expedient turnover of the building, arrange for authorities to witness procedures in a manner that avoids unnecessary duplication of tests.
- .2 Obtain certificates of approval, acceptance and comply with rules and regulations of a authorities having jurisdiction. Provide originals of all certificates to engineer.

1.7 CORRECTION OF DEFICIENCIES

- .1 Identify, record, resolve and correct all contract deficiencies found during commissioning.

1.8 COMPLIANCE WITH DEFINED PROCEDURES

- .1 Failure to follow the specific instructions defined herein pertaining to correct starting procedures may result in re-evaluation of components by independent testing agency selected by engineer at contractors expense. Should results reveal components have not been started in accordance with specified requirements, components may be rejected. If required, remove components from site and replace. Replacement components shall also be subject to full starting procedures. Using the same procedures specified on the originally installed components.

2. PRODUCTS

2.1 CONTRACTOR INSTRUMENTS TESTING

- .1 Provide two-way radios, ladders and other equipment as required to complete the program and as outlined in this Specification.
- .2 Provide all safety equipment required for personnel involved in the starting, testing, adjusting and balancing program.
- .3 Provide a list of equipment and instruments which will be used in starting, testing, adjusting and balancing of mechanical equipment for approval and review by the Engineer.
- .4 Use instruments supplied or calibrated by approved laboratory or manufacturer. Show the Engineer the current calibration certificate for each instrument to be used. Provide a copy of the calibration certificates with test reports

3. EXECUTION

3.1 GENERAL

- .1 Contractor and manufacturer startup and proving to be carried out in accordance with the respective Section.

3.2 COMPONENT VERIFICATIONS

- .1 The component verification forms will be completed by the Contractor as follows:
 - .1 The 'Specified' requirements shall be completed by the Contractor at the shop drawing submission stage.
 - .2 The 'Shop Drawing' information shall be completed by the Contractor at the shop drawing submission stage.
 - .3 The 'Installed' information shall be completed by the Contractor.
- .2 The component verification forms will be provided to the Contractor for information and convenience and will not relieve the Contractor of responsibility for verification of components not included on the verification forms.
- .3 A verification form is to be completed for each component in a system requiring verification.
- .4 Component verification forms will be approved and subject to random verification by the Engineer.

3.3 COMPONENT VERIFICATION FORMS

- .1 For the purposes of this specification the following sample component verification forms have been provided. The forms are attached in Section 23 84 14A.

3.4 SYSTEM PERFORMANCE VERIFICATION TESTING

- .1 All Contractor and manufacturer startup and proving tests are to be completed and approved by the Engineer prior to conducting the defined system Performance Verification Tests.
- .2 All Component verifications related to a given system shall be completed by the Contractor and approved by the Engineer prior to conducting the defined system Performance Verification Test.
- .3 The Contractor will complete the Contractor verification portion of the System Performance Verification Test form prior to notifying the Engineer that the system is ready for verification.
- .4 Attached at the end of this section is a specific example of a System Performance Verification Test. Each system listed on the system test ledger will require a similar level of testing by the Contractor. The Engineer will provide the Contractor with

clarification of the test procedure and provide technical assistance prior to the test being performed.

- .5 System Performance Verification tests will be coordinated with Building automation System Trend data and graphs to provide additional documentation of system performance. A hard copy of this data will be attached to the System Performance Verification test document.
- .6 System Performance Verification Testing shall be Scheduled and conducted by the Contractor.
- .7 System Performance Verification Tests as per the verification forms will be conducted in the presence of the Engineer.
- .8 Systems requiring performance verification tests are listed on the ledger following this section.

3.5 SYSTEM PERFORMANCE VERIFICATION TEST FORMS

- .1 Refer to System Test Forms located in the Commissioning Appendix.

END OF SECTION

Project# L0683

TYPICAL BOILER DATA SHEET (B-1S)

	Specification	Shop Drawing	Installed	Verified Cont/ CxA
Manufacturer:				
Type:				
Model:				
Serial Number:				
Location:				
Boiler Capacity (KW):				
Steam Pressure Supply (KPa)				
Water Flow (L/s):				
EWT/ LWT (°C):				
Burner Fuel Type:				
Burner Stage:				
Burner HP:				
Burner V/P/H:				

INSTALLATION:

Nat. Gas Piping/ Valve:					Isolation / Balancing Valves:	
Supports/ Access:					PRV installed:	
Flue Ducting:					Pipe Pressure Tests Completed:	
Flow Tappings:					Pipe Connections Flanged	
Drain connection:					Steam Traps Installed	
No Damage to Flues & Boiler Jacket					Boiler Water at Correct Level Condensate Tank & Pumps:	
Thermometers:	In:		Out		Flow Meter:	
Pressure Gauges:	In:		Out:		Unit Identification	
Burner Set to Manuf. Spec.					Vibration/ Isolation:	
Local Boiler Inspection Report Attached:					Manufacture Start-up & Seasonal Reports Attached	

Project# L0683

TYPICAL BOILER DATA SHEET (B-1S)

OPERATIONAL:

Water Flow:		Pressure In/ out:	
EWT/ LWT:		PRV Set point:	
Main Gas Valve:		Burners Rapid Cycled 15 min. For Cond. Check:	
Low Gas Pressure Switch:		High Gas Pressure Switch:	
Sequence of Operation Verified:		Boiler Water Analysis Report Attached:	
Auto Blow Down Operation:		Controls Failure Modes Simulated:	
Low Fire Setting is Checked:		High Fire Setting is Checked:	

REMARKS/COMMENTS:

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CHECKED BY CONTRACTOR:.....

COMPANY DATE:.....

WITNESSED BY AND APPROVED BY CxA:

COMPANY DATE:.....

Project# L0683

TYPICAL BOILER DATA SHEET (B-2W to 4W)

Note: Individual check sheets shall be filled out for each boiler on this project

	Specification	Shop Drawing	Installed	Verified Cont/ CxA
Manufacturer:				
Type:				
Model:				
Serial Number:				
Location:				
Boiler Input / Output:				
EWT/ LWT (°F):				
Boiler Efficiency @ above Water Temp.:				
Boiler Water Vol.:				
Burner Fuel Type:				
Burner Stage:				
Burner HP:				
Burner V/P/H:				

INSTALLATION:

Nat. Gas Piping/ Valve:					Isolation / Balancing Valves:	
Supports/ Access:					Control Valve:	
Flue Ducting:					Water Make-Up:	
Flow Tappings:					Chemical Treatment is completed:	
Drain connection:					Air Separator Installed	
Manufacturer's start-up report submit:					Neutralization System:	
Thermometers:	In:		Out		Flow Meter:	
Pressure Gauges:	In:		Out:		Unit Identification	
Heating Media Charged:					Vibration/ Isolation:	
Local Boiler Inspection Report Attached:					Manufacture Start-up & Seasonal Reports Attached	

Project# L0683

TYPICAL BOILER DATA SHEET (B-2W to 4W)

Note: Individual check sheets shall be filled out for each boiler on this project

OPERATIONAL:

Water Flow:		Pressure In:	
EWT:		Pressure Out:	
LWT:		Low Water Cut Off:	
High Ambient:		Pilot Valve:	
Main Gas Valve:		PRV Set point:	
Flame Detector:		Flame Quality:	
Low Gas Pressure Switch:		High Gas Pressure Switch:	
Sequence of Operation Verified:			

REMARKS/COMMENTS:

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CHECKED BY CONTRACTOR:.....

COMPANY DATE:.....

WITNESSED BY AND APPROVED BY CxA:

COMPANY DATE:.....

Project# L0683

TYPICAL BACKFLOW PREVENTORS

Note: Individual check sheets shall be filled out for each BFP on the project.

	Specification Model	Shop Drawing Model	Installed Model	Verified Cont/CxA
Manufacture:				
Model No.:				
Size:				
Max Working Pressure (KPa)				
Maximum Supply Temperature (°C):				
Opening Pressure:				
Flow Rate (L/s)				
Pressure Drop (KPa):				

INSTALLATION:

Installed As per Dwg. Shown Location		Orientation Correct:	
Flow Direction Correct:		By-Pass Installed:	
Access/ Unions for Removal:		Strainer Cleaned:	

REMARKS/COMMENTS:.....
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CHECKED BY CONTRACTOR:

COMPANYDATE:.....

WITNESSED BY AND APPROVED BY CxA:.....

COMPANYDATE:.....

Project# L0683

TYPICAL PRESSURE REDUCING STATION:

	Specification Model	Shop Drawing Model	Installed Model	Verified Cont/CxA
Manufacture:				
Model No.:				
Size:				
Type:				
Inlet Pressure (KPa)				
Out-Let Pressure (KPa)				

INSTALLATION:

Installed As per Dwg. Shown Location		Piping Support:	
Inlet/ Outlet Pressure as Specified:		Inspection Report by Manufacture:	
Service Space:		Vent Connection:	

OPERATIONAL:

High Flow Inlet Pressure (KPa):		High Flow Outlet Pressure (KPa)	
Low Flow Inlet Pressure (KPa):		Low Flow Outlet Pressure (KPa)	

REMARKS/COMMENTS:.....

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CHECKED BY CONTRACTOR:

COMPANYDATE:.....

WITNESSED BY AND APPROVED BY CxA:.....

COMPANYDATE:.....

Project# L0683

TYPICAL DOMESTIC WATER SYSTEM MIXING VALVES

	Specification Model	Shop Drawing Model	Installed Model	Verified Cont/CxA
Manufacture:				
Model No.:				
Size:				
Max Working Pressure (KPa)				
Maximum Supply Temperature (°C):				
Adjustment Range:				
Flow Rate (L/s)				
Pressure Drop (KPa):				

INSTALLATION:

Installed As per Dwg. Shown Location		Installed As per Manufacture Instruction:	
Flow Direction Correct:		Orientation Correct:	
Access for Removal:		Shut-Off Valves:	

OPERATIONAL:

High Flow Supply Temp (°C):		High Flow Pressure Upset (KPa):	
Low Flow Supply Temp (°C):		Low Flow Pressure Upset (KPa):	

REMARKS/COMMENTS:.....

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CHECKED BY CONTRACTOR:.....

COMPANYDATE:.....

WITNESSED BY AND APPROVED BY CxA:.....

COMPANYDATE:.....

Project# L0683

TYPICAL HEAT EXCHANGER (HEX-1)

	Specification	Shop Drawing	Installed	Verified Cont/ CxA
Manufacturer:				
Model:				
Serial Number:				
Location:				
HX- Operating Pressure (Relief Valve Setting)				
Capacity (KW)				
Primary loop heating medium (Hot Side):				
EWT/ LWT (°C)				
Steam Pressure (KPa):				
P.D - Primary :				
Secondary loop heating medium (Cold Side):				
EWT/ LWT (°C)				
Flow-Secondary (L/s)				
P.D-Secondary:				

INSTALLATION:

Installed as per Drawings:		P.R.V.s Installed	
Isolation Valves		Steam Trap Installed	
Unit Slopes to Drain Cond.		Piping Support/ Connection:	
Control Hot Side Complete		Insulation Complete:	
Steam Trap Installed		Unit identification:	
Required Valve Installed on Cold Side		Control Cold Side Complete	
Flow Measuring		Air Vents:	
Spacing for Servicing:		Thermometers:	In: Out:
Wells:	In: Out:	Pressure Gauges:	In: Out:

Project# L0683

TYPICAL HEAT EXCHANGER (HX-1)

OPERATIONAL:

Steam Flow Hot Side:		Water Flow Cold Side:	
Hot Side EWT/ LWT:		Cold Side EWT/ LWT:	
Hot Side Pressure Drop:		Cold Side Pressure Drop:	
P.R.V Set points:		Hydronic Balancing is completed:	
		Cold Side Flow (GPM)	

REMARKS/COMMENTS:.....

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CHECKED BY CONTRACTOR:.....

COMPANYDATE:.....

WITNESSED BY AND APPROVED BY CxA:.....

COMPANYDATE:.....

Project# L0683

TYPICAL PUMP DATA SHEET (P-XX TO XX) (TYPICAL)

Note: Individual check sheets shall be filled out for each boiler on this project

	Specification	Shop Drawing	Installed	Verified Cont/ CxA
Serial Number:				
Manufacturer:				
Model:				
Flow (L/s):				
Head (KPA):				
Seal Type:				
Pump Construction:				
Location:				
Voltage/ Phase				
RPM:				
HP:				
Impeller diameter:				

INSTALLATION:

Discharge Valve:		Pump Mounting:	
Suction Valve:		Check Valve:	
Vibration Isolation:		Pressure Gauge:	
Flexible Connection:		Rotation:	
Strainer:		Disconnect Switch:	
Chemical Pot Feeder:		Particle Filter:	
Piping Supports:		Unit Identification:	
Lifting for Motor Installed (Large Pumps)		Division 25 installation Completed	

Project# L0683

TYPICAL PUMP DATA SHEET (P-01 TO 08) (TYPICAL)

Note: Individual check sheets shall be filled out for each pump on this project

OPERATIONAL:

Noise & Vibration:		Amperage Measured:	
Fluid Temperature:		Water Balancing Completed:	
Deadhead Pressure:		Flow Measured:	
System Pressure:			

REMARKS/COMMENTS:.....

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CHECKED BY CONTRACTOR:

COMPANYDATE:.....

WITNESSED BY AND APPROVED BY CxA:.....

COMPANYDATE:.....

Project# L0683

DHW TANK (DHW-1 OR 2) TYPICAL

Note: Individual check sheets shall be filled out for each tank on this project

	Specification	Shop Drawing	Installed	Verified Cont/ CxA
Manufacturer:				
Model:				
Serial Number:				
Type:				
Location:				
Storage Capacity (Litter):				
Dimensions (H x D_ mm):				
Heater Input / Output (KW):				
DHW ET/ LT (°C)				
Recovery at 78°C Temp. Rise				
Hr delivery @ 78°C Temp. Rise 1 st . hour				
V/P/F				

INSTALLATION:

Isolation valves:		Pressure gauges:	
Level gauge:		Drains:	
Thermostats:		Pressure relief:	
Insulation:		Unit identification:	
Serviceability:		Support Type:	
Tank Flushed/Vented/Filled:		Mounted Level:	

Project# L0683

DHW TANK (DHW-1OR 2) TYPICAL

Note: Individual check sheets shall be filled out for each tank on this project

OPERATION:

P.R.V set points:		Thermostats set @ 180°F:	
EWT :		LWT:	
Operated 12hr's Continuously		No leak from Mechanical system	

REMARKS/COMMENTS:

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CHECKED BY CONTRACTOR:.....

COMPANY DATE:.....

WITNESSED BY AND APPROVED BY CxA:

COMPANY DATE:

Project# L0683

TYPICAL EXPANSION TANK (TK-XX)

	Specification	Shop Drawing	Installed	Verified Cont/ CxA
Manufacturer:				
Model:				
Serial Number:				
Type:				
Location:				
Volume:				
Accept Volume:				
Maximum Operating pressure/ temperature:				
Fill Pressure:				
Dimensions (inch HxD)				

INSTALLATION:

Isolation valves:		Pressure Gauges:	
Level gauge:		Drains:	
Air separator:		Pressure Relief Valve:	
Air vent:		Unit identification:	
Piping Support:		Make-up Water Connection:	
System Connections Correct (Pump)		Drain Line Operational:	

OPERATIONAL:

Pressure (System Off):		Fluid Level in Tank (System Cold):	
Operating Pressure:		Fluid Level in Tank (System Warm):	
P.R.V Set-point:			

REMARKS/COMMENTS:.....

CHECKED BY CONTRACTOR:

COMPANYDATE:.....

WITNESSED BY AND APPROVED BY CxA.....

COMPANYDATE:.....

1. GENERAL

1.1 SYSTEM DESCRIPTION

- .1 The existing Building Management System (BMS) is the product of **Johnson Control (no alternative will be accepted)**. The control requirements shall be compatible to existing system. Operators shall be able to perform all normal operator functions through the web browser.
- .2 All new and modified systems shall be controlled from the front end web browser. Front end software and graphics shall be updated to reflect the new systems and changes made to existing air handling and heating systems.
- .3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASCs, Smart Standalone Control Units, and operator devices.
- .4 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- .5 The control sequences need to be fine tuned to serve the systems installed and amalgamated with existing control.
- .6 The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 & 26 Sections for details.
- .7 The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- .8 If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.2 BMS DESCRIPTION

- .1 The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
- .2 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a

building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

- .3 The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of these division specifications together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.
- .4 The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.
- .5 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- .6 Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- .7 The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
 - .1 Operator information, alarm management and control functions.
 - .2 Enterprise-level information and control access.
 - .3 Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
 - .4 Diagnostic monitoring and reporting of BMS functions.
 - .5 Offsite monitoring and management access.
 - .6 Energy management
 - .7 Standard applications for terminal HVAC systems.

1.3 SUBMITTALS

- .1 Shop Drawings, Product Data, and Samples
 - .1 The BMS contractor shall submit a list of all shop drawings with submittals dates within **30 days** of contract award.
 - .2 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.

- .3 Allow 15 working days for the review of each package by the Engineer in the scheduling of the total BMS work.
 - .4 Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.
 - .5 Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
 - .6 The BMS Contractor shall correct any errors or omissions noted in the first review.
- .2 At a minimum, submit the following:
- .1 BMS network architecture diagrams including all nodes and interconnections.
 - .2 Systems schematics, sequences and flow diagrams.
 - .3 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 - .4 Samples of Graphic Display screen types and associated menus.
 - .5 Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
 - .6 Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
 - .7 Details of all BMS interfaces and connections to the work of other trades.
 - .8 Product data sheets or marked catalog pages including part number, photo and description for all products including software.
- .3 At completion of work, make detailed checkout of automatic control system, and submit written report to the consultant.
- .4 Provide control diagrams for each system, framed under glass for wall mounting.

1.4 SYSTEM SPARES

- .1 The controls system shall have an **additional 25% point** capacity at each controller, provided and identified, as hardware spares in this Contract.

1.5 WORK BY OTHER TRADES

- .1 Electrical contractor will provide 120 Volt power for control panels, central computer equipment and control transformers.

- .2 BMS/ Mechanical contractor shall install thermal wells, control valves and devices on piping, BMS conduits, raceway, current switches, relay, low voltage and communication wiring furnished by controls contractor.

1.6 ELECTRICAL WORK INCLUDED (DIV. 26)

- .1 All low voltage (24V-12V) control wiring.
- .2 All line voltage (120V) control wiring.
- .3 All data communication cable between control panels, SCU's and central computer equipment.
- .4 Stand alone field control cabinets to be isolated in mechanical room or other appropriate service spaces.
- .5 Complete electrical installation including wiring is to conform to the Canadian Electrical Code.
- .6 In general, line voltage (120V) control wiring to be run in EM7 conduit. Low voltage and data communication wiring may be run free air provided that the installation is FT4 rated and concealed in walls or ceiling.
- .7 All wiring in service rooms and mechanical rooms (where exposed) must be installed in EMT conduit.
- .8 120V power supply requirements must be clearly identified to Div 16 prior to start of construction.
- .9 Interconnect wiring (in EMT conduit) to the main electrical service panel for monitoring of the electrical service essential data as noted on points list section.

1.7 CODES AND STANDARDS

- .1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable National and Territorial Codes and Regulations, and latest CSA Electrical Bulletins.

1.8 QUALITY ASSURANCE

- .1 General
 - .1 The Building Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.
 - .2 The BMS Contractor shall be a recognized national manufacturer, installer and service provider of BMS. This contractor shall be "Johnson Control".

- .3 As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the BMS business for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.
- .4 The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid. The product shall be "Johnson Control" to match the existing system.
- .5 Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

1.9 OWNER ORIENTATION

- .1 Contractor to provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.
- .2 Formal training sessions shall commence only after "as-built" drawings have been completed reviewed and approved by the Engineer.
- .3 Provide for operator training according to the following schedule.
 - .1 At job completion a 2 site seminar/workshop each with minimum of 6 hrs which covering all aspects of system use as follows:
 - .1 operation of hardware components
 - .2 system software configuration
 - .3 user/system interaction
 - .4 calibration of sensors and system
 - .5 trouble shooting of system and components
 - .6 preventative maintenance
- .4 Controls contractor to provide three complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Engineer.

1.10 WARRANTY

- .1 Include warranty provisions identified in the Division 26 contract.
- .2 The warranty provisions shall last for one year beginning at date of final acceptance and shall include at no cost all material and labour required to correct control system equipment failures that occur during the one year period.
- .3 In addition to warranty call backs provide 2 service and calibration inspections of a minimum 6 hours duration each. These calls will be initiated by the Owner.

- .4 The contractor shall supply and install at no cost all system software and hardware updates and upgrades occurring prior to the expiration of the warranty period.

1.11 SYSTEM ACTIVATION

- .1 Submit control calibration check sheet prior to system acceptance. Check sheets to include unit identification, controller/transmitter tag numbers, device controlled, controller PID settings, interlock devices and wire tag numbers.
- .2 Adjust and calibrate all controls **14 days prior** to system acceptance.

1.12 AS-BUILT DRAWINGS

- .1 Before the certification of substantial performance will be issued the contractor must provide the Engineer with as-built drawings as follows:
 - .2 Four (4) copies of as-built white prints in A1 size capacity blue binders bound in heavy fabric, hot stamped in white lettering front and spine. Each is to be identified As-Built Drawings and permanently numbered 1 to 4.
 - .3 The spine shall be lettered with the full identification title of the project and the front face shall be lettered with the following on the respective binders:
 - .1 Full identification title of the project.
 - .2 Prime Consultant and Sub-Consultant - full identification.
 - .3 Prime Contractor - full identification
 - .4 Mechanical Contractor - full identification
 - .5 Controls Contractor - full identification.
- .4 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

2. PRODUCTS

2.1 GENERAL

- .1 Provide control systems consisting of thermostats, control valves, operators, indicating devices, interface equipment, and other apparatus required to operate mechanical system, and to perform functions specified.
- .2 Provide the necessary components to connect factory-supplied controls with certain equipment where such controls are specified.
- .3 Unless specified otherwise, provide fully proportional components.
- .4 All Control devices of each category to be of same type and manufacturer and rated for use in Level III and higher laboratory environments, supplier to provide supporting documents.

- .5 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof and heat resistant assembly.
- .6 Operating conditions: -40 to 40°C with 10 - 90% RH (non-condensing) unless otherwise specified.
- .7 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .8 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .9 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .10 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
- .11 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

2.2 CONTROL PANELS

- .1 Provide control panel of unitized cabinet type construction. Mount relays, switches and control point adjustment in cabinet and pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face
- .2 Fabricate panels from 2.5 mm (12 ga.) rolled sheet metal sheet with baked enamel finish, flush fitting, gasketed doors hung on piano type hinges and three point latches and locking handles. CSA or ULC approved.
- .3 Mount panels on vibration free wall or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- .4 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.
- .5 All wiring in control panels to be CSA Class 2. All connections to transformers, relays, etc. greater than 30Volts to be made in approved separate junction boxes, motor starters or MCC.
- .6 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.
- .7 Identify all wiring by means of stamped markings on heat shrinkable tubing or 3M written wire tags using permanent acid pen. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in

plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.

- .8 Provide terminal blocks, tabular clamp, 300 v, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.
- .9 Wire "Hand-Off-Auto" selector switches such that safety controls and electrical over current protection are not overridden when selector switch is in the "Hand" position.

2.3 WIRE

- .1 Control wiring for digital output functions shall be 18 AWG minimum, control wire for digital input functions shall be 20 AWG minimum. (Wire to be shielded if required meeting manufacturers or application requirements). Wire insulation to meet code requirements.
- .2 Control wiring for analog output functions shall be 18-20 AWG minimum twisted (wire to be shielded if required to meet manufacturers or application requirements), 2 or 3 wire to match analog function hardware. Wire insulation to meet code requirements.
- .3 Analog input and sensor wiring shall be 18-20 AWG minimum twisted (wire to be shielded if required to meet manufacturers or application requirements), 2 or 3 wire to match analog function hardware. For multiple conductor room sensor wires, Cat 5 24 AWG wire may be used if approved by manufacturer and providing wire length is not greater than 20 meters. Wire insulation to meet code requirements.
- .4 Transformer current wiring shall be 16 AWG minimum. Wire insulation to meet code requirements.

2.4 CONDUITS AND CABLES

- .1 All wiring in exposed areas, mechanical rooms and electrical rooms shall be in conduit or trays. Conform to Division 26 requirements for conduit and tray specifications.
- .2 For wall sensors install CSA approved junction box recessed in wall, mount sensor to junction box. Install conduit from wall sensor box to accessible ceiling area.
- .3 Seal conduit where such conduit leaves heated areas and enters unheated area.

- .4 Run low level signal lines in separate conduit from high level signal and power transmission lines.
- .5 Identify each cable and wire at every termination point.
- .6 Where applicable, mount field interface equipment (i.e. relays, transducers, etc.) in local device cabinets adjacent to field interface panels.
- .7 Color code all conductors and conduits by permanently applied color bands. Color code shall follow base building schedule. Provide color band on each side of building structure that conduit penetrates, color code each junction box cover.

2.5 BMS IDENTIFICATION:

- .1 Name Plates for Panels:
 - .1 Identify by Plastic laminate, core, square-corners, lettering accurately aligned and engraved into core.
 - .2 Sizes: 25 x 67 mm minimum.
 - .3 Lettering: minimum 7 mm high, black.
 - .4 Inscriptions: machine engraved to identify function.
- .2 Name Plate for Filed Devices:
 - .1 Identify by plastic encased cards attached by chain.
 - .2 Sizes: 50 x 100 mm minimum.
 - .3 Lettering: minimum 5 mm high produced from laser printer in black.
 - .4 Data to include: point name, schematic designation number, model, capillary length, size, range, set point, other pertinent data, function, fail-safe position.
 - .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.
- .3 Warning Signs:
 - .1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.
 - .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative's and Consultant's.
- .4 Wiring:
 - .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
 - .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.
- .5 Conduit:
 - .1 Colour code EMCS conduit.
 - .2 Pre-paint box covers and conduit fittings.
 - .3 Coding: use fluorescent orange paint and confirm colour with Departmental Representative and Consultant during "Preliminary Design Review".

2.6 TEMPERATURE SENSORS

- .1 General: except for room sensors to be resistance or thermocouple type to following requirements:
 - .1 RTD's: 1000 or 10000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored lead wires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
 - .2 Sensing element: hermetically sealed.
 - .3 Stem and tip construction: copper or type 304 stainless steel.
 - .4 Time constant response: less than 3 seconds to temperature change of 2°C.
 - .5 Immersion wells: install new: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 6" inch as indicated.
- .2 Water temperature sensors:
 - .1 Stainless Steel probe, High accuracy, Fast response, wide sensing range fluid type: suitable for insertion into system operating with hot water at various orientations, maximum insertion length 9" inch.
 - .2 Temperature sensing range of **-40 to +140°C**, nominal value of 20,000 ohm at 25°C and response time of less than 2.5 seconds,
- .3 Outdoor air temperature sensors (Use Existing If available, if use existing Johnson to provide sensor test report prior to commissioning) for new sensors:
 - .1 Outside air type: complete with probe length 150 mm long, no corroding shields to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.
 - .2 Temperature sensing range of **-45 to +60°C**, nominal value of 10,000 ohm at 25°C, suitable for installation of 600' away from main controller and response time of less than 5 min,

2.7 TEMPERATURE TRANSMITTERS

- .1 Requirements:
 - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0°C, platinum resistance detector type sensors.

- .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.
- .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .4 Input and output short circuit and open circuit protection.
- .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 5 %.
- .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
- .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.
- .8 Integral zero and span adjustments.
- .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50° C.
- .10 Long term output drift: not to exceed 0.25 % of full scale/ 6 months.
- .11 Transmitter ranges: select narrowest range to suit application from following:
 - .1 -50° C to +50°C, +/-0.5°C.
 - .2 10° C to +40°C, +/-0.25°C.

2.8 TEMPERATURE SWITCHES

- .1 Requirements:
 - .1 Operate automatically. Reset automatically, except as follows:
 - .1 Low temperature detection: manual reset.
 - .2 High temperature detection: manual reset.
 - .2 Adjustable setpoint and differential.
 - .3 Accuracy: +/-1° C.
 - .4 Snap action rating: 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
 - .5 Type as follows:
 - .1 Thermowell: stainless steel, with compression fitting for NPS ¾ thermowell. Immersion length: 125 mm.
 - .2 Low temperature detection: continuous element with 6000 mm insertion length, to detect coldest temperature in any 100'-0" length.
 - .3 Strap-on: with helical screw stainless steel clamp.

2.9 PRESSURE TRANSDUCERS

- .1 Requirements:
 - .1 Combined sensor and transmitter measuring pressure.
 - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

- .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .3 Output variations: less than 0.2% full scale for supply voltage variations of +/-10%.
- .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed +/-0.5% of full scale output over entire range.
- .5 Temperature effects: not to exceed plus or minus 1 % full scale/ 50°C.
- .6 Over-pressure input protection to at least twice rated input pressure.
- .7 Output short circuit and open circuit protection.
- .8 Accuracy: plus or minus 1% of Full Scale.

2.10 DIFFERENTIAL PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 LCD three digits display for Room Pressure monitor to show space pressure
 - .2 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
 - .3 Output signal: 4 to 20 mA into 500 ohm maximum load.
 - .4 Output variations: less than 0.2 % full scale for supply voltage variations of +/-10%.
 - .5 Combined non-linearity, repeatability, and hysteresis effects: not to exceed +/-0.5% of full scale output over entire range.
 - .6 Integral zero and span adjustment.
 - .7 Temperature effects: not to exceed plus or minus 1 % full scale/ 50°C.
 - .8 Over-pressure input protection to at least twice rated input pressure.
 - .9 Output short circuit and open circuit protection.
 - .10 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.11 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

- .1 Requirements:
 - .1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.
 - .2 Adjustable setpoint and differential.
 - .3 Switch: snap action type, rated at 24 V DC.
 - .4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
 - .5 Accuracy: within 1% repetitive switching.
 - .6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.

- .7 Switches on steam and high temperature hot water service: provide pigtail syphon.

2.12 ELECTROMECHANICAL RELAYS

- .1 Requirements:
 - .1 Double voltage, DPDT, plug-in type with termination base.
 - .2 Coils: rated for 120 V AC or 24V DC. Other voltage: provide transformer.
 - .3 Contacts: rated at 5 amps at 120 V AC.
 - .4 Relay to have visual status indication

2.13 SOLID STATE RELAYS

- .1 General:
 - .1 Relays to be socket or rail mounted.
 - .2 Relays to have LED Indicator
 - .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
 - .4 Operating temperature range to be -20 degrees C to 70 degrees C.
 - .5 Relays to be CSA Certified.
 - .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
 - .7 Operational frequency range, 45 to 65 HZ.
- .2 Input:
 - .1 Control voltage, 3 to 32 VDC.
 - .2 Drop out voltage, 1.2 VDC.
 - .3 Maximum input current to match AO (Analog Output) board.
- .3 Output.
 - .1 AC or DC Output Model to suit application.

2.14 CURRENT TRANSDUCERS

- .1 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:
 - .1 4-20 mA DC.
 - .2 0-1 volt DC.
 - .3 0-10 volts DC.
 - .4 0-20 volts DC.
- .2 Frequency insensitive from 10 - 80 hz.
- .3 Accuracy to 0.5% full scale.
- .4 Zero and span adjustments. Field adjustable range to suit motor applications.

- .5 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.15 CURRENT SENSING RELAYS

- .1 Requirements:
 - .1 Suitable to detect belt loss or motor failure.
 - .2 Trip point adjustment, output status LED.
 - .3 Split core for easy mounting.
 - .4 Induced sensor power.
 - .5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.
 - .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
 - .7 Adjustable latch level.

2.16 RELATED ACCESSORIES

- .1 Provide and install all necessary transformers, transducers, interposing relays, interface devices, contactors, starters and EP's to perform control functions required.
- .2 Generally motor starters and contactors for motors greater than 0.37 kW (1/2 HP) to be supplied with equipment or by Div. 26 contractor. Where control is specified for fractional horsepower motors (less than 0.37 kW), controls contractor to supply relays or contactors where not provided with equipment or by Div. 26.
- .3 It is the responsibility of the Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.
- .4 Items required but not identified at the time of tender acceptance shall be the Contractor's responsibility.

2.17 CONTROL VALVES

- .1 Two-way and three-way valves for liquids: Two-way valves shall have equal percentage characteristics and three-way valves shall have linear characteristics. Size two-way valve operators to close against maximum pump shut-off head. Ball valves as control valves are not acceptable.
- .2 Size control valves as per following criteria:
 - .1 Select control valves in to supply varying water temperature to the system at 25 KPa or less pressure drop.
 - .2 Select two-way control valves for heat exchangers with a maximum pressure drop of 20 KPa.

- .3 Select three-way control valves for water system for pressure drop equal or maximum of 30 KPa.
- .3 Steam Valves: Modified linear characteristics. Provide separate valves for each bank of coil. Provide two valves in parallel where steam load exceeds 1500 lb/hr. Capacities for two valves in parallel shall have 1/3 - 2/3 load capacities sequenced with pilot positioners so that smaller valve opens first. Size low pressure valves for approximately 60 KPa inlet pressure and 20 KPa drop.
- .4 Provide pilot positioners on all valves that are to be sequenced (on all steam valves).
- .5 Valves shall "fail-safe", spring return to normal position.
- .6 Provide valves in accordance with general valve specification. Provide position indicators on valves, and pilot positioners on sequenced valves.

2.18 ELECTRONIC / ELECTRIC VALVE ACTUATORS

- .1 Requirements:
 - .1 Construction: steel, cast iron, aluminum.
 - .2 Control signal: 0-10V DC or 4-20 mA DC.
 - .3 Positioning time: to suit application. 90 second maximum.
 - .4 Fail to normal position as indicated.
 - .5 Scale or dial indication of actual control valve position.

2.19 CENTRAL COMPUTER UNIT

- .1 There is existing Central Computer Unit, upgrade the existing computer unit and associated software in order to meet the new system requirements if new controls are not compatible with existing computer unit.

3. EXECUTION

3.1 INSTALLATION

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Fire stopping: provide space for fire stopping in accordance with ULC and national building code requirements. Maintain fire rating integrity.
- .6 Electrical:
 - .1 Complete installation in accordance with Section 26 05 00 - Common Work Results - Electrical.
 - .2 Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Consultant before beginning Work.
 - .3 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
 - .4 Install communication wiring in conduit.
 - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
 - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
 - .3 Maximum conduit fill not to exceed 40%.
 - .4 Design drawings do not show conduit layout.
 - .7 Wire "hand/off/auto" selector switches such that automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.
 - .8 Install all safety limits at the 1800 mm above finished floor or operator level.

3.2 TEMPERATURE AND HUMIDITY SENSORS

- .1 Outdoor installation:
 - .1 Protect from solar radiation and wind effects by non-corroding shields.
 - .2 Install in NEMA 4 enclosures.
- .2 Thermo-wells: install for piping installations.
 - .1 Locate well in elbow where pipe diameter is less than well insertion length.
 - .2 Thermowell to restrict flow by less than 30%.
 - .3 Use thermal conducting paste inside wells.

3.3 PANELS

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

- .3 Identify wiring and conduit clearly.

3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
 - .1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.5 TESTING AND COMMISSIONING

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 23 84 14 & 23 84 14A.

3.6 ALARMS

- .1 Provide Alarm 1 (Indicate Alarm only, maintainers to deal with alarm no later than next day):
- .2 Provide Alarm 2 (Alarm signal shall Indicate “Urgent High Priority” alarm, maintainers to be called out to deal with the alarm immediately):
- .3 Alarm 3: Fire alarm (fire or equivalent)
- .4 Interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.

3.7 STEAM BOILER (B-1S) AND ASSOCIATED ACCESSORIES SYSTEMS

- .1 The Building BMS system shall determine the facility manager or whenever “Animal Cook Tank” systems is commended on and require steam; boiler shall maintain required steam flow and constant pressure at all time.
- .2 Building BMS shall monitor the boiler and system low Pressure, supply and return temperature and flow rate steam at 103 KPa (15 psig); the low-pressure steam shall be constant at all time;
- .3 Boiler shall be off during emergency power failure.
- .4 The following safeties shall be monitored:
 - .1 Boiler failure command on status off system to generate Alarm 2;
 - .2 Low Water Level system to generate Alarm 2;
 - .3 A manual reset of the boiler safety will be required before the boiler will can be restarted;
 - .4 Indicate Alarm 1, if return temperature from condensate system is below 82°C (adj.);

- .5 Indicate Alarm 2, if return temperature from condensate system is above 98°C (adj.);
- .6 Alarms 2 shall be generated if the system pressure in B-1S increase above 150 KPa (adjustable).
- .5 Building BMS shall monitor and sequence following steam system accessories:
 - .1 Condensate tank (CTS-1) level, Indicate Alarm 2, when tank level rise above the set point;
 - .2 Chemical feed system status point (CHT-1);
 - .3 Condensate return pumps P-27 & 28 as follows:
 - .1 BMS shall monitor the Status and start-stop of for each pump (one pump will be use as standby at all time, lead pump selection will be manually by facility O&M, div 25 to coordinate with condensate package supplier regarding the pump selector switch and control);
 - .2 Lead pump shall start upon “Boiler B-1S” energizing and stop as required (time delay to be reviewed after boiler is selected) whenever the boiler is turn-off.
 - .3 During Emergency Power failure both pumps shall remain off;
 - .4 Alarms 1 shall be generated upon receiving lead pump failure when the pump is commanded on, but the status is off.
 - .5 Lag pump shall start within 30 second (user adj.) after system generate Alarm1 on lead pump;
 - .6 Alarms 2 shall be generated upon receiving lag pump failure when the pump is commanded on, but the status is off.

3.8 HEATING BOILER SEQUENCE OF OPERATION (B-2W TO 4W)

- .1 The heating system consists of three (3) boilers, each sized for 60% of the total heating requirement. The two (2) heating water pumps are sized for 100% capacity each, one as standby pump.
- .2 Fire Mode: System to run normally.
- .3 Emergency Power Mode: System to run normally
- .4 The boiler system shall be enabled to run whenever outside air temperature is less than 12°C (adjustable).
- .5 The boilers shall be set up on a lead lag basis. The boiler management system “BOMS” (by boiler manufacturer) shall control the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant.
 - .1 The BOMS unit will be monitored/ communicate by building control system (BMS) and shall report an Alarm 2 condition if any of the boilers failed to operate.

- .2 Alarm 2 shall be generated if any of the boilers low water switch is activated (one for each unit).
- .3 Boiler 2W Failure: Commanded on, but the status is off, initiate an alarm 1;
- .4 Boiler 3W Failure: Commanded on, but the status is off, initiate an alarm 1;
- .5 Boiler 4W Failure: Commanded on, but the status is off, initiate an alarm 2;
- .6 The set point of boilers shall be provided by the BOMS system to the individual boilers, and each boiler shall have feedback to the BMS indicating loading of the boiler. When a boiler is selected the automatic shut-off valve on boiler heating water return pipe shall open. Boiler loop supply temperature set point is to be reset based on outside air temperature according to the following schedule:

OAT (°C)	Main Supply Glycol Temp (°C)
≤ -15	76.6
$-15 \leq \text{OAT} \leq 0$	65.5
$0 \leq \text{OAT} \leq 12$	54.4
$12 \leq \text{OAT}$	OFF

- .1 Alarm 2 shall be generated if the “Heating Supply Glycol Temperature” is $\pm 5^{\circ}\text{C}$ (adj.) below or above the system schedule.
- .2 If return system temperature is higher than 60°C initiate an alarm 1;
- .7 BOMS shall monitor the Supply and Return temperature to each boiler (One for each boiler);
- .8 BMS shall monitor the Main Supply and Return temperature, Existing Building Radiation Heating System (Associated with P-7 & 8).
 - .1 Contractor shall reuse existing supply return points associated with AHU’s heating coils (associated with P-25/26)
- .9 Control to monitor P-25 & 26 as follows:
 - .1 BMS shall monitor the Status and start-stop of for each pump;
 - .2 The boiler system shall be enabled to run whenever outside air temperature is less than 12°C (adjustable).
 - .3 During Emergency Power failure or Fire Mode lead pump shall remain operational;
 - .4 The two variable speed heating pumps shall operate in a lead/lag fashion.
 - .1 The lead pump shall run first.

- .2 If lead pump fails, the next lag pump shall stage on as required to maintain differential pressure.
- .3 The BMS shall measure the differential pressure and modulate the lead pump VFD to maintain set-point differential pressure. (Note: set point shall be field adjusted during the commissioning period and after full hydronic balancing to meet the requirements of actual field conditions).
- .4 Minimum VFD speed shall not drop below 20% (adj.)
- .5 Alarms 2 shall be generated upon receiving "High Hot Water Differential Pressure" If the hot water differential pressure is greater than set point. If the hot water differential pressure is 20% (adj.) greater than set point;
- .6 Alarms 2 shall be generated upon receiving "Low Hot Water Differential Pressure" If the hot water differential pressure is less than set point. If the hot water differential pressure is 20% (adj.) less than set point.
- .7 Alarms 1 shall be generated upon receiving lead pump failure when the pump is commanded on, but the status is off.
- .8 Lag pump shall start within 30 second after system generate Alarm1 on lead pump;
- .9 Alarms 2 shall be generated upon receiving lag pump failure when the pump is commanded on, but the status is off.
- .5 The designated lead pump shall be to be rotated manually through a software switch (user selectable).
- .10 Control to monitor P-7 & 8 as follows:
 - .1 BMS shall monitor the Status and start-stop of for each pump;
 - .2 The boiler system shall be enabled to run whenever outside air temperature is less than 12° C (adjustable).
 - .3 To prevent short cycling, the pumps shall run for and be off for minimum adjustable times (both user definable).
 - .1 The lead pump shall run first.
 - .2 If lead pump fails, the next lag pump shall stage on as required to maintain differential pressure.
 - .3 Alarms 1 shall be generated upon receiving lead pump failure when the pump is commanded on, but the status is off.
 - .4 Lag pump shall start within 30 second after system generate Alarm1 on lead pump;

- .5 Alarms 2 shall be generated upon receiving lag pump failure when the pump is commanded on, but the status is off.

3.9 HEAT EXCHANGER HEX-1:

- .1 Control contractor shall modify existing HEX-1 sequence of operation to suite new sequence as follows:
- .2 The heat exchanger system shall be able to be operational whenever outside air temperature is less than 10°C (adj.)
- .3 To prevent short cycling, the heat exchanger shall run for and be off for minimum adjustable times (both user definable).
- .4 COLD SIDE (Existing to be Modified if Require, Re-Use Existing Points):
 - .1 Heating Circulation Pump Lead/Standby Operation (existing P-11 & 12):
 - .1 The pumps shall be enabled whenever the outside temperature is less than 10°C (adj.);
 - .2 The two hot water pumps shall operate in a lead/standby fashion.
 - .3 The lead pump shall run first.
 - .4 During Emergency Power failure lead pumps shall start immediately;
 - .5 On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.
 - .6 The designated lead pump shall rotate upon one of the following conditions (user selectable):
 - .1 Manually through a software switch;
 - .7 Following alarms shall be provided for each set of pump as follows:
 - .1 Alarm 2: Failure, commanded on, but the status is off.
 - .2 Alarm 1: Running in Hand, commanded off, but the status is on.
 - .8 The supply temperature after heat exchanger shall be set to maintain 35.6°C (adj.).
 - .9 Once maximum heat has been recovered from the heat recovery system, the temperature for the heating coil will engage the VFD and increase pump (existing P-11 or 12) speed to maintain temperature set point.
 - .10 Alarm shall be provided as follows:
 - .1 Alarm 1_High Hot Water Supply Temp: If greater than 45°C (adj.).

- .2 Alarm 2_Low Hot Water Supply Temp: If less than 20°C (adj.).

.5 HOT SIDE (NEW)

- .1 Hot side 3 way diverting valve: The controller shall measure the hot water supply temperature and modulate the steam valve to maintain cold side supply set point. The 3 way mixing valve shall be enabled whenever:
 - .1 The cold side is called to run, and hot water supply temperature is below set point.
 - .2 The valve shall open to 100% (adj.) whenever the AHU's are in freeze protection due to low outside air temperature.
 - .3 The valve shall close whenever the cold side water supply temperature rises from 35.6°C to 45°C (adj.).

3.10 UNIT HEATERS (UH-1 & 2)

- .1 Controls for the unit heaters are to be hard wired and not run through the BMS system.
- .2 Check and verify location of thermostats, and other exposed control sensors with plans and room details before installation. Locate thermostats 1.65 m above floor. Locate the ring beam zone thermostats on the parapet wall.
- .3 Individual room thermostat shall modulate two-way heating control valve. Aquastat on return heating water line shall stop unit on low temperature.
- .4 The unit shall be continuously enabled to maintain a zone temperature set point of 12°C.
- .5 The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating set point.

3.11 DOMESTIC HOT WATER SYSTEM (DHWT-1 & 2)

- .1 This loop consists of a fully modulating 3-way mixing control valve, 2 water heater storage tanks and associated existing re-circulation pump.
- .2 The system and associated pumps shall be enabled to run whenever it is commanded to be enabled by "BMS occupied/ unoccupied" or Facility manager;
- .3 A temperature controlled mounted on the each DHWT will energize associated burner & existing re-circulating pump to maintain water temperature inside each unit and building supply temperature of 82°C (adjustable) set point;
- .4 The following safeties shall be monitored:
 - .1 DHWT failure command on status off system to generate Alarm 2 (one per boiler);

- .2 Indicate Alarm 2, when tank temperature (one per tank) does not match with the schedule. (+/- 2°C difference.)
- .3 Indicate Alarm 2, when main high high supply temperature (180F system) does not match with the schedule. (+/- 2°C difference.)
- .4 Indicate Alarm 2, when main high supply temperature (140F system) does not match with the schedule. (+/- 2°C difference.)
- .5 During occupied/un-occupied hours (adjustable by facility manager), the BMS system shall measure the both secondary hot water supply temperatures and modulate the mixing valve (MX-1) to maintain the system @ 60°C whenever the hot water system is called to run.
- .1 The following safeties shall be monitored:
 - .1 Indicate Alarm 2, when secondary supply temperature (one per system) does not match with the schedule. (+/- 1°F difference.); also main EM-DHV shall close if the secondary system temperature rises above 62°C.

3.12 NEW CONTROL POINTS:

UNIT	Point	Description	Type	Range	Remarks
<u>Steam System</u>	B1S-STAT	Boiler 1S/ manual-off	DI	Two Stage	
“	B1S-FL/FA	Boiler 1S burner flame failure	DI		Indicate Alarm 2, when Burner status does not match.
“	B1S-REST	Boiler1S Reset	AO		
“	STP-Supply	Steam Pressure Supply	AI	0 to 700 KPa	Indicate Alarm 2, if system pressure is higher than 150 KPa (adj.)
“	STF-Supply	Steam Flow Rate supply	AI	0 to 250 Kg/hr	
“	STT-supply	Steam system supply temperature	AI	70°/ 150° C	
“	STT-return	Steam system return temperature	AI	50°/ 150°C	Indicate Alarm 1, if return temperature from condensate system is below 82°C (adj.), Indicate Alarm 2, if return temperature from condensate system is above 98°C (adj.)
“	P27-STAT	Cond. Return Pump Status	DI	On/Off	Indicate Alarm 1, when pump Status does not match.
“	P27-SST	Cond Return Pump Start/ Stop	DO	“	
“	P28-STAT	Cond. Return Pump Status	DI	On/Off	Indicate Alarm 2, when pump Status does not match.
“	P28-SST	Cond Return Pump Start/ Stop	DO	“	

UNIT	Point	Description	Type	Range	Remarks
“	CTS-1-LE	Condensate Tank (CT-1) Level Switch	DI	High/Normal	Indicate Alarm 2, when tank level rise above the set point
“	CHT	Chemical Feed Tank and associate system status	DI	On/Off	
<u>Heating System</u>	B2W-STAT	Boiler 2W/ modulation/ manual-off	DI	Fully modulation 0-100% flame	
	B2W-FL/FA	Boiler 2W burner flame failure	DI		Indicate Alarm 1, when Burner status does not match.
	B2W-REST	Boiler2W Reset	AO		
	B3W-STAT	Boiler 3W/ modulation/ manual-off	DI	Fully modulation 0-100% flame	
	B3W-FL/FA	Boiler 3W burner flame failure	DI		Indicate Alarm 2, when Burner status does not match.
	B3W-REST	Boiler3W Reset	AO		
	B4W-STAT	Boiler 4W/ modulation/ manual-off	DI	Fully modulation 0-100% flame	
	B4W-FL/FA	Boiler 4W burner flame failure	DI		Indicate Alarm 2, when Burner status does not match.
	B4W-REST	Boiler4W Reset	AO		
“	P25-STAT	Pump Status	DI	On/Off	Indicate Alarm 1, when pump Status does not match.
“	P25-SST	Pump Start/ Stop	DO	“	
“	P25-VFD	Pump VFD	AO	0 TO 100%	
“	P26-STAT	Pump Status	DI	On/Off	Indicate Alarm 2, when pump Status does not match.
“	P26-SST	Pump Start/ Stop	DO	“	
“	P25-VFD	Pump VFD	AO	0 TO 100%	
“	AHS-PD	AHU's Line Pressure Differential	AI	0 TO 200 KPa	
“	RADS-PD	RAD Line Pressure Differential	AI	0 TO 200 KPa	

UNIT	Point	Description	Type	Range	Remarks
“	MHD-PD	Main Heating Line Pressure Differential	AI	0 TO 200 KPa	Indicate Alarm 2, for low or high differential pressure
“	MH-SWT	Main Supply Temp	AI	50°/ +110° C	Indicate Alarm 2, when supply temperature does not match with the schedule. (+/- 5°C difference.)
“	MH-RWT	Main Return Temp	AI	50°/ +110° C	
“	P7-STAT	Pump Status	DI	On/Off	Indicate Alarm 1, when pump Status does not match.
“	P7-SST	Pump Start/ Stop	DO	“	
“	P8-STAT	Pump Status	DI	On/Off	Indicate Alarm 2, when pump Status does not match.
“	P8-SST	Pump Start/ Stop	DO	“	
“	HEX1-HST	HEX1 hot side Supply Temp	AI	50°/ +110° C	
“	HEX1-HRT	HEX1 hot side Return Supply Temp	AI	50°/ +110° C	
“	HEX1-H3MV	HEX1 hot side 3 way diverting valve	AO	0 to 100%	
	Control Contractor to use existing building outdoor temperature points				
	Control Contractor to use existing points for HEX-1 Cold Side				
	Control Contractor to use existing points for AHU's heating coil Side				
	Control Contractor to use existing points for Bldg. Radiation heating Side				
Domestic Hot Water	DHW-T1	DHW System Tank#1 Temp	AI	40°/ +100°C	Indicate Alarm 2, when tank temperature does not match with the schedule. (+/- 2°C difference.)
“	DHW-T2	DHW System Tank#2 Temp	AI	40°/ +100°C	Indicate Alarm 2, when tank temperature does not match with the schedule. (+/- 2°C difference.)
“	Control Contractor to use existing points for Building re-circulating DHWR pump				
“	DHHW-ST	DHHW (180F System) Supply Temp	AI	40°/ +100°C	Indicate Alarm 2, when tank temperature does not match with the schedule. (+/- 2°C difference.)
“	DHW-ST	DHW (140F System) Supply Temp	AI	40°/ +100°C	Indicate Alarm 2, when tank temperature does not match with the schedule. (+/- 2°C difference.)

UNIT	Point	Description	Type	Range	Remarks
“	DHW-3MV	DHW system 3 way mixing valve (MX-1)	AO	0 to 100%	
“	EM-DHV	DHW system emergency valve	AO	Open-close	Indicate <u>Alarm 2</u> , when valve is closed.

END OF SECTION

1. GENERAL

1.1 SUMMARY

.1 Section Includes:

General requirements that are common to NMS sections found in Division 26.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-09, Canadian Electrical Code, Part I (21th Edition), Safety Standard for Electrical Installations.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

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

.1 Material Safety Data Sheets (MSDS).

1.3 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates and labels for control items in English.

1.4 SUBMITTALS

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

.2 Shop drawings:

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

.2 If changes are required, notify Departmental Representative and Consultant of these changes before they are made.

.3 Quality Control:

.1 Provide CSA certified equipment and material.

.2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction inspection authorities for special approval before delivery to site.

.3 Submit test results of installed electrical systems and instrumentation.

- .4 Permits and fees: in accordance with General Conditions of contract.
- .5 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.
- .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

1.5 QUALITY ASSURANCE

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 26 - Governmental Safety Requirements.

1.6 SYSTEM STARTUP

- .1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

2. PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - Submittals.
- .2 Factory assemble control panels and component assemblies.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit, wiring and connections below 50 V which are related to control systems and specified in mechanical sections and as shown on mechanical drawings.

2.3 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction inspection authorities, Departmental Representative & Consultant.
- .2 Porcelain enamel signs, minimum size 175 x 250 mm.

2.4 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for copper conductors.

2.5 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
 - .1 Nameplates: lamicoid, matt white finish face, black core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Consultant prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled, voltage, phase, horsepower and circuit numbers.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.

2.6 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.

2.7 CONDUIT AND CABLE IDENTIFICATION

- .1 Conduits should be marked as per use: "Power" or "Control".
- .2 Colour code conduits, boxes and metallic sheathed cables.
- .3 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.
- .4 Colours: 25mm wide prime colour and 20mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green

2.8 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green" finish.
 - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

2.9 FIRE-STOPPING

- .1 Fire-stop all pipe, duct, conduit, and wire penetrations through floors and walls designated as fire and/or smoke separations in accordance with Section 07 84 00 – Fire-Stopping.
- .2 Fire-stopping materials to meet ULC CAN 2S115.
- .3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer's instructions.

3. EXECUTION

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

- .1 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

3.4 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400mm.
 - .2 Wall receptacles:
 - .1 In mechanical rooms: 1400mm.
 - .3 Panelboards: as required by Code or as indicated.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.7 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - Submittals: phase and neutral currents on panelboards, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control:
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

- .4 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental Representative; and submit test report to consultant.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .6 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Certified wood.
 - .8 Low-emitting materials.

3.8 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

1. GENERAL

1.1 INTENT

- .1 This Section specifies electrical requirements relating to the commissioning of electrical components and applies to all applicable sections in Division 26.
- .2 Related Sections:
 - .1 Section 01 91 13 – General Commissioning (Cx) Requirements
- .3 Commissioning of building electrical components in affected renovation areas is of the utmost importance to ensure the successful operation of this building. The building renovations will not be considered complete until all components have been demonstrated to work precisely in accordance with the Contract requirements.
- .4 Responsibility for the satisfactory completion of the building and demonstration that the requirements of the commissioning are satisfied rests with the Contractor, who will employ and pay for any specialist supervision, inspection and testing as required to complete the work described.
- .5 The commissioning process consists of:
 - .1 Component verifications per this Section.
 - .2 Integrated Component Performance Verification Testing and Demonstration per Section 01 91 13.
- .6 Read this Section in conjunction with related Sections, which specify portions of electrical commissioning work. Refer also to Division 1.
- .7 Except where otherwise specified, arrange and pay for the testing and related requirements specified in this and related Sections.
- .8 If test results do not conform to applicable requirements, repair, replace or adjust components. Repeat testing as necessary until results acceptable to the Engineer are achieved.

1.2 VERIFICATION AND REPORTING

- .1 General:
 - .1 Component Verification Testing shall be conducted per this Section.
 - .2 Submit completed verification and test reports immediately after inspections and/or tests are performed.
 - .3 Record all data gathered on site on approved verification forms with completed shop drawing data.
 - .4 Provide the Engineer with original of each completed verification form.
 - .5 Maintain one photocopy on site of all data taken during commissioning.
 - .6 Maintain one copy of all final reports on site up to interim acceptance of the work for reference purposes.
 - .7 All final verification forms are to be typewritten.

- .8 Submit to engineer for approval.
- .9 Make corrections and re-submit as requested by Engineer.

1.3 SCHEDULE

- .1 Prior to starting and testing of components, prepare a schedule for the required testing.
- .2 Provide sufficient notice minimum 21 calendar days prior to commencing tests.
- .3 Engineer may witness all or any portion of the component testing.
- .4 Contractor to be present for and participates in all tests.
- .5 Unless otherwise specified in writing by the Engineer all testing and related requirements specified herein will be performed prior to the issue of the Interim Certificate of Completion.

1.4 COORDINATION

- .1 Coordinate all sub-trades, manufacturers, suppliers and other specialists as required to ensure all phases of work shall be properly organized prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.
- .2 Where any components require testing prior to starting, ensure that such work has been completed and approved prior to starting of these components. In particular, the requirements specified in Division 26 shall be coordinated by the Contractor to complete the commissioning requirements

1.5 COMMISSIONING MEETINGS

- .1 Provide the appropriate representation at the scheduled commissioning meetings as outlined in Section 019100.

1.6 PRESIDING AUTHORITIES

- .1 Starting procedures defined in this section may duplicate verification conducted by presiding authorities. To facilitate expedient turnover of the building, arrange for authorities to witness procedures in a manner that avoids unnecessary duplication of tests.
- .2 Obtain certificates of approval, acceptance and comply with rules and regulations of authorities having jurisdiction. Provide originals of all certificates to engineer.

1.7 CORRECTION OF DEFICIENCIES

- .1 Identify, record, resolve and correct all contract deficiencies found during commissioning.

1.8 COMPLIANCE WITH DEFINED PROCEDURES

- .1 Failure to follow the specific instructions defined herein pertaining to correct starting procedures may result in re-evaluation of components by independent testing agency selected by engineer at contractors expense. Should results reveal components have not been started in accordance with specified requirements, components may be rejected. If

required, remove components from site and replace. Replacement components shall also be subject to full starting procedures. Using the same procedures specified on the originally installed components.

1.9 TESTING CONDUCTED BY ENGINEER

- .1 The Engineer may select and conduct at random, components to be re-tested.
- .2 Testing of any component by the Engineer does not reduce the Contractors obligations for complete testing and start-up of that component.
- .3 The Engineer will be responsible for the direct costs of any Engineer's testing excepting Contractor's support.
- .4 Contractor will provide, without cost, support for these tests.
- .5 Making all test equipment and instrumentation available to the Engineer.
- .6 Operating appropriate components.
- .7 Any tests duplicated by the Engineer will be conducted under the same terms of reference applied to the Contractor.
- .8 The Contractor can choose to witness any testing conducted by the Engineer.
- .9 Should any component fail under Engineer's testing the Contractor will correct the deficiency and re-test to the satisfaction of the Engineer at the Contractor's expense.

1.10 SPECIALTY AGENT AND TESTING LABORATORIES

- .1 All reports generated by special testing agencies or testing laboratories shall be submitted by the Contractor to the Engineer.
- .2 All agencies and testing laboratories shall be pre-approved by the Engineer and have acceptable facilities and qualifications.

2. PRODUCTS

2.1 CONTRACTOR INSTRUMENTS TESTING

- .1 Provide two-way radios, ladders and other equipment as required to complete the program and as outlined in this Specification.
- .2 Provide all safety equipment required for personnel involved in the starting, testing, adjusting and balancing program.
- .3 Provide a list of equipment and instruments which will be used in starting, testing, and adjusting of electrical equipment for approval and review by the Engineer.
- .4 Use instruments supplied or calibrated by approved laboratory or manufacturer. Show the Engineer the current calibration certificate for each instrument to be used. Provide a copy of the calibration certificates with test reports

3. EXECUTION

3.1 GENERAL

- .1 Contractor and manufacturer startup and proving are to be carried out in accordance with the respective Section.

3.2 COMPONENT VERIFICATIONS

- .1 The component verification forms will be completed by the Contractor as follows:
 - .1 The 'Specified' requirements shall be completed by the Contractor at the shop drawing submission stage.
 - .2 The 'Shop Drawing' information shall be completed by the Contractor at the shop drawing submission stage.
 - .3 The 'Installed' information shall be completed by the Contractor.
- .2 The component verification forms will be provided to the Contractor for information and convenience and will not relieve the Contractor of responsibility for verification of components not included on the verification forms.
- .3 A verification form is to be completed for each component requiring verification.
- .4 Component verification forms will be approved and subject to random verification by the Engineer.

3.3 PERFORMANCE VERIFICATION TESTING

- .1 All Contractor and manufacturer startup and proving tests are to be completed and approved by the Engineer prior to conducting the defined Performance Verification Tests.
- .2 All component verifications shall be completed by the Contractor and approved by the Engineer prior to conducting the defined Performance Verification Test.
- .3 The Contractor will complete the Contractor verification portion of the Performance Verification Test form prior to notifying the Engineer that the components are ready for verification.
- .4 Performance Verification Testing shall be Scheduled and conducted by the Contractor.
- .5 Performance Verification Tests as per the verification forms will be conducted in the presence of the Engineer.

3.4 PERFORMANCE VERIFICATION TEST FORMS

- .1 Refer to Test Forms located in the Electrical Commissioning Forms (Section 26 05 10A).

END OF SECTION

MOULDED CASE CIRCUIT BREAKER COMMISSIONING FORM

Form E-1

Panel ID.: _____
Panel Location: _____
Voltage: _____

	BREAKER TYPE	BREAKER SIZE	BREAKER CURRENT TRIP SETTING (A)	INTERRUPTING CAPACITY (A)	PHASE	CORRECT CIRCUIT (✓)	LABELLED (Lamacoid or Typed Directory)	MEASURED LOAD (kW / kVA)	LOCK DOG (✓)
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									
Breaker #									

REMARKS

(Signature of Contractor)

(Name of Contracting Firm)

(Date)

(Signature of Consultant)

(Name of Consulting Firm)

(Date)

DISCONNECT SWITCH COMMISSIONING FORM

Form E-2

LOCATION	INDOOR / OUTDOOR	SIZE (A)	FUSED (YES/NO)	IDENTIFICATION LAMACOID (✓)	GENERAL CONDITION OF DISCONNECT ASSEMBLY (✓)	3 LOCK LOCKING ABILITY (✓)

REMARKS

(Signature of Contractor)

(Name of Contracting Firm)

(Date)

(Signature of Consultant)

(Name of Consulting Firm)

(Date)

INSULATION RESISTANCE COMMISSIONING FORM

Form E-3

Insulation Resistance (Megger) Test Voltages and Results for Circuits, Feeders and Electrical Equipment:

Maximum Voltage Rating of Equipment	Minimum dc Test Voltage	Minimum Acceptable Insulation Resistance	Recorded Insulation Resistance (MΩ)	Indicate Acceptance with a (✓) Mark

REMARKS

(Signature of Contractor)

(Name of Contracting Firm)

(Date)

(Signature of Consultant)

(Name of Consulting Firm)

(Date)

GROUNDING COMMISSIONING FORM

Form E-4

<u>GROUNDING TEST REVIEW</u>	INDICATE ACCEPTANCE WITH A (✓) MARK		<u>COMMENTS</u>
	CONTRACTOR	CxA	
Perform ground continuity and resistance tests in affected areas including but not limited to: main and sub distribution panels, motors, transformers, control panels, building steel work, VFDs.	()	()	
Perform tests before energizing electrical system	()	()	
Disconnect ground fault indicator during tests	()	()	
Tabulate data and attach to this report	()	()	
Use of a recognized, commercially available ground resistance test operated by trained personnel	()	()	

REMARKS

(Signature of Contractor)

(Name of Contracting Firm)

(Date)

(Signature of Consultant)

(Name of Consulting Firm)

(Date)

MISC. MECHANICAL EQUIPMENT COMMISSIONING FORM

Form E-5

MOTOR NO.	LOCATION	HP/KW PHASE	NAME PLATE FLA	MOTOR ID. (✓)	MOTOR CONTRO L (✓)	BREAKE R SIZE (✓)	O/L SIZE (✓)	RUNNIN G LOAD AMP.

REMARKS

(Signature of Contractor)

(Name of Contracting Firm)

(Date)

(Signature of Consultant)

(Name of Consulting Firm)

(Date)

PANELBOARD COMMISSIONING FORM

Form E-6

Panel ID.:	_____	Fed From:	_____
Panel Location:	_____	Main Breaker Size:	_____
Manufacturer:	_____	No. of Circuits:	_____
Model No.:	_____	Bus Bracing kA:	_____
Volt/Phase/Wire:	_____	Mounting (F/S):	_____
Bus Amp:	_____	Contactor Size:	_____
Feeder Size:	_____	Isolated Ground:	_____

INDICATE ACCEPTANCE
WITH A (✓) MARK

<u>INSTALLATION REVIEW</u>	<u>CONTRACTOR</u>	<u>CxA</u>	<u>COMMENTS</u>
Equipment Conform to Shop Drawings	()	()	
Nameplate Complete	()	()	
Identification Lamicoid	()	()	
Cable and Wiring Identifications	()	()	
Bus Bolts Torqued	()	()	
Breaker Cable Lugs Tightened	()	()	
Breaker Interrupting Capacities	()	()	
Spare Conduit Stub-ups	()	()	
Breaker Lock-On Device*	()	()	
Filler Pieces In Place	()	()	
Door and Key Lock	()	()	
Grounding of Equipment	()	()	
Typewritten Panel Directory Confirmed	()	()	
Condition of Assembly & Paint Finish	()	()	
Equipment Cleanliness	()	()	
Clearance around Equipment	()	()	

POST-ENERGIZATION CHECKS

Voltage Checks

$V_{AN} =$ _____	$V_{BN} =$ _____	$V_{CN} =$ _____
$V_{AB} =$ _____	$V_{BC} =$ _____	$V_{CA} =$ _____

Load Checks

$I_A =$ _____	$I_B =$ _____	$I_C =$ _____
$I_N =$ _____		

Test Results Reviewed () ()

REMARKS

Note: * (1) List Circuit Breaker with Lock-On Device in Remarks

_____ (Signature of Contractor)	_____ (Name of Contracting Firm)	_____ (Date)
------------------------------------	-------------------------------------	-----------------

_____ (Signature of Consultant)	_____ (Name of Consulting Firm)	_____ (Date)
------------------------------------	------------------------------------	-----------------

CONTACTOR COMMISSIONING FORM

Form E-7

Contactor ID.: _____
Location: _____
Manufacturer: _____
Catalogue No.: _____
Volt / Phase: _____
Rating (Amps/Poles): _____
EEMAC Size: _____
EEMAC Enclosure Type: _____

Fed From: _____
Feeder Size: _____
IC Rating (kA): _____
Auxiliary Contacts: _____
Emergency Shutdown
Switch _____
Control xformer Rating: _____

<u>INSTALLATION REVIEW</u>	INDICATE ACCEPTANCE WITH A (✓) MARK		<u>COMMENTS</u>
	CONTRACTOR	CxA	
Equipment Conforms to Shop Drawings	()	()	
Nameplate Complete	()	()	
Identification Lamicoid	()	()	
Cable Phasing Identified Correctly	()	()	
Mounting / Cleanliness	()	()	
Contactors Interrupting Capacity OK.	()	()	
Lockable Enclosure	()	()	
Emergency Shutdown Switch Operation	()	()	
Contactors Operation	()	()	

REMARKS

_____ (Signature of Contractor)	_____ (Name of Contracting Firm)	_____ (Date)
_____ (Signature of Consultant)	_____ (Name of Consulting Firm)	_____ (Date)

VARIABLE FREQUENCY DRIVE (VFD) COMMISSIONING FORM

Form E-8

Unit ID.: _____
Location: _____
Manufacturer: _____
Serial No.: _____
AC Input Voltage: _____
DC Bus Voltage: _____
Output Ratings: _____
Current draw at maximum speed _____
Ambient conditions: _____
All programmable settings: _____

INDICATE ACCEPTANCE
WITH A (✓) MARK

INSTALLATION REVIEW

CONTRACTOR CxA

COMMENTS

Confirms to Shop Drawings	()	()
Nameplate Complete	()	()
Identification Lamacoid	()	()
Condition of Wiring and Cable	()	()
Condition of Assembly & Paint Finish	()	()
Grounding of Equipment	()	()
Equipment Cleanliness	()	()
VFD Bypass function test	()	()
VFD operation under emergency power test	()	()
Coordinate with mechanical contractor (Div.23) & control contractor (Div. 25) to confirm sequence controls, interlocking with other equipment, control devices and operate as required	()	()

TEST RESULTS

Displacement Power Factor = _____

Note: Attach manufacturer's start-up test/commissioning report.

REMARKS

(Signature of Contractor)

(Name of Contracting Firm)

(Date)

(Signature of Consultant)

(Name of Consulting Firm)

(Date)

1. GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for wire and box connectors.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65-93(R1999), Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Divert unused wiring materials from landfill to metal recycling facility as approved by Engineer Consultant.

2. PRODUCTS

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 NEMA to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors bar.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
 - .5 Sized for conductors as indicated.

- .4 Clamps or connectors for armoured cable, flexible conduit, as required to:
CAN/CSA-C22.2No.18.

3. EXECUTION

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.
 - .2 Install fixture type connectors and tighten. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2 NEMA.

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 REFERENCES

- .1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.

1.3 PRODUCT DATA

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

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

2. PRODUCTS

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.
- .3 VFD cables: size as indicated, with 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RA90; 3 stranded tinned copper circuit conductors plus (3) symmetrical bare copper ground wires; two spiral copper tape shields providing 100% coverage. VFD cables shall be used between VFDs and pumps P-25 & P-26.

3. EXECUTION

3.1 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34.

END OF SECTION

1. GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for connectors and terminations.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No. 65-03. Wire Connectors.
 - .2 CSA C22.2 No.41-M1987(R1999), Grounding and Bonding Equipment.

1.4 PRODUCT DATA

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

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Engineer.

2. PRODUCTS

2.1 CONNECTORS AND TERMINATIONS

- .1 Copper compression connectors to CSA C22.2No.65-03 as required sized for conductors.

3. EXECUTION

3.1 INSTALLATION

- .1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2 Bond and ground as required to CSA C22.2No.41.

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - Electrical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

2. PRODUCTS

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2 Grounding conductors: bare stranded copper, tinned, soft annealed, size as required by code.
- .3 Insulated grounding conductors: green.
- .4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.

3. EXECUTION

3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.

- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.
- .6 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .7 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .8 Connect building structural steel and metal siding to ground by welding copper to steel.
- .9 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end and load end.
- .10 Ground secondary service pedestals.
- .11 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.2 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral of secondary 600V system.

3.3 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, switchgear, duct systems, frames of motors, motor control centres, Variable Frequency Drive Cabinets, starters, control panels, building steel work, distribution panels.

3.4 GROUNDING BUS

- .1 Ground items of electrical equipment in electrical room to existing ground bus with individual bare stranded copper connections size 2/0AWG.

3.5 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

END OF SECTION

1. GENERAL

1.1 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

2. PRODUCTS

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted.

3. EXECUTION

3.1 INSTALLATION

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .6 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels at 3000mm on centre spacing.

- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

1. GENERAL

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

2. PRODUCTS

2.1 JUNCTION AND PULL BOXES

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

3. EXECUTION

3.1 JUNCTION AND PULL BOXES INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.2 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name voltage and phase.

END OF SECTION

1. GENERAL

1.1 REFERENCES

- .1 CSA C22.1-2009, Canadian Electrical Code, Part 1.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

2. PRODUCTS

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

2.3 CONDUIT BOXES

- .1 Cast FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.4 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.5 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

- .4 Double locknuts and insulated bushings on sheet metal boxes.

3. EXECUTION

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

1. GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA C22.2 No. 18-98, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
 - .2 CSA C22.2 No. 56-1977(R1999), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .3 CSA C22.2 No. 83-M1985(R1999), Electrical Metallic Tubing.
 - .4 CSA C22.2 No. 211.2-M1984(R1999), Rigid PVC (Unplasticized) Conduit.
 - .5 CAN/CSA C22.2 No. 227.3-M91(R1999), Flexible Nonmetallic Tubing.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Place materials defined as hazardous or toxic waste in designated containers.
- .2 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

2. PRODUCTS

2.1 CONDUITS

- .1 Rigid galvanized steel threaded conduit: to CSA C22.2 No. 45.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83.
- .3 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .4 Flexible metal conduit: to CSA C22.2 No. 56, steel aluminum liquid-tight flexible metal.
- .5 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits NPS 2 50 mm. Two hole steel straps for conduits larger than NPS 2 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 3000mm oc.
- .4 Threaded rods, 6 mm dia., to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90E bends are required for NPS 1 25 mm and larger conduits.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- .1 Polypropylene.

3. EXECUTION

3.1 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms in unfinished areas.
- .3 Surface mount conduits except as indicated on the drawing.
- .4 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.
- .5 Use rigid metal conduit where subject to mechanical injury.
- .6 Use rigid PVC conduit underground in corrosive areas.
- .7 Use flexible metal conduit for connection to motors in dry areas connection to recessed incandescent fixtures without a prewired outlet box connection to surface or recessed fluorescent fixtures work in movable metal partitions.
- .8 Minimum conduit size for lighting and power circuits: NPS 3/4 19 mm.
- .9 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Mechanically bend steel conduit over 19 mm dia.
- .11 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

- .12 Install fish cord in empty conduits.
- .13 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.

3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.3 CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

END OF SECTION

1. GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 Common Work Results – For Electrical.

1.2 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No.29-11, Panelboards and Enclosed Panelboards.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for panelboards and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Alberta of Canada.
 - .2 Include on drawings:
 - .1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 23 – Operation and Maintenance Data and Manuals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
 - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect panelboards from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1 PANELBOARD

- .1 Existing panelboard to be used to add new circuit breakers.

2.2 BREAKERS

- .1 Add new breakers to match existing breakers in the panelboard.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to Departmental Representative.

2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

3. EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for new breaker installations in existing panelboard in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install new breakers in existing panelboard as indicated.
- .2 Connect loads to circuits.
- .3 Connect neutral conductors to common neutral bus with respective neutral identified.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by new breaker installations.

END OF SECTION

1. GENERAL

1.1 SECTION INCLUDES

- .1 Materials and installation for non-fused disconnect switches.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 35 26 – Governmental Safety Requirements.
- .3 Section 26 05 00 – Common Work Results - Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.
 - .2 CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

1.4 SUBMITTALS

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

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 26 – Governmental Safety Requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

2. PRODUCTS

2.1 DISCONNECT SWITCHES

- .1 Non-fusible, horsepower rated disconnect switch in CSA Enclosure, to CAN/CSA C22.2 No.4 size as required.

- .2 Provision for padlocking in on-off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

3. EXECUTION

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-2002, Part 4: Contactors and motor-starters.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 23 – Operation and Maintenance Data and Manuals.
- .2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 23 – Operation and Maintenance Data and Manuals.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contact, auxiliary.
 - .4 1 control transformer.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Place materials defined as hazardous or toxic waste in designated containers.

- .2 Ensure emptied containers are sealed and stored safely for disposal away from children.

2. PRODUCTS

2.1 MATERIALS

- .1 Starters: to IEC 947-4 with AC4 utilization category.

2.2 MANUAL MOTOR STARTERS

- .1 Single /Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One /Three overload heater s, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 Toggle switch pushbutton: heavy duty labelled as indicated.
 - .2 Indicating light: heavy duty type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

2.4 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results - Electrical.

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

3. EXECUTION

3.1 INSTALLATION

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct overload devices elements installed.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and manufacturer's instructions.
- .2 Operate switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 National Electrical Manufacturers Association (NEMA) MG1, Part 30
- .2 National Electrical Manufacturers Association (NEMA) NEMA MG1, Part 31
- .3 IEEE-519-1992 – IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.
- .4 Canadian Standards Association (CSA) 22.2, current edition.
- .5 UL508C – Standard for Safety for Power Conversion Equipment.

1.3 SCOPE OF WORK

- .1 Install standalone VFD cabinets adjacent to pumps P-25 & P-26 as indicated on the electrical drawing. VFDs shall have the capability to be bypassed and to be taken out completely for service without affecting motor running on that branch at full voltage full speed output.
- .2 One VFD will control one pump.
- .3 Coordinate VFD's commissioning (start-up) with mechanical contractor (Div.23) and control contractor (Div.25) who will provide the control sequence of operations.
- .4 Provide on-site commissioning (start-up) of the Variable Frequency Drive(s) by factory trained service personnel. Adequate time must be allowed to thoroughly and safely start, program, and test run the VFD with the building management system. A separate site visit to be provided for training of operation and maintenance personnel.

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 All bid submittals must include the following:
 - .1 A detailed description of all components in the VFD package, including line and load reactor impedance ratings and/or filter design type, VFD current, HP, and voltage rating.
 - .2 A list of any exceptions to this specification.
- .3 All submittals shall include the following and approvals must be received prior to delivery of any goods:
 - .1 Schematic wiring diagrams showing all VFD package component connections and all serial, digital and analog inputs and outputs to be connected to the control system.

- .2 Mechanical dimensional drawings including VFD cabinet dimensions with mounting details.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide full commissioning report documenting all programmable settings, AC input voltage, DC Bus voltage, current draw at maximum speed, and a description of ambient conditions.
- .2 Provide operation and maintenance data for each VFD installed for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .3 Provide one 8.5"x11" wiring diagram for each VFD installed.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal, and with the Waste Reduction Work plan.
- .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.

Part 2 Products

2.1 GENERAL DESIGN CHARACTERISTICS

- .1 The VFD shall be of the Pulse Width Modulated (PWM) drive with minimum 6-pulse rectifier front-end c/w passive harmonic filters.
- .2 The VFD shall be rated for variable torque applications, with an overload rating of 110% for 60 seconds Variable Torque (VT) and an overload rating of 150% for 60 seconds Constant Torque (CT).
- .3 All VFD's shall be factory UL/cUL Listed.
- .4 All packaged drive systems shall be CSA Listed.
- .5 The VFD shall have the capability of operating multiple motors. The minimum VFD continuous current rating shall be the sum of the full load current ratings of the connected motors.
- .6 The VFD shall have a minimum displacement power factor of 0.96 or higher at all output frequencies.
- .7 The VFD and options (e.g. line and load reactors, filters, etc) must be supplied as part of the VFD cabinet assembly.
- .8 The VFD manufacturer shall have a minimum of ten years experience in the Canadian Market.

- .9 Warranty of the VFD System shall be for 12 months from the date of start-up or 18 months from date of delivery, whichever is sooner. The warranty shall include all parts and repair labor.

2.2 STANDARD VFD DESIGN FEATURES

- .1 Keypad Display: A digital LCD keypad shall be provided for input of parameter settings and operating commands. The digital display shall indicate operating data such as output frequency, motor RPM, output current, power, I/O status etc as well as fault history information, Status information and real time warning alarms. The keypad shall be able to Upload & Download parameter sets between individual VFD's and also be able to store up to three (3) individual parameter sets. Also available is the capability to upload & Download parameter sets without applying 600V power to the VFD.
- .2 Digital Inputs: The VFD shall include a minimum of ten (10) programmable digital inputs.
- .3 Motor Winding Thermistor Input: The VFD shall accept a direct PTC thermistor input without the need for additional relays.
- .4 Analog Inputs: The VFD shall accept an analog speed reference input signal of 0-5Vdc, 0-10 Vdc, and/or 4-20 mA). If both inputs are active, the 0-10Vdc or 4-20mA signals shall be selectable by a digital input.
- .5 Relay Outputs: The VFD shall include two (2) Form C relay outputs which are fully programmable as to function e.g. Run, At Speed, Fault.
- .6 Analog Output: The VFD shall provide two (2) programmable analog output signals (0-10 Vdc and 4-20mA) proportional to e.g. Output frequency, Output current, Power etc.
- .7 RS485 Network Communication: The VFD shall include Terminals for RS485 network communication and include Modbus RTU protocol as standard. Also available are protocols for FLN/P1; Metasys N2, BACnet and Lon Works networks
- .8 Auto Restart after Power Loss: The VFD shall have the capability to automatically restart the motor after an interruption of input power with programmable Coast Time and Cushion Time.
- .9 Auto Restart after Fault Trip: The VFD shall have the capability to automatically restart the motor after a fault trip and complete with a programmable number of allowed restarts and the time delay between restarts. Also programmable, are the types of fault trips for which a restart is allowed.
- .10 Start Into a Spinning Motor: The VFD shall be capable of starting into spinning motor without fault.
- .11 Soft PWM Control: The carrier frequency shall be continuously modulated to eliminate metallic motor noise without requirement to de-rate the VFD.
- .12 Energy Savings: The VFD shall include Optimum Excitation Control to further reduce energy consumption by optimizing the motor flux continuously and automatically at all speed and load points.

- .13 Fault Log: A fault log will record the details of the last 8 faults including mode, frequency, current, voltage and run time.
- .14 Safety Interlocks: Terminals to be provided for connection of safety interlocks such as Fire-stat and Freeze-stat. These interlocks shall shutdown operation in either the Drive or Bypass operating modes.
- .15 Critical Frequency Rejection the VFD shall have a minimum of (3) selectable frequency jump points, with programmable bandwidth, used to avoid critical resonance of the mechanical system.
- .16 Acceleration/Deceleration Control: The VFD shall provide independent programmable settings for accel / decel time (0-999 seconds). The VFD shall also include a setting to allow the motor to coast to a stop.
- .17 Min/Max Speed: Minimum and maximum speed settings shall be adjustable from 0 - 100%.
- .18 RJ45 Serial Port Interface: A Serial Port (RJ45) for Blue Tooth or connection option is to be provided for PC based configuration software and for "real time" monitoring and diagnostics.
- .19 Adjustable Torque/Current Limit: To allow the limiting of torque and/or current to match motor and load characteristics to the VFD capabilities.

2.3 OUTPUT RATINGS

- .1 The VFD shall operate within the following rated values.
 - .1 Output Frequency Range: 0.1 to 400 Hz.
 - .2 Overload Rating: VT – 110% for 60 seconds
CT – 150% for 60 seconds.

2.4 INPUT POWER

- .1 Voltage: 3 phase + ground 600V +10% / -20%
- .2 Frequency: 48-62 Hz

2.5 ENVIRONMENTAL RATINGS

- .1 The VFD shall operate within the following parameters without the need for derating:
 - .1 Temperature: -10 to 50 degrees C.
 - .2 Humidity: 20 - 90% RH non-condensing.
 - .3 Altitude: up to 1,200 meters.
 - .4 Vibration of 0.2 G or less.
- .2 Enclosures: Standard enclosures to be NEMA 12 design.

2.6 PROTECTIVE FEATURES

- .1 The VFD shall be designed to include the following protective functions and display for maintainability:

- .1 Instantaneous Over Current Protection: The VFD output shall be turned off if the operating current exceeds the specified level.
- .2 Motor Overload Protection: cUL/CSA approved electronic thermal overload protection.
- .3 External Trip Input: Programmable for either N/O or N/C operation.
- .4 Over Voltage Protection: The VFD output shall turn off if the DC Bus voltage exceeds the specified level.
- .5 Ground Fault Protection: The VFD output shall turn off in the event of a ground fault.
- .6 Line or Load Phase Loss Protection: Programmable for enable - disable
- .7 Software Lock: The VFD shall include a software function that prevents changes to the user-defined settings.
- .8 CPU or EEPROM Error: The VFD output shall be turned off in the event of an error in the CPU or EEPROM.

2.7 INPUT & OUTPUT FILTERING

- .1 All VFD's shall be furnished with the following protective devices as a minimum:
A 3% impedance Reactor for the line side of the drive;
A 3% impedance Reactor for the load side of the drive.

2.8 EXTRA VFD FEATURES

- .1 Provide Door-interlocked, Lockable and Circuit Breaker.
- .2 Provide 120 VAC control power transformer, fused in both primary and secondary
- .3 Provide filtered cooling fans and vents to maintain adequate cabinet cooling.
- .4 All power and control wiring shall be wired out to terminal blocks for customer connection.
- .5 VFD keypad shall be mounted on enclosure door for ease of access for monitoring and programming.

2.9 HARMONICS

- .1 Harmonic Passive Filter(s) are required for each VFD to meet IEEE-519-1992 harmonic guidelines.
- .2 Point of Common Coupling (PCC) is to be the line side of the VFD.
- .3 Level of Total Harmonic Distortion (THD) at PCC point is to be 5% or lower.

2.10 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results - Electrical.

2.11 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

Part 3 Execution

3.1 INSTALLATION

- .1 Install new VFDs as specified. Control is by control contractor (Div.25), conduits and wiring are by electrical contractor (Div.26).
- .2 Install VFD cables between VFDs and motors with CSA type RA90 VFD cables suitable for VFD applications along with connectors suitable for VFD cables. VFD cables are in accordance with Section 26 05 21 – Wires and Cables (0 ~ 1000V).
- .3 Ensure correct fuses and overload devices elements installed.
- .4 Adjust circuit breakers' trip unit to suit motor over current protection requirements.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results – Electrical, manufacturer's instructions and as specified herein.
- .2 Commissioning VFD per scope of work; operate VFDs to verify correct control functioning per control contractor (Div. 25).
- .3 Check that sequence controls, interlocking with other equipment and control devices operate as required.

END OF SECTION