



Saint Catherine of Siena Catholic School Glycol Boiler to Heat Exchanger Replacement Project Specifications



**DURHAM CATHOLIC
DISTRICT SCHOOL BOARD**
Learning and Living in Faith

Prepared For	Durham Catholic District School Board (DCDSB)
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DISCIPLINE	SEAL AND SIGNATURE
<p>MECHANICAL</p> <p>This seal governs all Documents and Sections of these Specification</p>	
<p>ELECTRICAL</p> <p>This seal governs all Documents and Sections of these Specification</p>	



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1 GENERAL

1.1 DESCRIPTION OF WORK

- .1 The project scope consists of the replacement of the existing Boiler to heat exchanger and new pumps, replacement of pumps and expansion tanks, and various BAS upgrades, as outlined in the drawings and specifications.
- .2 Drain, flush, clean and refill hydronic systems, both water and glycol, within the boiler room and up to the isolation valves. Verify glycol concentration after refill."
 - .1 Once system is clean and water quality is adequate, add inhibitors as required.
 - .2 See specifications Section 23 08 16 and Section 23 25 00 for detailed requirements.
- .3 General Contractor (or Prime Contractor) shall assume all responsibility for coordination of work with all sub-trades, equipment suppliers and specialized personnel.
- .4 General Contractor shall be solely responsible for division of the work and scope of material/equipment supply between sub-trades. The intent of the drawings and specification is not to define responsibilities between the trades.
- .5 Contractor shall be responsible for all delivery and moving costs as required to place equipment and materials in proposed locations.
- .6 Contractor shall retain qualified base building vendors. Obtain contact details for each vendor from Owner's Representative, if not listed below. Base building vendors shall include:
 - .1 Building Automation System (BAS)/Controls Contractor
[Automated Logic](#)
[Wajiha Akbar](#)
O: 905-660-0878
M: 416-528-7803
E: wajiha.akbar@carrier.com
 - .2 All roof work must be completed by roofing contractors that are on the DCDSB's prequalified roofing contractor list.
[Semple Gooder Roofing Corporation](#)
[Mark Baxter](#)
M: 416-997-0732
E: mbaxter@semplegooder.com
- .7 Furnish TWO (2) year warranty for all labour and materials as per contract documents.
- .8 Start, test, adjust and troubleshoot all systems prior to demonstration. Demonstrate operation and commission all systems in presence of Consultant and Owner's Representative. Provide all the required labour and materials to complete a demonstration of each system's operation.
- .9 Provide 3-part (seal, primer, epoxy) epoxy system on all floors within mechanical room and mechanical room vestibule including 300mm of all vertical walls. Protect flooring during installation work, repair damage prior to substantial completion.
- .10 Contractor to include application to TSSA for the removal of the existing boilers. All work shall be done by contractors, G1 licensed gas fitter. From attached for reference, section 23 52 00.01.
- .11 Start up, test, adjust and balance all systems.
- .12 All work as per drawings, specifications, and front-end documents.



1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit Project construction progress schedule in accordance with Section 01 32 16.16 - Construction Progress Schedule - Critical Path Method (CPM) or 01 32 16.19 - Construction Progress Schedule - Bar (GANNT) Chart.
- .3 Submit site-specific and Work Plan Health and Safety Planning accordance with Section 01 35 29.06 - Health and Safety Requirements .

1.3 WORK SEQUENCING

- .1 Construct Work in stages to accommodate Owner's use of premises during construction.
- .2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction.
- .3 Required stages:
 - .1 Demolition and preparatory work
 - .2 Installation of new systems
- .4 Maintain fire access/control and means of egress at all times.
- .5 Protect workers and public safety.

1.4 CONTRACTOR USE OF PREMISES

- .1 Unless otherwise noted, work areas shall be limited to the areas identified on the drawings.
- .2 Limit use of premises for Work, storage and for access to allow:
 - .1 Owner occupancy.
 - .2 Partial owner occupancy.
 - .3 Work by other contractors.
 - .4 Public usage.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .4 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .5 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Consultant .
- .6 Ensure that operations conditions of exiting work at completion are still the same, equal to or better than that which existed before new work started.
- .7 Provide hoarding protection of the areas adjacent to construction areas from dust and construction debris. Protections shall by means of fire rated plywood sealed to ensure leak tight construction or fire retardant tarp (Griffolyn or equivalent).
- .8 Contractor shall ensure that all tools and materials are safely secured or stored and do not pose site safety hazard.
- .9 All materials, construction waste, temporary construction facilities are only permitted in locations designated by General or Prime Contractor. Such location shall be approved by the Owner prior to Contractor Mobilization. Contractor shall incur all costs of temporary equipment/materials storage off site if site condition do not permit storage on site.
- .10 Submit Methods of Procedure (MOP) document outlining sequence of work, list of



personnel, their contact details for all critical work including hoarding, connection to existing mechanical/electrical services, system drain and refill, welding, hot work, after hours work, x-ray of building assemblies, temporary provisions, systems shut down and star-up, etc.

- .11 No smoking allowed on premises.
- .12 Contractor and their sub-trades shall comply with Public Health and Owner's Covid-19 protocols.
- .13 Existing facilities including walkways, parking, public corridors, loading dock, elevating devices, washrooms shall remain in use at all times during the project.

1.5 OWNER OCCUPANCY

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.7 PRE-PURCHASED EQUIPMENT

- .1 N/A, all equipment and materials supplied by contractor.

1.8 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

- .1 Execute work with least possible interference or disturbance to building operations, occupants, public and normal use of premises.
- .2 Use only elevators or stairwells approved by Owner's Representative for moving workers and materials. Contractor shall be responsible for protection of all finishes and incur all costs associated with repair of the damages. Contractor shall carry out survey of the existing route and equipment prior to moving and submit photos of the existing damages to Consultant and Owner's Representative. Otherwise, all damages will be deemed to be result of this work and responsibility of the contractor.
 - .1 Investigate the status of existing elevators, dumbwaiters, conveyors or escalators in building(s), if they are functional and safe for moving workers and materials before the Work starts.
 - .2 Provide the required protection for passenger elevators walls, obtain Consultant approval before using these elevators.
 - .3 Accept liability for damage, safety of equipment and overloading of existing equipment.

1.9 EXISTING SERVICES

- .1 Notify Consultant and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, provide Consultant and Owner's Representative minimum 5 working days notice for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to pedestrian, vehicular traffic and facility operations.
- .3 Provide alternative routes for personnel, pedestrian and vehicular traffic.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Consultant of findings.



- .5 Submit schedule for approval by Consultant and Owner's Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide temporary services, when directed by Consultant to maintain critical building and tenant services.
- .7 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .10 Record locations of maintained, re-routed and abandoned service lines. These observations shall be captured on project record drawings and included in Closeout Manuals.
- .11 Construct barriers, as required, in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.10 DOCUMENTS REQUIRED

- .1 Maintain at job site, one copy of each document as follows:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Reviewed Shop Drawings.
 - .5 List of Outstanding Shop Drawings.
 - .6 Change Orders.
 - .7 Other Modifications to Contract.
 - .8 Field Test Reports.
 - .9 Copy of Approved Work Schedule.
 - .10 Health and Safety Plan and Other Safety Related Documents.
 - .11 Other documents as specified.

1.11 PROJECT WARRANTY

- .1 Unless specified elsewhere in specifications to furnish extended warranty for specific equipment or components, all labour and materials shall be warranties for period of **(2) years** from the date of substantial performance.
- .2 Warranty certificates shall be submitted to Owner and shall include project name/address, warranty period/duration, warranty start date and authorized signature/seal of the company issuing warranty.

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 ACCESS AND EGRESS

- .1 Maintain means of egress in accordance with relevant municipal, provincial and other regulations.

1.2 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Owner's Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work, provide temporary means to maintain security.
- .4 Closures: protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

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

1.4 EXISTING SERVICES

- .1 Notify Owner's Representative, Consultant and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, provide a minimum (5) business days notice for necessary interruption of mechanical or electrical services throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
- .3 Provide for personnel, pedestrian and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.5 SPECIAL REQUIREMENTS

- .1 Carry out noise generating Work Monday to Friday from 18:00 to 06:00 hours and on Saturdays, Sundays, and statutory holidays unless otherwise noted. Owner's requirements, if more stringent, shall precede and be adhered to.
- .2 Submit schedule in accordance with 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
- .3 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .4 Keep within limits of work and avenues of ingress and egress.
- .5 Contractor shall coordinate with Owner's Representative designated area for parking, storage of materials and machinery during construction.
- .6 Deliver materials outside of peak traffic hours unless otherwise approved by Owner's Representative.



1.6 SECURITY

.1 N/A.

1.7 BUILDING SMOKING ENVIRONMENT

.1 Smoking is not permitted on premises.

1.8 OTHER RESTRICTIONS

.1 Refer to Front End and Supplementary documents for other Owner's directives.

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 REFERENCE STANDARDS

- .1 Canadian Construction Documents Committee (CCDC)
 - .1 CCDC 2 - 2020, Stipulated Price Contract.
- .2 Project Supplementary Conditions

1.2 CASH ALLOWANCES

- .1 Refer to CCDC 2, GC 4.1.
- .2 Include in Contract Price specified cash allowances.
- .3 Cash allowances, unless otherwise specified, cover net cost to Contractor of services, products, construction machinery and equipment, freight, handling, unloading, storage and other authorized expenses incurred in performing Work.
- .4 Contract Price, and not cash allowance, includes Contractor's overhead and profit in connection with such cash allowance.
- .5 Contract Price will be adjusted by written order to provide for excess or deficit to each cash allowance.
- .6 Where costs under a cash allowance exceed amount of allowance, Contractor will be compensated for excess incurred and substantiated plus allowance for overhead and profit as set out in Contract Documents.
- .7 Include progress payments on accounts of work authorized under cash allowances in Consultant's monthly certificate for payment.
- .8 Prepare schedule jointly with Consultant and Contractor to show when items called for under cash allowances must be authorized by Consultant for ordering purposes so that progress of Work will not be delayed.
- .9 List the amount of each allowance, for each work specified in each respective specification Section as follows:
 - .1 N/A

1.3 CONTINGENCY ALLOWANCE – N/A

- .1 Refer to CCDC 2, GC 4.2.
- .2 Include in Contract Price contingency allowance of \$0.
- .3 Do not include in Contract Price, additional contingency allowances for products, installation, overhead or profit.
- .4 Expenditures under contingency allowance will be authorized in accordance with procedures provided in CCDC 2, GC 6.1 - Changes CCDC 2, 6.2 Change Order and CCDC 2, 6.3 Change Directive.

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 ADMINISTRATIVE

- .1 Schedule and administer regular project meetings throughout the progress of the work at periodic intervals specified in this section or at the call of Owner's Representative or Consultant.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting (4) days in advance of meeting date to Owner's representative and Consultant.
- .4 Provide physical space and make arrangements for meetings.
- .5 General (or Prime) Contractor and their sub-trades shall be available at all meetings.
- .6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7 Reproduce and distribute copies of minutes within (3) days after meetings and transmit to meeting participants and affected parties not in attendance.
- .8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.
- .9 Coordinate construction meetings with other third parties which may be engaged directly by Owner including Commissioning Authority, Environmental Consultant, Quality Assurance, etc.

1.2 PRECONSTRUCTION MEETING

- .1 Within (15) days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Senior representatives Owner, Consultant, Contractor, major Subcontractors, field inspectors and supervisors shall be in attendance.
- .3 Establish time and location of meeting and notify parties concerned minimum (5) days before meeting.
- .4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
- .5 Agenda to include:
 - .1 Appointment of official representative of participants in the Work.
 - .2 Schedule of Work: in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
 - .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
 - .5 Delivery schedule of specified equipment in accordance with Owner's Requirements.
 - .6 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
 - .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
 - .8 Health and Safety.



- .9 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .10 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .11 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
- .12 Monthly progress claims, administrative procedures, photographs, hold backs.
- .13 Appointment of inspection and testing agencies or firms.
- .14 Insurances, transcript of policies.
- .15 Approvals AHJ including permitting, status of inspections/permits, infractions, follow-up visits.

1.3 PROGRESS MEETINGS

- .1 During course of Work and (2) weeks prior to project completion, schedule progress meetings on bi-weekly basis.
- .2 Contractor, major Subcontractors involved in Work, Owner's Representative, Consultant, Commissioning Authority, Quality Assurance personnel are to be in attendance.
- .3 Notify parties minimum (4) days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within (2) days after meeting.
- .5 Agenda to include the following:
 - .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Field observations, problems, conflicts.
 - .4 Problems which impede construction schedule.
 - .5 Review of off-site fabrication delivery schedules.
 - .6 Corrective measures and procedures to regain projected schedule.
 - .7 Revision to construction schedule.
 - .8 Progress schedule, during succeeding work period including detailed 2-week look ahead.
 - .9 Review submittal schedules: expedite as required.
 - .10 Review of the status and response to documentation including RFI's, CCN's or Site Instructions (SI's).
 - .10 Maintenance of quality standards.
 - .11 Review proposed changes for affect on construction schedule and on completion date.
 - .12 Review of critical work including services shut downs, status of Methods of Procedures (MOP) and approval by the team, Owner's approval of shut downs.
 - .12 Commissioning – progress, noted issues and status (Issues Log) and 2-week look ahead at expected commissioning milestones.
 - .12 New business.



2 PRODUCTS

2.1 NOT USED

.1 Not Used.

3EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION



1 GENERAL

1.1 DEFINITIONS

- .1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.
- .2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.
- .3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.
- .4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.
- .5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.
- .6 Master Plan: summary-level schedule that identifies major activities and key milestones.
- .7 Milestone: significant event in project, usually completion of major deliverable.
- .8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.

1.2 REQUIREMENTS

- .1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.
- .2 Plan to complete Work in accordance with prescribed milestones and time frame.
- .3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.
- .4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit to Owner's Representative and Consultant within 10 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.
- .3 Submit Project Schedule to Owner's Representative and Consultant within 5 working days of receipt of acceptance of Master Plan.



1.4 MASTER PLAN

- .1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).
- .2 Owner's Representative and Consultant will review and return revised schedules within 5 working days.
- .3 Revise impractical schedule and resubmit within 5 working days.
- .4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

1.5 PROJECT SCHEDULE

- .1 Develop detailed Project Schedule derived from Master Plan.
- .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows (as applicable to the project):
 - .1 Project Award.
 - .2 Shop Drawings, Samples.
 - .3 Permits.
 - .4 Mobilization.
 - .5 Excavation.
 - .6 Backfill.
 - .7 Building footings.
 - .8 Slab on grade.
 - .9 Structural Steel.
 - .10 Siding and Roofing.
 - .11 Interior Architecture (Walls, Floors and Ceiling).
 - .12 Plumbing.
 - .13 Lighting.
 - .14 Electrical.
 - .15 Piping.
 - .16 Controls.
 - .17 Heating, Ventilating, and Air Conditioning.
 - .18 Millwork.
 - .19 Fire Protection Systems.
 - .20 Fire Alarm and Life Safety Systems.
 - .21 Equipment Delivery.
 - .22 Equipment Start-up.
 - .23 Testing and Commissioning.
 - .24 Engineer supplied equipment required dates.
 - .25 Deficiency Review and Correction.
 - .26 Training.
 - .27 Closeout.
 - .28 Warranty Phase Inspection.



1.6 PROJECT SCHEDULE REPORTING

- .1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress and submit to Owner's Representative and Consultant.
- .2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

1.7 PROJECT MEETINGS

- .1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.
- .2 Weather related delays with their remedial measures will be discussed and negotiated.

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 ADMINISTRATIVE REQUIREMENTS

- .1 Submit to Consultant submittals as required per contract documents. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by submittal until review is complete and submittals are accepted by Consultant.
- .3 Present shop drawings, product data, samples and mock-ups in SI Metric units.
- .4 Where items or information is not produced in SI Metric units, converted values are acceptable.
- .5 Review submittals before submission to Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Keep one reviewed copy of each submission on site.
- .7 Verify site measurements and affected adjacent Work are coordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.
- .9 Deviations
 - .1 Notify Consultant, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations. Deviations are subject to Consultant's review and approval. Contractor shall ultimately be responsible for meeting performance requirements in every aspect including equipment construction, operation, capacity/performance, turndown/low load operation, efficiency across range of operation, finishes/colors, lead times, warranty, service department representation and local parts availability, standards compliance and listings/approvals.
 - .2 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant's review.
- .10 Contractors Review and Responsibility
 - .1 Submittals which have not been reviewed, coordinated, and verified by Contractor will be rejected.
 - .2 Contractor or manufacturer's representative shall be responsible for field take offs as required to prepare calculations and properly size systems (eg. venting system, heat tracing) prior to preparation of the submittal.
 - .3 Contractor shall advise Consultant in writing of changes to submittals. Consultant's review of the submittals shall not relieve Contractor of responsibility for changes made without written review and approval of these changes by Consultant.
 - .4 Elements of the design have been carefully coordinated between various Engineering disciplines. Contractor shall be solely responsible for all provisions including all material, labour, engineering, approvals associated with provision of alternate equipment or any deviations in the submittal including electrical/power, structural, acoustic and architectural work.



- .11 Consultant's Review and Responsibility
 - .1 Consultant's review of the submittals is for the sole purpose of ascertaining compliance with the general design intent and concepts. This review does not imply Consultant's approval of the detailed design presented in the submittals; responsibility for compliance with all details of the contract documents shall remain with the Contractor.
 - .2 Consultant's review shall not relieve the Contractor of responsibility for errors or omissions in the submittals or responsibility for complying with the contract document requirements.
 - .3 As part of consulting scope of services, Consultant is not to review submittals more than twice. Should three or more reviews of the submittals be required due to Contractor's omissions, Contractor shall be responsible for reimbursing Consultant for time associated with additional review(s). Additional efforts shall be invoiced to Owner and deducted from the Contractors contract amount. Additional administrative efforts incurred by Owner's department shall also be deducted from Contractor's contract amount.
- .12 Engineered Submittals
 - .1 Submittals for engineered systems (venting system, fire protection, thermal expansion, heat tracing, etc) shall be sealed by professional Engineer licensed in Ontario, with a minimum professional liability insurance as required by the Contract documents.
 - .2 Engineered design shall meet or exceed regulatory requirements, standards, codes.
 - .3 Field measurements and take offs shall be completed by Engineer preparing submittals as required to familiarize with the spatial constraints, site conditions and carry out engineered calculations.
 - .4 Calculations shall be completed in accordance with good engineering practice and have all pertinent assumptions, details, take-offs, measurements, etc. so that they can be easily reviewed and interpreted by third parties.
 - .5 Engineer involved in preparation of the submittals shall complete periodic reviews to witness erection, fabrication, installation, testing of the related systems and components. Field review reports shall be provided following each visit and Engineer shall be responsible for communicating noted deficiencies and concerns noted during field reviews. Field review shall be completed at reasonable intervals to assess workmanship and quality of the installation. Engineer responsible for preparation of the submittals shall provide final report and certificate of conformance following final inspection, asserting that installation meets design intent and to satisfaction of Authorities Having Jurisdiction.
 - .6 Costs for all reviews, reports and certificates shall be included in the contract price.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.



- .3 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 coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to Contract drawings and specifications. Submittals must clearly indicate proposed equipment model, options, accessories and other specific particular in clear manner such arrows, circling or highlighting of such; generic submittals will returned to the contractor.
- .4 Allow minimum 3 days for Consultant's review of each submission.
- .5 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.
- .6 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.
- .7 Accompany submissions with transmittal letter, in duplicate, 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.
- .8 Submissions to include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of site measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified site dimensions and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics, including part load operational data.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.



- .10 Relationship to adjacent work.
- .11 Operating and maintenance information.
- .12 Acoustical and sound power data.
- .13 Certification of compliance to applicable codes and product listings
- .6 All products shall be certified and listed for installation in Canada. Submittals must clearly demonstrate compliance, standards and listings as specified in equipment specifications.
- .9 After Consultant's review, distribute copies.
- .10 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Consultant may reasonably request.
- .11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Consultant where shop drawings will not be prepared due to standardized manufacture of product.
- .12 Submit electronic copies 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 3 years of date of Contract award for project.
- .13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Consultant.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of Contract complete with project name.
- .14 Submit electronic copies of manufacturer's 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 Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit electronic copies of Manufacturer's Site Reports for requirements requested in specification Sections and as requested by Consultant.
- .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Consultant.
- .18 Delete information not applicable to project.
- .19 Supplement standard information to provide details applicable to project.
- .20 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.



- .21 By reviewing and submitting product submittals, Contractor acknowledges that field measurements and take-offs, coordination between trades, review of the existing conditions and proposed design as per contract document have taken place. All submittals must be reviewed and stamped by General Trade and relevant sub-trades.

1.3 SAMPLES

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Departmental Representative's and Consultant's business address.
- .3 Notify Departmental Representative and Consultant in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative or Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative and Consultant before proceeding with Work.
- .6 Make changes in samples which Departmental Representative or Consultant may require, consistent with Contract Documents.
- .7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.
- .8 No work shall be completed prior to received written review and approval from Consultant and Owner's Representative.
- .9 Unless otherwise noted, all samples shall be submitted in duplicate.

1.4 MOCK-UPS

- .1 Erect mock-ups in accordance with section 01 43 00 - Quality Assurance.

1.5 PHOTOGRAPHIC DOCUMENTATION

- .1 Submit electronic copy of colour digital photography minimum 3,264 x 2,449 pixel resolution monthly with application for payment and as directed by Consultant.
- .2 Project identification: name and number of project and date of exposure indicated.
- .3 Each photograph shall identify:
 - .1 Project Name and Number
 - .2 Contractor Name
 - .3 Consultant Name
 - .4 Date
 - .5 Equipment/System Name and Tag
- .4 Submit additional photographs at request of the Consultant.

1.6 CERTIFICATES AND TRANSCRIPTS

- .1 Immediately after award of Contract, submit Workers' Compensation Board status.
- .2 Submit transcription of insurance immediately after award of Contract.
- .3 Submit licenses and credential for all trades (plumbers, pipe fitters, gas fitters, etc).



- .4 Submit credentials of Testing, Balancing and Adjustment (TAB) Contractor, along with the calibration certificates for all equipment used for systems testing, adjustment and balancing.

1.7 COORDINATION DRAWINGS

- .1 Contractor shall be responsible for preparation of interference drawings to ensure proper fitment and positioning of all equipment, components and services. Drawing shall be comprehensive and reflect coordination between all sub-trades (mechanical, electrical, control, life safety, general, etc). Drawings shall denote minimum observed clearances and distances between equipment, services, systems and building components.
- .2 Ensure that all equipment clearances and component access as required by manufacturer's instructions and AHJ are observed.
- .3 Distribute coordination drawings well in advance of fabrication and installation of work affected. Place no orders for affected equipment without submission of coordination Drawings to the supplier.

1.8 FEES, PERMITS AND CERTIFICATIONS

- .1 Contractor shall submit documentation including test reports, factory acceptance test reports, manufacturer's data, calculations, and other pertinent information as requested by AHJ.
- .2 Contractor shall include all costs of inspections, permitting, reviews as required to obtain certificates.

1.9 REQUESTS FOR INFORMATION (RFI's)

- .1 Submit RFI's in a timely manner and provide sufficient review by Consultant to avoid any scheduling implications.
- .2 Consultant shall review and respond to RFI within (5) working days. All RFI's will be responded to in the order received. It shall be solely responsibility of the contractor to identify critical RFI which will require expedited review and direction.
- .3 Contractor shall conduct thorough review of the contract documents prior to submitting RFI, RFI shall be submitted if portion of scope is not identified is not included in contract documents or if there is discrepancy in the noted site conditions.
- .4 Consultant shall provide response in the form of either:
 - .1 Site Instruction
 - .2 Change Notice
 - .3 Change Directive
 - .4 Information is already included in the contract documents

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 REFERENCE STANDARDS

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Province of Ontario
 - .1 Occupational Health and Safety Act and Regulations for Construction Projects, R.S.O. 1990, c.0.1, as amended and O. Reg. 213/91 as amended – latest version.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
- .3 Submit 3 copies of Contractor's authorized representative's work site health and safety inspection reports to Owner's Representative and Consultant or authority having jurisdiction, on weekly basis.
- .4 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit WHMIS Safety Data Sheets (SDS) in accordance with 02 81 00 - Hazardous Materials.
- .7 Owner's Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 5 working days after receipt of plan. Revise plan as appropriate and resubmit plan to Owner's Representative within 5 working days after receipt of comments.
- .8 Owner's Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel Owner's Representative.
- .10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.3 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.
- .2 Contractor shall agree to install proper site separation and identification in order to maintain time and space at all times throughout life of project.

1.4 SAFETY ASSESSMENT

- .1 Perform site specific safety hazard assessment related to project.



1.5 MEETINGS

- .1 Schedule and administer Health and Safety meeting with Owner's Representative prior to commencement of Work.

1.6 REGULATORY REQUIREMENTS

- .1 Do Work in accordance with Section 01 41 00 - Regulatory Requirements.

1.7 GENERAL REQUIREMENTS

- .1 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.
- .2 Owner's Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

1.8 RESPONSIBILITY

- .1 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.
- .2 Contractor will be responsible and assume the role Constructor as described in the Ontario Occupational Health and Safety Act and Regulations for Construction Projects.
- .3 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.

1.9 COMPLIANCE REQUIREMENTS

- .1 Comply with Ontario Occupational Health and Safety Act, R.S.O. 1990, c. 0.1 and Ontario Regulations for Construction Projects, O. Reg. 213/91.

1.10 UNFORSEEN HAZARDS

- .1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, advise Health and Safety coordinator and follow procedures in accordance with Acts and Regulations of Province having jurisdiction and advise Owner's Representative and Consultant verbally and in writing.

1.11 HEALTH AND SAFETY CO-ORDINATOR

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Coordinator. Health and Safety Coordinator must:
 - .1 Have site-related working experience specific to activities associated with Work similar in nature to proposed Work.
 - .2 Have working knowledge of occupational safety and health regulations.
 - .3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
 - .4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.
 - .5 Be on site during execution of Work



and report directly to and be under direction of Registered Occupational Hygienist, Certified Industrial Hygienist or site supervisor.

1.12 POSTING OF DOCUMENTS

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province having jurisdiction, and in consultation with Owner's Representative and Consultant.

1.13 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Owner's Representative and Consultant.
- .2 Provide Owner's Representative and Consultant with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Owner's Representative or Consultant may stop Work if non-compliance of health and safety regulations is not corrected.

1.14 POWDER ACTUATED DEVICES

- .1 Use powder actuated devices only after receipt of written permission from Owner's Representative.

1.15 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.

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 This Section references to laws, by laws, ordinances, rules, regulations, codes, orders of Authority Having Jurisdiction, and other legally enforceable requirements applicable to Work and that are; or become, in force during performance of Work.

1.2 REFERENCES TO REGULATORY REQUIREMENTS

- .1 Department of Justice Canada (Jus):
 - .1 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations
- .2 Perform Work in accordance with the latest version of National Building Code of Canada (NBC) including amendments up to bid closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .3 Specific design and performance requirements listed in specifications or indicated on Drawings may exceed minimum requirements established by referenced Building Code; these requirements will govern over the minimum requirements listed in Building Code
 - .1 Meet or exceed requirements of:
 - .1 Contract Documents.
 - .2 Specified standards, codes, and referenced documents.
- .4 Ontario Regulation 213/07 – Fire Code.

1.3 HAZARDOUS MATERIAL DISCOVERY

- .1 Asbestos: Demolition of spray or trowel-applied asbestos is hazardous to health. Stop work immediately when material resembling spray or trowel-applied asbestos is encountered during demolition work. Notify Owner's Representative and Consultant.
- .2 PCB: Polychlorinated Biphenyl: Stop work immediately when material resembling Polychlorinated Biphenyl is encountered during demolition work. Notify Owner's Representative and Consultant.
- .3 Mould: Stop work immediately when material resembling mould is encountered during demolition work. Notify Owner's Representative and Consultant.
- .4 Do not proceed with any work until directions from Environmental Consultant are received.

1.4 BUILDING SMOKING ENVIRONMENT

- .1 Comply with smoking restrictions and municipal by-law – no smoking on premises.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: Except as otherwise specified, Contractor shall apply for, obtain, and pay fees associated with, permits, licenses, certificates, and approvals required by regulatory requirements and Contract Documents, based on General Conditions of Contract and the following:
 - .1 Regulatory requirements and fees in force on date of Bid submission, and
 - .2 A change in regulatory requirements or fees scheduled to become effective after date of bid submission and of which public notice has been given before date of bid



submission.

1.6 FIRE PREVENTION AND SAFETY

- .1 Contractor shall be responsible for overall enforcement of fire protection and prevention methods, good housekeeping practices and compliance with the local fire regulations.
- .2 Furnish ULC listed fire extinguishers and other fire fighting equipment.
- .3 Maintain unobstructed means of egress for emergency exit for all personnel and occupants at all times.
- .4 Use only fire rated blankets and similar materials for hoarding.

1.7 REFERENCE STANDARDS

- .1 All work shall be completed to the latest version of the relevant standard approved by issuing organization at the time of the project.
- .2 Noted standards are used to establish minimum performance requirements.
- .3 Contractor shall have a copy of the referenced standard, specification and manufacturer's instruction always available at the construction site.
- .4 Standards, specifications and regulatory requirements are typically referred within the specifications by abbreviations as follows.

Abbreviation	Association
(AMCA)	Air Conditioning and Mechanical Contractors Association
(ARI)	Air Conditioning and Refrigeration Institute
(AMCA)	Air Movement and Control Association
(ACI)	American Concrete Institute
(AIHA)	American Industrial Hygiene Association
(AISC)	American Institute of Steel Construction
(AISI)	American Iron & Steel Institute
(ANSI)	American National Standards Institute
(API)	American Petroleum Institute
(ASTM)	American Society for Testing and Materials
(ASHRAE)	American Society of Heating, Refrigerating and Air Conditioning Engineers
(ASME)	American Society of Mechanical Engineers
(ASSE)	American Society of Sanitary Engineer's
(AWWA)	American Water Works Association
(AWS)	American Welding Society
(ADA)	Americans with Disability Act
(AABC)	Associated Air Balance Council
(AWEI)	Association of the Wall and Ceilings Industries International
(BICSI)	Building Industry Consulting Services International
(CCAC)	Canadian Council on Animal Care
(CaGCB)	Canada Green Building Council
(CCMC)	Canadian Construction Materials Centre
(CCME)	Canadian Council of Ministers of the Environment



Abbreviation	Association
(CEPA)	Canadian Environmental Protection Act
(CGA)	Canadian Gas Association
(CGSB)	Canadian General Standards Board
(CISC)	Canadian Institute of Steel Construction
(CPMA)	Canadian Paint Manufacturer's Association
(CRCA)	Canadian Roofing Contractors' Association
(CSSBI)	Canadian Sheet Steel Building Institute
(CSA)	Canadian Standards Association
(CSDFMA)	Canadian Steel Door and Frame Manufacturers' Association
(CUFCA)	Canadian Urethane Foam Contractors' Association Inc.
(CEA)	Consumer Electronics Association
(CTI)	Cooling Technology Institute
(EEMAC)	Electrical and Electronic Manufacturers' Association of Canada
(EC)	Environment Canada
(EPA)	Environmental Protection Agency
(EPS)	Environmental Protection Services
(ETL)	Electrical Testing Laboratories
(FM)	Factory Mutual
(FCC)	Federal Communications Commission
(WHMIS)	Health Canada - Workplace Hazardous Materials Information System
(HI)	Hydraulics Institute
(IBR)	Institute of Boiler and Radiator Manufacturers
(IRC)	Institute for Research in Construction
(IEEE)	Institute of Electrical and Electronics Engineers
(ICEA)	Insulated Cable Engineers Association
(IEC)	International Electro Technical Commission
(ISO)	International Standards Organization
(LSGA)	Laminators Safety Glass Association
(MSS)	Manufacturer's Standardization Society of the Valve and Fittings Industry
(NAAMM)	National Association of Architectural Metal Manufacturer's
(NACE)	National Association of Corrosion Engineers
(NBC)	National Building Code of Canada
(NBS/PS)	National Bureau of Standards/Products Standard
(NEMA)	National Electrical Manufacturers Association
(NECB)	National Energy Code of Canada for Buildings
(NEBB)	National Environmental Balancing Bureau
(NFC)	National Fire Code of Canada
(NFPA)	National Fire Protection Association
(NFCA)	National Fireproofing Contractors Association
(NPC)	National Plumbing Code of Canada
(NRC)	National Research Council Canada



Abbreviation	Association
(NRCA)	National Roofing Contractors Association
(NSF)	National Sanitation Foundation
(OAA)	Ontario Association of Architects
(OBC)	Ontario Building Code
(OFC)	Ontario Fire Code
(OGCA)	Ontario General Contractors Association
(OHSA)	Ontario Occupational Health and Safety Act
(OIRCA)	Ontario Industrial Roofing Contractors Association
(OPCA)	Ontario Painting Contractors Association
(OPSS)	Ontario Provincial Standard Specification
(PDI)	Plumbing and Drainage Institute
(SMACNA)	Sheet Metal and Air Conditioning Contractors' National Association
(SAE)	Society of Automotive Engineers
(SSPC)	The Society for Protective Coatings
(TIAC)	Thermal Insulation Association of Canada
(TC)	Transport Canada
(TBITS)	Treasury Board Information Technology Standard
(TB)	Treasury Board of Canada
(TGS)	Toronto Green Standard
(TSSA)	Technical Standards and Safety Authority
(UL)	Underwriters' Laboratories Inc.
(ULI)	Underwriters Laboratories Incorporated (USA)
(ULC)	Underwriter's Laboratories of Canada
(USAS)	United States of America Standards Institute
(WHO)	World Health Organization
(WSIB)	Workplace Safety and Insurance Board

1.8 REGULATORY REQUIREMENTS

- .1 Contractor shall ensure that pollution, noise and environmental control measures are exercised during construction.
- .2 All work shall be performed in accordance with Ontario Regulations.
- .3 Remove snow and ice from all side walks as required by the Municipality.
- .4 Maintain clear access for roads, sidewalks and public property.

2 PRODUCTS

2.1 NOT USED

- .1 Not Used.



3 EXECUTION

3.1 EASEMENTS AND NOTICES

- .1 Owner will obtain permanent easements and rights of servitude that may be required for performance of Work.
- .2 Contractor shall give notices required by regulatory requirements.

3.2 PERMITS

- .1 Building Permit:
 - .1 Contractor shall apply for, obtain and pay for building permit on behalf of Owner, and other permits required for Work and its various parts.
 - .2 Contractor shall display building permit and other permits in a conspicuous location at Place of Work.
 - .3 Contractor will require that specific Subcontractor's obtain and pay for permits required by authorities having jurisdiction, where their Work is affected by Work requiring permits. Below list of permit is for reference only and by no means constitute complete list of permits which may be required for performance of Work. Contractor shall be solely responsible for costs including applications, coordination with authorities, submitting of supporting documentation as required to secure permits.
 - .1 Building Permit (to construct or demolish)
 - .2 Mechanical Permit (HVAC)
 - .3 Plumbing and Drainage Permit
 - .4 Fire Protection Permit
 - .5 Life Safety Permit
 - .6 Mag Lock Permit
 - .7 Structural Permit
 - .8 Road Closure Permit
 - .9 Backwater Valve Permit
 - .10 Backflow Prevention Device Permit
 - .11 Noise Exemption Permit
 - .12 Security Upgrades Permit
 - .13 Injure or Remove Trees Permit
 - .14 Street Occupation Permit
 - .15 Temporary Sign (New Development) Permit
 - .16 Tents and Temporary Structures Permit
 - .17 Fire Hydrant Use Permit
 - .18 Fire Hydrant Flow Test Permit
- .3 Occupancy Permits:
 - .1 Contractor shall apply for, obtain, and pay for occupancy permits, including partial occupancy permits where required by authority having jurisdiction.
 - .2 Owner's Representative or Consultant will issue appropriate instructions to Contractor for correction to Work where Contract Document deficiencies are required to be



- corrected in order to obtain occupancy permits, including partial occupancy permits.
- .3 Contractor shall correct deficiencies in accordance with Consultant's instructions. Where deficiency is not corrected, Owner reserves the right to make correction and charge Contractor for costs incurred.
 - .4 Contractor shall turn occupancy permits over to Owner.

END OF SECTION



1 GENERAL

1.1 SUMMARY

- .1 This Section describes administrative and procedural requirements for reactive activities to verify that completed Work conforms to Contract Documents requirements.
- .2 Having inspection and testing agencies by Contractor or Owner does not relieve the Contractor of their responsibility to perform Work in accordance with Contract Documents.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Allow and coordinate access to Work on site, manufacturing off site, and fabrication off site with inspection and testing agencies.
- .2 Retain and pay for inspection and testing that are designated for Contractor's own quality control plan, and when testing and inspection are required by Authorities Having Jurisdiction (AHJ).
- .3 Give advanced notice to Owner's Representative and Consultant and to each inspection/testing agency for inspection and testing required by Contract Documents or by AHJ.
- .4 In advance of each test, notify appropriate agency and Owner's Representative and Consultant in the order that attendance arrangements can be made.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit schedule of testing and inspection activities to Owner's Representative and Consultant, Commissioning Authority, applicable Subcontractors, testing agencies, and other affected parties. Include the following:
 - .1 List each testing and inspection agency
 - .2 Identify types of tests and inspections for each agency, and cross reference to applicable specification Section number-title in Contract Documents
 - .3 Description of test and inspection
 - .4 Identify applicable reference standard
 - .5 Identify test and inspection method
 - .6 Indicate number of each test and inspection required
- .3 Submit one digital copy and one hardcopy of each quality assurance inspection and test report to Owner's Representative and Consultant.
- .4 Submit reports for inspection and testing required by Contract Documents or by AHJ and performed by Contractor-retained inspection and testing agencies within (5) working days after inspection or test is completed, except where a technical specification Section indicates a different time period.
- .5 Submit one digital copy and one hardcopy of each quality control inspection and test report to Owner's Representative and Consultant, except where a technical specification Section indicates otherwise.
- .6 Deliver copies of quality control reports to Subcontractor of work being inspected or tested.



1.4 SITE QUALITY CONTROL PROCEDURES

- .1 Provide labour, equipment and temporary facilities to obtain and handle test samples and materials on site. Arrange for sufficient space to store and cure test samples.
- .2 Deliver samples and materials required for testing, as requested in technical specification Sections. Submit with reasonable promptness and in an orderly sequence to avoid delays in Work.

1.5 TESTING AND INSPECTION SERVICES

- .1 Provide equipment required for executing inspection and testing by appointed agencies.
- .2 Correct defects and deficiencies when they are revealed during inspection or testing as advised by Owner's Representative and Consultant at no change to Contract Price or Contract Time. Pay costs for retesting and re-inspection. Appointed agency will request additional inspections or tests to ensure full degree of defects or deficiencies are revealed and corrected.
- .3 Quality control testing and inspection reports to include the following:
 - .1 Project name and number
 - .2 Testing/Inspection agency's name, address, telephone number, and website
 - .3 Date of issuing report
 - .4 Dates and locations of tests, inspections, or samples
 - .5 Description of the Work and test and inspection method
 - .6 Numbers and titles of associated specification Sections
 - .7 Test and inspection data and interpretation of test results (e.g., pass or fail)
 - .8 Ambient conditions at time of test, inspection, or sampling
 - .9 Recommendations on re-testing and re-inspecting, if applicable
- .4 Maintain Test and Inspection Log on site all times and distribute copy to Consultant, Commissioning Authority and Testing Agencies on bi-weekly basis, include:
 - .1 Date of inspection and test.
 - .2 Party responsible for testing including company name, qualifications and contact details.
 - .3 Description of Work tested or inspected.
 - .4 Summary of test results (pass, fail or re-testing required)

1.6 TOLERANCES

- .1 Unless specific tolerance are required by a Section of the Specifications or a referenced standards, the following tolerances shall be observed for all installed work:
 - .1 "Plumb" shall mean plumb within +/- 3mm in 3m of true plumb.
 - .2 "Level" shall mean level within +/- 3mm in 3m of true level.
 - .3 "Square" shall mean within +/- 30seconds of true 90 degree.
 - .4 "Straight" shall mean +/- 3mm in 3m under a 3m straight edge.
- .2 All Work shall be installed plumb, level, square and straight unless otherwise noted or required by Code or Standards.



1.7 ACCESS TO WORK

- .1 Provide access to Work for all Inspection and Testing Agencies, including off site manufacturing and fabrication facilities.
- .2 Completion of work shall be held off until testing has been completed.
- .3 Repair all damages as a result of inspection or testing work.
- .4 Inspection and testing agencies do not relieve Contractor from responsibility for site inspections and quality control of manufacturing, factory acceptance testing and installation.

1.8 INSPECTION AND TESTING

- .1 Source and Field Quality Control Specified in Other Sections:
 - .1 This Section includes requirements for performance of inspection and testing specified under Source Quality Control and Field Quality Control in other Sections of the Specification.
 - .2 Do not include in work of this Section responsibilities and procedures that relate solely to an inspection and testing company's function under the direction of the Owner and that are specified in another Section which is paid for directly by the Owner. Such information is included in this Section for only the Contractor's information.
- .2 Do not limit responsibility for ensuring that products and execution of the work meet Contract requirements and inspection and testing required to this end, to specified inspection and testing.
- .3 Contractor shall be responsible for specified inspection and testing as required by specifications and regulatory agencies.
- .4 Test results will be reviewed by Consultant and other third party agencies (Commissioning Authority, Quality Control personnel, etc). If the results are deemed to be unacceptable, contractor shall be solely responsible costs of additional adjustments, re-balancing and verification.

1.9 INSPECTION AND TESTING SERVICES AND REFERENCE STANDARDS

- .1 Companies engaged for inspection and testing shall provide equipment, methods of recording and evaluation, and knowledgeable personnel to conduct tests precisely as specified in reference standards.
- .2 If requested, submit affidavits and copies of certificates of calibration made by an accredited calibrator to verify that testing equipment was calibrated and its accuracy ensured within the previous 12 months.
- .3 Inspection, testing and balancing of HVAC systems shall be completed by agency certified and in good standing with NEBB or AABC. Refer to Section 23 05 93 – Testing, Adjusting and Balancing for HVAC for more information.
- .4 Testing and adjusting of the systems shall be completed in accordance with referenced standards.

1.10 REGULATORY REQUIREMENTS

- .1 All Work shall be completed to meet or exceed requirements of specified standards, provincial regulations, municipal by-laws, building codes and referenced documentations.



1.11 REJECTED AND DEFECTIVE WORK

- .1 Work rejected by Consultant or other third party agency (Commissioning Authority, Quality Control, Independent Testing Agency) shall be removed and replaced in accordance with Contract Documents.
- .2 Contractor shall be solely responsible for all corrections, examination, re-testing, re-certification, and inspections/reviews by authorities as required to correct Work which is found to be not in compliance with Contract Documents.
- .3 If in opinion of Consultant it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner may deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which shall be determined by Consultant.
- .4 If rejected, defective materials or work incorporating defective materials or workmanship shall be promptly removed and replaced or repaired to the satisfaction of Consultant and third-party testing Agency, at no expense to the Owner.
- .5 **Significant effort was spent to coordinate and develop Contract Documents including Design Specifications, Design Drawings, Installation Details and other materials. No deviations from details, specifications and requirements of Contract Documents will be accepted without written review and approval from Consultant. Contractor will be solely responsible for all corrective work and potential delays as a result of including but not limited to re-work, replacement materials/equipment, additional security escorts, corrective actions, re-testing, re-commissioning of the systems.**

1.12 MANUFACTURER'S REVIEW AND SERVICES

- .1 In addition to start-up of all systems, Manufacturer shall provide a factory trained and qualified personnel to complete field review of the installation to ensure that Work meets installation requirements in all aspects. Progress reviews at various stages may be carried out at discretion of Manufacturer to ensure all equipment, systems, services, components, and accessories are adequately installed. Manufacturer shall coordinate all field reviews, timing of reviews and specific requirements with the Contractor following acceptance of submittals.
- .2 Manufacturer's Representative shall submit progress reports within (2) working days from date of the visit and final report of conformance within (3) working days. Final conformance report shall state that all equipment, systems, components are installed in accordance with manufacturer's instructions and confirm provision of warranty following installation.
- .3 If any defects are noted, Contractor shall be solely responsible for all costs to complete corrections to mutual satisfaction between Manufacturer, Consultant, AHJ and third-party testing Agency. Consultant's direction shall always take precedence.

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 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.
- .4 Should disputes arise as to quality or fitness of products, decision rests strictly with Consultant based upon requirements of Contract Documents.
- .5 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .6 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.
- .7 All materials, equipment and product shall be listed and certified for installation in Canada, provide certificates of compliance and listing with regulatory agencies (ESA, CSA, ASTM, etc) within the submittal package. Products which do not demonstrate required listings will be rejected.
- .8 Requirements outlined in referenced standards, regulations and codes shall be used as minimum requirements and shall be at least met or exceeded by the contractor.

1.2 SUBSTITUTIONS

- .1 In the event that alternate products are accepted by the Contract and proposed by the Contractor, it shall be solely responsibility of the Contractor to ensure compliance with the performance specifications, referenced standards and codes.
- .2 Contractor shall submit compliance matrix assessing the base (specified) product and alternate (proposed) product, identifying differences line by line in each area of specification.
- .3 Alternate product will be subject to Consultant's review and approval.
- .4 Incomplete or partial submissions will be grounds for non-compliance and rejected.
- .5 Contractor shall be responsible for all additional costs including, but not limited to costs of engineering, additional materials, services, field labour, approvals associated with alternate equipment. No claims for additional costs will be accepted by Owner and Consultant.
- .6 Contractor carefully consider, investigate, and coordinate implications of proceeding with the alternate equipment, materials and products with the sub-trades and AHJ. Contractor shall make all necessary changes and modifications as required to Complete work. Revisions of the design documentations, additional calculations and consulting efforts shall be made by Consultant and all costs for this work reimbursed by Contractor.
- .7 Additional costs for any work required by sub-trades shall be borne by the Contractor.



- .8 Product substitutions shall not affect product warranty, servicing (i.e. manufacturer's must have local service department with ability to respond to the service call within 24 hours and local inventory of spare parts available).
- .9 Product substitutions shall not adversely impact project schedule, delays as a result of additional lead time, re-engineering or re-work will be rejected.
- .10 Substitutions requiring substantial revision of contract documents will not be accepted.
- .11 Contractor shall not proceed with procurement and installation of the substituted products prior to review and written approval from consultant. Consultant reserves the right to reject substituted product if found to be of lesser quality or not meeting contract documents.
- .12 If substituted work is rejected, contractor shall be responsible for all time spent to coordinate and review substituted product, materials, and equipment. Contractor shall be responsible for expedited project delivery, including increasing workforce to multiple crews, working afterhours and weekends, premiums for expedited equipment delivery.

1.3 AVAILABILITY

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

1.4 DELIVERY, 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 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Consultant or AHJ.
- .9 Touch-up damaged factory finished surfaces to Consultant's or AHJ satisfaction. Use touch-up materials to match original. Do not paint over name plates.
- .10 Store manufactured products, materials and equipment in accordance with manufacturer's recommendations and good practices.



- .11 Store all materials in locations designated and approved by Owner's Representative. Contractor shall not assume that storage areas will be readily available and shall coordinate storage location at least (10) working days in advance of delivery.
- .12 Contractor shall carefully coordinate delivery of materials and equipment and be responsible for all costs of warehouse off site storage.
- .13 When equipment is specified and delivered in sections, retain services of manufacturer's representative to provide supervision and witness assembly of the equipment. Manufacturer's Representative shall provide letter confirming that installation is within manufacturer's instructions and industry standards.
- .14 Protect building elements including but not limited to floor, wall, elevator, escalator finishes, hand and guard rails from damages during handling and moving of materials. Contractor shall exercise special measures when handling excessive loads. Repair all damages as a result of this work at no expense to the Owner. All conditions shall be repairs to match existing condition. If any prior damages are noted, contractor shall take photographs of these damages and submit to Owner's Representative and Consultant. Otherwise, Contractor shall be responsible for all damages in area of Work and pathway used to deliver equipment to final destination. All repair work shall be completed to satisfaction of Consultant and Owner's Representative.

1.5 TRANSPORTATION

- .1 Pay costs of transportation of products required in performance of Work.

1.6 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, materials, services or accessories 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.

1.7 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. Owner's Representative or Consultant reserve 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 Consultant, whose decision is final.
- .4 All work requiring specific credentials (gas fitter, plumber, refrigeration technician, etc) shall be completed by skilled and qualified tradesmen. Provide credentials and certification to Consultant prior to any work.
- .5 Decisions with respect to quality or fitness of workmanship in the event of disputes shall rest solely with the Consultant, whose decision is final.



- .6 All services including ductwork, pipework, conduits and wiring shall be concealed in floors, walls, ceiling or chases except where indicated otherwise or required to be exposed by AHJ. Provide access panels for all components and devices requiring access for operation or maintenance.
- .7 Contractor shall ensure that integrity of fire rated assemblies is maintained where penetrations are made as a result of the Work.

1.8 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 Be responsible for installation of services (controls, power, life safety, fire protection, mechanical, etc) in a manner such that adequate clearances, access and maintenance provisions are observed at any point. Contractor shall be responsible for all re-work and additional materials/equipment to satisfaction of Consultant or AHJ.

1.9 CONCEALMENT

- .1 In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation inform Owner's Representative, Consultant if there is interference. Install as directed by Consultant.
- .3 Arrange for inspections of the concealed Work by the Consultant and AHJ (where applicable) prior to concealment, provide minimum 5 working days' notice. Otherwise, contractor will be responsible for all costs associated with exposing concealed work and required concealment and finished at the request of the Consultant or AHJ.

1.10 REMEDIAL WORK

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

1.11 LOCATION OF FIXTURES

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

1.12 FASTENINGS

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.



- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.13 FASTENINGS - EQUIPMENT

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

1.14 PROTECTION OF WORK IN PROGRESS

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

1.15 EXISTING UTILITIES

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, building occupants and pedestrian and vehicular traffic.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

1.16 FIELD MEASUREMENTS

- .1 Contractor shall field verify all dimensions, measurements, required clearances and interferences with the existing conditions prior to fabrication or ordering products. If any conflicts are found, inform Consultant promptly for course of action.
- .2 Ensure areas designated for future equipment installation are clear and available for future Work. If any services or equipment interferes future installation and clearances around equipment, contractor shall be solely responsible for all re-work and re-location.
- .3 Drawings indicate approximate locations of equipment, fixtures, devices and services. Contractor shall review proposed locations and routing of services on site to ensure no impacts on aesthetics of building elements and suit specific site conditions. Allow for offsets of services and relocation of equipment within 3 meter radius of the proposed locations at no additional change to the Contract Price. Contractor shall receive written approval from Consultant on all changes prior to proceeding with the installation.
- .4 All installed equipment and systems shall have uncompromised access for routine maintenance and servicing of the equipment and its components. Contractor shall be solely responsible for all relocation and re-work to satisfaction of Consultant.



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 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit proof of anchor and fastener load carrying capacity for a work result, when requested.
- .3 Submit written request before cutting or altering to existing conditions which may affect the following:
 - .1 Structural integrity of existing elements: Submit structural details and calculations performed by a professional structural engineer registered or licensed in Province of Work. Include evidence of unsatisfactory structural integrity of the elements according to Owner's Representative and Consultant.
 - .2 Integrity of weather-exposed and moisture-resistant elements
 - .3 Efficiency, maintenance, safety , or accessibility of operational elements
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner and other contractors.
- .4 Submit a request for cutting or altering which includes:
 - .1 Identification of the Project; and
 - .2 Location and description of affected existing conditions including changes to structural elements, function of elements, and visual appearance of existing elements; and the location and identification of utilities that will be temporarily out of service during cutting and patching activities.
- .5 Submit site plan drawings indicating relative location of various services and equipment upon the request of Owner's Representative and Consultant.
- .6 Submit a work plan including:
 - .1 A statement why cutting or altering is unavoidable and describe alternatives to cutting and patching if available;
 - .2 A description of proposed work and proposed Products;
 - .3 The effect of cutting or altering on work by Owner or other contractors;
 - .4 Written acknowledgement by other contractors affected by cutting or altering , if applicable; and
 - .5 Proposed date(s) and time(s) work will be executed.

1.2 QUALIFICATIONS

- .1 Licensed Professionals: Engage a structural engineer licensed at the Place of the Work, to submit details and calculations when altering existing structural elements.

2 PRODUCTS

2.1 MATERIALS

- .1 Patching Materials: If possible, use the same materials found in the existing conditions, except in fire-resistance rated materials and assemblies.



- .2 Materials Visible from the Floor Area: Use materials that visually match existing adjacent surfaces, and match existing functional performance.

3 EXECUTION

3.1 COMMON INSTALLATION/APPLICATION/ERECTION REQUIREMENTS

- .1 Fit several parts together, to integrate with other Work.
- .2 Remove and replace defective and non-conforming Work.
- .3 Unless otherwise indicated in specifications, install, or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
- .4 Notify Owner's Representative and Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant will establish course of action.
- .5 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.
- .6 Provide openings in non-structural elements for penetrations of mechanical and electrical work.
- .7 Conceal pipes, ducts and wiring in floor, wall, partition, and ceiling assemblies in finished areas, except where indicated otherwise.
- .8 In addition to the manufacturer's recommendations for safety, access, accessibility, and maintenance, locate equipment, fixtures, and distribution systems where it shall provide minimal interference and shall maximize on usable space.
 - .1 Location of equipment, fixtures, and outlets indicated on Drawings and specifications are approximate.
 - .2 Notify Consultant of impending installation and obtain approval for actual locations.

3.2 BRACING AND ANCHORING

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

**3.3 CUTTING AND PATCHING**

- .1 Proceed with cutting and patching after the review and acceptance by the Consultant of all submittals.
- .2 Perform cutting, fitting, and patching including excavation and fill, to complete Work in accordance with related technical specification Sections.
- .3 Use special techniques to avoid damaging existing conditions that will remain, and which will result in proper surfaces to receive patching and finishing.
- .4 Employ original installer to perform cutting and patching for weather-exposed elements, moisture-resistant elements, and surfaces exposed to view.
- .5 Cut rigid materials using masonry saw, core drill, or other tool recommended by the product manufacturer or applicable industry association. Pneumatic or impact tools are not allowed on masonry work without the approval of Consultant.
- .6 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .7 Refinish surfaces to match adjacent finishes. Refinish continuous surfaces to nearest intersection (e.g., edges of partition). Refinish assemblies by refinishing entire unit. Provide entire surface with uniform finish, colour, and texture.

3.4 ADJUSTING

- .1 Remove and replace patching that is visually unsatisfactory to Consultant at no changes to Contract Price.

END OF SECTION



1 GENERAL

1.1 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Owner's Representative or Consultant. Do not burn waste materials on site.
- .3 Clear snow and ice from access to building, bank/pile snow in designated areas only or remove from site where no designated areas are available.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Provide on-site containers for collection of waste materials and debris.
- .6 Provide and use marked separate bins for recycling.
- .7 Dispose of waste materials and debris off site in accordance with regulatory requirements.
- .8 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .9 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .10 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .11 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .12 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste products and debris including that caused by Owner or other Contractors.
- .5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Owner's Representative. Do not burn waste materials on site.
- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.
- .9 Clean lighting reflectors, lenses, and other lighting surfaces.
- .10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.



- .11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .14 Remove dirt and other disfiguration from exterior surfaces.
- .15 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .16 Sweep and wash clean paved areas.
- .17 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .18 Clean roofs, downspouts, and drainage systems.
- .19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .20 Remove snow and ice from access to building.
- .21 Where existing grilles, louvers and terminal HVAC units are re-used in the area of Work, contractor shall steam clean all coil and enclosure services of all units include wall fins, radiators, fan coils, induction units, unit heaters, cabinet unit heaters and duct mounted heating coils. Allow for disassembly and re-assembly as required to complete cleaning. Repeat cleaning where unsatisfactory results are noted by Consultant at no change in Contract Price.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling.

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 ADMINISTRATIVE REQUIREMENTS

- .1 Acceptance of Work Procedures:
 - .1 Contractor's Inspection: Contractor shall conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .1 Notify Consultant in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.
 - .2 Submit request for Consultant's inspection once all deficiencies had been corrected or provide log of outstanding and in progress items prior to Consultant's review.
 - .3 Coordinate deficiencies with other third party Agencies hire by the Owner including Commissioning Authority and Quality Assurance personnel.
 - .2 Consultant's Inspection:
 - .1 Consultant and Contractor to inspect Work and identify defects and deficiencies.
 - .2 Contractor shall correct Work as directed in timely manner.
 - .3 Consultant or Owner's representative will not be responsible for preparation of exhaustive list of deficiencies. Contractor shall be primarily responsible for ensuring that installed work meets requirements of the Contract Documents.
 - .4 Requests to declare Substantial Performance will be rejected upon discovery of substantial outstanding deficiencies.
 - .3 Completion Tasks: submit written certificates in English that tasks have been performed as follows:
 - .1 Work: completed and inspected for compliance with Contract Documents.
 - .2 Defects: corrected and deficiencies completed.
 - .3 Equipment and systems: tested, adjusted and balanced and fully operational.
 - .4 Certificates required by regulatory agencies (ESA, TSSA, etc) submitted.
 - .5 Operation of systems: demonstrated to Owner's personnel.
 - .6 Commissioning of mechanical systems: completed in accordance with 01 91 13 - General Commissioning Requirements and copies of final Commissioning Report submitted to Owner's Representative, Consultant and Contractor. Contractor shall include final commissioning report in Closeout Manuals.
 - .7 Work: complete and ready for final inspection.
 - .4 Declaration of Substantial Performance
 - .1 Contractor shall be responsible for conducting inspection of the installed Work and identification of deficiencies, which shall be repaired in timely manner.
 - .2 Once the contractor considers the project to be substantially completed, contractor shall submit list of deficiencies including items which had been corrected, in progress and outstanding for Consultant's consideration on meeting Substantial Performance.
 - .3 Once consensus on substantial performance is reached, Contractor shall submit request for site inspection and verification of the Substantial Performance. Consultant will attend the site no later than (10) working days following receipt of the request for inspection.



- .4 When Consultant considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance. Consultant will identify which deficiencies must be rectified prior to declaration of Substantial Performance and which can be addressed as part of warranty repairs.
- .5 Closeout Manuals shall be submitted prior to declaration of Substantial Performance.
- .5 Final Inspection:
 - .1 When completion tasks are done, request final inspection of Work by Consultant, and Contractor.
 - .2 When Work incomplete according to Consultant, complete outstanding items and request re-inspection.
 - .3 Any deficiencies identified during final inspection shall be compiled into Final deficiency list by the Consultant. Resolution of items identified in Final deficiency list will govern acceptance of the Work under the contractual obligations.
 - .4 All deficiencies must be repaired within reasonable time frame agreed upon by Contractor and Consultant. Contractor shall request final follow up inspection by Consultant. Once all deficiencies are deemed to be resolved by Consultant, Contractor shall submit progress draw and invoice for final payment.
- .6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.
- .7 Final Payment:
 - .1 When Consultant considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.
 - .2 When Work deemed incomplete by Consultant, complete outstanding items and request re-inspection.
- .8 Payment of Holdback: after issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with contractual agreement.

1.2 WARRANTY PHASE

- .1 Contractor shall be responsible for all labour, materials and parts as required to address issues discovered during warranty period. Contractor and required personnel shall attend the site no later than (2) working days for all non-critical issues and within (4) hours for all critical issues. Issue shall be considered critical if it results in disruption of normal facility operations, health and safety concern or code violation.
- .2 Conduct warranty progress inspection at (4) months after project acceptance to review installation and operation of the installed systems, equipment, and components. Interview building operations team to identify any arising issues, defects, or concerns. Any issues, which are determined to be part of the contract by Consultant shall be repaired by Contractor in timely manner.



- .3 One month prior to the end of warranty term, Contractor shall arrange and coordinate Warranty Inspection of all elements of Work. Contractor shall provide minimum (20) working days notice to Owner, Owner's Representative, Consultant and third party agencies (Commissioning Authority, Quality Assurance) and be responsible for scheduling of Warranty Phase inspection.
- .4 In the event of delays in scheduling or lack of Warranty Phase inspection, warranty period shall be extended accordingly until Warranty Inspection takes place.
- .5 Status of previously noted deficiencies, new issues discovered by operations teams will be examined and Consultant will be solely responsible for determining which issues shall be covered under warranty at no change in Contract Price.

1.3 FINAL CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Remove surplus materials, excess materials, rubbish, tools and equipment.

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 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Two weeks before Substantial Performance of the Work, submit to the Consultant four final copies of operating and maintenance manuals in English.
- .3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.
- .4 Provide evidence, if requested, for type, source and quality of products supplied.

1.2 FORMAT

- .1 Organize data as instructional manual.
- .2 Binders: Vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used correlate data into related consistent groupings.
 - .1 Identify contents of each binder on spine.
- .4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems or process flow, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: manufacturer's printed data, or typewritten data.
- .8 Drawings: Provide with reinforced punched binder tab.
 - .1 Bind in with text; fold larger drawings to size of text pages.
- .9 Provide 1:1 scaled CAD files in dwg format on USB drive. Contractor shall be responsible for reflecting all deviations as a result of changes, RFI's, CCN's, etc in CAD drawings. CAD drawings shall be prepared in accordance with Owner's CAD Guidelines. Contractor shall verify exact requirements prior to preparation of the CAD record drawings.

1.3 CONTENTS - PROJECT RECORD DOCUMENTS

- .1 **Table of Contents for Each Volume:** provide title of project;
 - .1 Date of submission; names.
 - .2 Schedule of products and systems, indexed to content of volume.
- .2 **TAB A – Contact Information**
 - .1 Addresses, and telephone numbers of Consultant, Contractor and all sub-trades, Commissioning Authority along with names of responsible parties.
 - .2 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 **TAB B - Warranty**
 - .1 Provide certificate of warranty including start date and duration of the warranty on company letter head.



- .2 Include the following details:
 - .1 Warranty coverage details.
 - .2 Warranty start date.
 - .3 Warranty period or expiry date.
 - .4 Contact name, address and phone number in the event issues arise during warranty phase.
 - .5 Extended warranties supplied by manufacturer in accordance with specifications requirements.
- .4 **TAB C – Shop Drawings**
 - .1 A copy of all reviewed submittals bearing mark of approval from Consultant and if applicable Commissioning Authority
- .5 **TAB D – Test Reports**
 - .1 For each product or system:
 - .1 Test reports including factory test reports, field test reports.
 - .2 Manufacturer’s start-up reports.
 - .3 Certifications and Approvals by AHJ.
 - .4 Field test reports including but not limited to pressure testing of equipment and systems, leakage testing, sound performance testing, radiographic testing of welds, flushing and cleaning, water treatment, TAB, calibration reports, point to point to point controls verification reports, meggering, etc.
- .6 **TAB E – Control Sequences of Operation**
 - .1 Provide as built control sequences of operation for all equipment.
 - .2 For retrofit project or alterations of components or selected systems, controls contractor shall be responsible for amending site-wide control binder with the new, revised or deleted sequences of operations and points lists.
 - .3 Include point to point verification reports, sensor calibration reports and itemized list of all adjustable setpoint per each system along with the default setpoint, indication if setpoint is fixed or reset and recommended min/max limits of adjustments.
- .7 **TAB F - Maintenance and Servicing Procedures**
 - .1 Provide inventory of all equipment including schedule and description of service tasks to complete periodic maintenance of systems and equipment.
 - .2 Include measured for preventative and corrective maintenance with specific service procedures and service intervals.
 - .2 Manual will be reviewed by Consultant, Owner and Commissioning Authority for completeness prior to including in the Closeout Manual.
- .8 **Tab G – As-built Drawings**
 - .1 Provide record drawings in CAD and PDF format in accordance with the requirements of this Section.
- .9 **Tab H – CMMS Data Sheets**
 - .1 Contractor shall fill out Computerized Maintenance Management System (CMMS) data sheets in the template or standard used by Owner and include original versions on the USB drive and printed copies in the physical binders.



- .2 CMMS data sheets shall be provided for all equipped deleted, removed, added or replaced as part of the project.
- .10 **Tab I – Inspection Reports**
 - .1 Include inspection reports by Contractor’s, Consultants, Commissioning Agent and regulatory bodies (AHJ).
- .11 **Tab J – Training**
 - .1 Include record of training including names, positions and signatures of trainees and personnel responsible for each area of training.
 - .2 Contractor shall complete video record of each training session in minimum 1080p resolution, all videos must clearly demonstrate discussed topics and have clear audio.
- .12 **Tab K – Final Commissioning Manual**
 - .1 Where third party Commissioning Authority is retained by the Owner, a final commissioning manual shall be provided in accordance with referenced standards.
 - .2 Commissioning Authority shall provide a confirmation letter certifying that all performance verification test have met the required of the contract specifications and documents, basis of the design and requirements of the project.
- .13 **Tab L - Systems Troubleshooting Guide**
 - .1 Provide instruction on troubleshooting of the systems including issue description, likely causes and resolutions steps for all equipment and systems as required to return systems to operational condition.
- .14 **Tab M - List of provided spare parts and specialized tools.**

1.4 AS-BUILT DOCUMENTS AND SAMPLES

- .1 Maintain, in addition to requirements in General Conditions, at site for Consultant and Owner one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Site test records.
 - .7 Inspection certificates.
 - .8 Manufacturer’s certificates.
 - .9 Issues Log.
 - .10 Log of shop drawings, CCN’s, RFI’s.
- .2 Store record documents and samples in site office apart from documents used for construction.
 - .1 Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.
 - .1 Label each document “PROJECT RECORD” in neat, large, printed letters.



- .4 Maintain record documents in clean, dry and legible condition.
 - .1 Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Consultant.
- .6 Record (or as-built) CAD drawings shall be prepared using AutoCAD version 2020 or higher. Drawings shall be prepared in accordance with Owner's CAD Guidelines or Consultants CAD Standards, including layers, colors, fonts, text sizes. Contractor shall obtain instructions and familiarize with the requirements prior to preparation of CAD drawings. Issued for Construction (IFC) set of AutoCAD drawing file (.dwg) will be made available by the Consultant for Contractor's use. Contractor shall be responsible for coordination and submission of AutoCAD drawings to Owner's CAD Department for review and acceptance; make all necessary changes to satisfaction of Owner's CAD Manager or Consultant prior to inclusion in closeout manuals.
- .7 Drawings shall be submitted as follows:
 - .1 (4) sets of digital CAD and PDF drawings on (4) separate USB drives
 - .2 (4) sets of minimum A1 or Arch D size prints in color, single side printed and spine bound
 - .3 (4) sets of half size – A2 or Arch C size prints in color, single side printed and spine bound

1.5 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

- .1 Record information on set of blue line opaque drawings, and in copy of Project Manual.
- .2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress.
 - .1 Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Site changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 Referenced Standards to related shop drawings and modifications.
- .5 Specifications: mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: Maintain manufacturer's certifications, inspection certifications, site test records, AHJ approvals, required by individual specifications Sections.
- .7 Provide digital photos, if requested, for site records.



1.6 FINAL SURVEY

- .1 Submit final site survey certificate in accordance with Section 01 71 00 - Examination and Preparation, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.7 EQUIPMENT AND SYSTEMS

- .1 For each item of equipment and each system include description of unit or system, and component parts.
 - .1 Give function, normal operation characteristics and limiting conditions.
 - .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
 - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
 - .2 Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control, Section 23 05 93 – Testing, Adjusting and Balancing for HVAC and Section 01 91 13 - General Commissioning Requirements.
- .15 Underground or Aboveground storage tank inspection documentation, registration, forms, decommissioning and removal in accordance with CEPA SOR/2008-197.
- .16 Additional requirements: As specified in individual specification Sections.

1.8 MATERIALS AND FINISHES

- .1 Building products, applied materials, and finishes: Include product data, with catalogue number, size, composition, and colour and texture designations.
 - .1 Provide information for re-ordering custom manufactured products.



- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and weather-exposed products: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional requirements: As specified in individual specifications Sections.

1.9 MAINTENANCE MATERIALS

- .1 Spare Parts:
 - .1 Provide spare parts, in quantities specified in individual specification Sections.
 - .2 Provide items of same manufacture and quality as items in Work.
 - .3 Deliver to site and store in location designated by Owner's Representative.
 - .4 Receive and catalogue items.
 - .1 Submit inventory listing to Consultant.
 - .2 Include approved listings in Maintenance Manual.
 - .5 Obtain receipt for delivered products and submit before final payment.
- .2 Extra Stock Materials:
 - .1 Provide maintenance and extra materials, in quantities specified in individual specification Sections.
 - .2 Provide items of same manufacture and quality as items in Work.
 - .3 Deliver to site and store in location designated by Owner's Representative.
 - .4 Receive and catalogue items.
 - .1 Submit inventory listing to Consultant.
 - .2 Include approved listings in Maintenance Manual.
 - .5 Obtain receipt for delivered products and submit before to final payment.
- .3 Special Tools:
 - .1 Provide special tools, in quantities specified in individual specification Section.
 - .2 Provide items with tags identifying their associated function and equipment.
 - .3 Deliver to site and store in location designated by Owner's Representative.
 - .4 Receive and catalogue items.
 - .1 Submit inventory listing to Consultant.
 - .2 Include approved listings in Maintenance Manual.

1.10 WARRANTIES AND BONDS

- .1 Develop warranty management plan to contain information relevant to Warranties.
- .2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Owner's Representative and Consultant for approval.
- .3 Warranty management plan to include required actions and documents to assure that Owner receives warranties to which it is entitled.
- .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.



- .5 Submit, warranty information made available during construction phase, to Consultant for approval before each monthly pay estimate.
- .6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:
 - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
 - .2 List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
 - .3 Obtain warranties and bonds, executed in duplicate by Subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
 - .4 Verify that documents are in proper form, contain full information, and are notarized.
 - .5 Co-execute submittals when required.
 - .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Conduct joint warranty inspections at (4) months following acceptance and (1) month prior to warranty expiry, measured from time of acceptance, by Owner's Representative and Consultant.
- .9 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, Subcontractors, manufacturers, or suppliers involved.
 - .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers, chillers, boilers, air handling equipment and commissioned systems such as fire protection, alarm systems, sprinkler systems, lightning protection systems.
 - .3 Provide list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of manufacturers or suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.



- .4 Contractor's shall be responsible for coordinating and planning for attendance at (4) and (9) month post-construction warranty inspections. Provide timely notices to all attending parties prior to the inspections.
- .5 Procedure and status of tagging of equipment covered by extended warranties.
- .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- .10 Respond in timely manner to oral or written notification of required construction warranty repair work.
- .11 Written verification to follow oral instructions.
 - .1 Failure to respond will be cause for the Owner to proceed with action against Contractor.

1.11 WARRANTY TAGS

- .1 Tag, at time of installation, each warranted item. Provide durable, oil- and water-resistant tag approved by Owner's Representative and Consultant.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.
- .4 Indicate the following information on tag:
 - .1 Type of product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Contract number.
 - .5 Warranty period.
 - .6 Inspector's signature.
 - .7 Construction Contractor.

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 ADMINISTRATIVE REQUIREMENTS

- .1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel two weeks before date of final inspection. Contractor shall allow for multiple sessions, at minimum two 6-hour training session on alternate dates to complete training of separate groups of operational personnel.
- .2 Owner: Provide list of personnel to receive instructions, and coordinate their attendance at agreed-upon times.
- .3 Preparation:
 - .1 Verify conditions for demonstration and instructions comply with requirements.
 - .2 Verify designated personnel are present.
 - .3 Ensure equipment has been inspected and put into operation.
 - .4 Ensure testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - General Commissioning Requirements and equipment and systems are fully operational.
- .4 Demonstration and Instructions:
 - .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the equipment designated 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 needed during instructions.
- .5 Time Allocated for Instructions: ensure amount of time required for instruction of each item of equipment or system.
- .6 For projects completed in multi-phase approach and handed over to Owner phase by phase, training and demonstration shall be completed at the conclusion of each phase along with the specific Closeout Manuals.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks before designated dates, for Owner's Representative's and Consultant's approval.
- .3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .4 Give time and date of each demonstration, with list of persons present.
- .5 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.



1.3 QUALITY ASSURANCE

- .1 When specified in individual Sections requiring manufacturer to provide authorized representative to demonstrate operation of equipment and systems:
 - .1 Instruct Owner's personnel.
 - .2 Submit written report that demonstration and instructions have been completed.

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 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .3 CAN/CSA G30.18, Billet-Steel Bars for Concrete Reinforcement.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures .
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in Cast-In-Place Concrete and additives 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 the respective province of Canada.
 - .1 Submit placing drawings prepared in accordance with plans to clearly show size, shape, location and necessary details of reinforcing.
 - .2 Submit drawings showing formwork and falsework design to: CSA A23.1/A23.2 .
- .4 Quality Assurance Submittals:
 - .1 Submit in accordance with Section 01 43 00 - Quality Assurance.

2 PRODUCTS

2.1 MATERIALS

- .1 Portland Cement: Normal Portland Cement in accordance with CAN/CSA A3000 , Type GU.
- .2 Water: to CSA A23.1/A23.2.
- .3 Reinforcing bars:
 - .1 Billet steel, grade 350, deformed bars to CSA G30.18 , unless indicated otherwise.
 - .2 Epoxy Coating of reinforcement: to ASTM A775/A775M.
- .4 Welded steel wire fabric:
 - .1 Plain in accordance ASTM A1064/A1064M , fabricated from as drawn steel wire into flat sheets;
 - .2 Finish:
 - .1 Galvanized: Fabricated from galvanized wire having Class A coating in accordance with ASTM A1064/A1064M .
 - .2 Epoxy Coated: Epoxy coated after welding in accordance with ASTM A884/A884M , Class A coated <175 µm, Type 1 intended for use in concrete or masonry, colour contrasting with rust.
- .5 Premoulded joint filler:
 - .1 Bituminous impregnated fibreboard: to ASTM D1751 .



- .6 Joint sealer/filler: grey to ASTM C920 , Type M, Grade NS.
- .7 Sealer: proprietary poly-siloxane resin blend .
- .8 Other concrete materials: to CSA A23.1/A23.2 .

2.2 MIXES

- .1 Performance Method for specifying concrete: to meet Consultant performance criteria to CSA A23.1/A23.2 .
 - .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as described in PART 3 - VERIFICATION.
 - .2 Provide concrete mix to meet following plastic state requirements:
 - .1 Uniformity.
 - .2 Workability: free of surface blemishes and segregation .
 - .3 Provide concrete mix to meet following hard state requirements:
 - .1 Durability and class of exposure: N
 - .2 Compressive strength at 28 day age: 50 MPa minimum.
 - .3 Intended application: Housekeeping pads.
 - .4 Aggregate size 15 mm maximum.
 - .4 Concrete supplier's certification.
 - .5 Provide quality management plan to ensure verification of concrete quality to specified performance.

3 EXECUTION

3.1 PREPARATION

- .1 Provide Consultant min 48 hours notice before each concrete pour.
- .3 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Concrete delivery and handling to facilitate placing with minimum of rehandling, and without damage to existing structure or Work.
- .4 Protect previous Work from staining.
- .5 Clean and remove stains before application of concrete finishes.

3.2 INSTALLATION/APPLICATION

- .1 Do cast-in-place concrete work in accordance with CSA A23.1/A23.2 .
- .2 Sleeves and inserts:
 - .1 Cast in sleeves, ties, slots, anchors, reinforcement, frames, conduit, bolts, waterstops, joint fillers and other inserts required built-in.
 - .2 Sleeves and openings minimum 100 mm x 100 mm not indicated, reviewed by Consultant.

3.3 FINISHES

- .1 Equipment pads: provide smooth trowelled surface.



3.4 CURING

- .1 Use curing compounds compatible with applied finish on concrete surfaces free of bonding agents and to CSA A23.1/A23.2 .

3.5 SEALING APPLICATION

- .1 After curing complete, apply poly-siloxane resin blend sealer at 4 m² /L .
- .2 Cure concrete surfaces in accordance with CSA A23.1/A23.2

3.6 SITE TOLERANCES

- .1 Concrete floor slab finishing tolerance to CSA A23.1/A23.2 .

3.7 SITE QUALITY CONTROL

- .1 Concrete testing: to CSA A23.1/A23.2 by testing laboratory designated and paid for by Contractor.

3.8 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Use trigger operated spray nozzles for water hoses.
- .3 Designate cleaning area for tools to limit water use and runoff.
- .4 Waste Management: separate waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Disposal of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location posing health or environmental hazard is prohibited.

END OF SECTION



GENERAL

1.1 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM E595 , Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.
 - .2 ASTM E2032 , Standard Guide for Extension of Data From Fire Resistance Tests Conducted in Accordance with ASTM E 119.
 - .3 ASTM E2174 , Standard Practice for On-Site Inspection of Installed Firestops.
 - .4 ASTM E2307 , Standard Test Method for Determining Fire Resistance of Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus.
 - .5 ASTM E2393, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
 - .6 ASTM E2837, Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies.
 - .7 ASTM E814-11a, Standard Test Method for Fire Tests of Penetration Firestop Systems
- .2 Firestop Contractors International Association (FCIA)
 - .1 FCIA Firestop Manual of Practice.
- .3 Factory Mutual Approvals (FM)
 - .1 FM 4991, Approval Standard for Firestop Contractors.
- .4 International Accreditation Service (IAS)
 - .1 IAS AC291, Accreditation Criteria for Special Inspection Agencies.
- .5 International Firestop Council (IFC)
 - .1 IFC Guidelines for Evaluating Engineering Judgments.
 - .2 IFC Guidelines for Evaluating Engineering Judgments - Perimeter Fire Barrier Systems.
 - .3 IFC Inspection Guidelines for Penetration Firestop Systems and Fire Resistive Joint Systems in Fire Resistance Rated Construction.
- .6 National Research Council Canada (NRC)
 - .1 National Building Code of Canada (NBC).
- .7 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S115, Standard Method of Fire Tests of Firestop Systems.
 - .2 ULC Qualified Firestop Contractor Program.

1.2 DEFINITIONS

- .1 Fire Blocking: materials, components or system installed in a concealed space in the building to restrict the spread of fire and smoke in that concealed space or from that concealed space to an adjacent space.



- .2 Fire Stop: a material, component or system, and its means of support, used to protect gaps between fire separations, between fire separations and other construction assemblies, or used in openings where penetrating items wholly or partially penetrate fire separations, to restrict the spread of fire and smoke thus maintaining the fire-resistance continuity of a fire separation.
- .3 Fire Stop System: the combination of specific materials and/or devices required with the penetrating item(s), the assembly and the opening to assemble the fire stop.
- .4 Intumescent: materials that expand with heat to prevent fire spread through fire separations.
- .5 Listed Fire Stop System: a specific site erected construction consisting of the assembly, fire stop materials, any penetrating items and their means of support which have met the requirements for an F, FT, FH, FTH and/or L rating when tested in a fire-resistance rated assembly in accordance with CAN/ULC-S115 - Standard Method of Fire Tests of Firestop Systems.
 - .1 F-Rating: the amount of time a fire stop system can remain in place without the passage of flame through the opening or the occurrence of flaming on the unexposed face of the fire stop.
 - .2 FT-Rating: a fire stop system with an F-Rating for the required time period which can also resist the transmission of heat through the fire stop during the same period and limit the rise in temperature on the unexposed face and/or penetrating item of the fire stop.
 - .3 FH-Rating: a fire stop system with an F-Rating for the required time period which can also resist the force of a hose stream without developing openings for a prescribed period.
 - .4 FTH-Rating: a fire stop system with an FT-Rating for the required time period which also passed the hose stream test for a prescribed period.
 - .5 L-Rating: largest test sample leakage rate, determined in accordance with the optional air leakage test of CAN/ULC-S115 .
- .6 Multi-penetration: two or more service penetrations through an opening in the fire separation.
- .7 Non-rated Fire Separation: fire separation acting as a barrier to the spread of smoke until a response is initiated such as the activation of a fire suppression system.
- .8 Single-penetration: single service penetration through an opening in the fire separation.
- .9 System Design Listing: document providing proof of testing with technical details, specifications and requirements that leads to the application of a specific listed fire stop system.

1.3 SYSTEMS DESCRIPTION

- .1 This Section specifies fire stop systems and/or fire stop materials intended to fill gaps between fire separations, between fire separations and other construction assemblies, or used in or around items which fully or partially penetrate a fire separation, to restrict the spread of fire and smoke thus maintaining the integrity of a fire separation.
- .2 This Section includes requirements for:
 - .1 Through-penetration fire stops:
 - .1 For openings created to allow a penetrating item such as piping, conduits, raceways, ducts, cable trays, cables, tubing or structural components to pass



- completely through a fire separation or fire-resistance rated assembly.
- .2 Membrane penetration fire stops:
 - .1 For openings where penetrating items such as piping, conduits, raceways, ducts, cable trays, cables, tubing, recessed components (e.g.: panels, electric boxes, devices) or structural components pass through only one membrane of a fire separation or fire-resistance rated assembly.
 - .3 Blank opening fire stops:
 - .1 For openings created in a fire separation where the penetrating item has not yet been installed or has been removed.
 - .4 Construction joint fire stops:
 - .1 For locations where adjacent fire separations or components of fire separations meet. These locations include: ceiling/wall and roof/wall joints, wall/wall joints at corners or in the same plane, wall/floor joints, floor/floor joints and ceiling/ceiling joints.
 - .2 Includes fire stops for seismic joints, vertical control joints, expansion joints, and joints which occur at the tops and bottoms of fire separation walls.
 - .3 Includes fire stops for head of wall to non-rated roof or floor assemblies.
 - .5 Building perimeter fire stops:
 - .1 For the space between a fire-resistance rated floor assembly and the curtain wall (e.g.: safing slot gaps).
 - .3 This Section includes fire stopping work for entire Project including selection, installation and inspection of all required fire stops.

1.4 PREINSTALLATION MEETINGS

- .1 Convene preinstallation meeting two weeks before beginning work of this Section, with Contractor's representative and Consultant to:
 - .1 Verify Project requirements.
 - .2 Review sustainable requirements.
 - .3 Review installation and substrate conditions.
 - .4 Coordinate with other building trades.
 - .5 Review system design listings, manufacturer's installation instructions and warranty requirements.
 - .6 Review quantity and location of mock-ups.
- .2 Convene preinstallation meetings with other trades to review:
 - .1 Installation procedures and precautions.
 - .2 Location, scheduling and sequencing of other work around fire stops that can affect the outcome of the installation.
 - .3 Requirements for annular opening sizes.
 - .4 Requirements and preparations for wall/floor single and multi-penetrations.
 - .5 Requirements for construction and perimeter joints.
 - .6 Mock-up requirements.
- .3 Submit copies of applicable listed fire stop system details to each trade for opening preparation. Include installation details required for the listed system.



- .4 Meeting minutes: Contractor to take minutes of preinstallation meetings and distribute to Project Team and each affected trades.

1.5 SEQUENCING

- .1 Proceed with installation only when submittals have been reviewed by Consultant.
- .2 Fire stops located in floor assemblies: install before interior partition erections.
- .3 Metal deck bonding: unless noted otherwise on system design listing and manufacturer's installation instructions, fire stopping to precede spray applied fireproofing to ensure required bonding.
- .4 Pipe and duct insulation: certified fire stop system component.
 - .1 Ensure pipe and duct insulation installation precedes fire stopping.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Qualification Statement
 - .1 Submit contractor qualification statements and certificates demonstrating compliance with the qualification requirements of this Section within 10 working days after award of contract and before starting Work.
- .3 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet. Submit complete product data for each individual component and include:
 - .1 Product name and product number.
 - .2 Product characteristics and performance criteria.
 - .3 Physical size, finish and limitations.
 - .4 Technical data on out-gassing, off-gassing and age testing.
 - .5 Curing time.
 - .6 Chemical compatibility to other construction materials.
 - .7 Shelf life.
 - .8 Life expectancy.
 - .9 Temperature range for installation.
 - .10 Humidity range for installation.
 - .11 Sound attenuation STC-Rating.
 - .2 Manufacture Product Certification:
 - .1 Submit certification by the manufacturer that products supplied comply with local regulations controlling use of Volatile Organic Compounds (VOC's) and are non-toxic to building occupants.
 - .2 Submit test reports showing compliance to ASTM E595 .
 - .3 For each individual component, Submit copies of WHMIS Safety Data Sheets (SDS).
 - .4 Submit a comprehensive list of all products and components included in submittal.
- .4 Shop Drawings:
 - .1 Submit shop drawings showing system design listings for Project including proposed



- materials, reinforcement, anchorage, fastenings and method of installation.
- .2 Construction details to accurately reflect actual job conditions for each product and assembly.
 - .3 Submit details for materials and prefabricated devices.
 - .4 Submit electronic copy of shop drawings and include:
 - .1 Title page, labelled "Fire and Smoke Stop System Listings". Include project name, date and the names of the installation company and the manufacturer of proposed products. Insert title in front and spine of binder.
 - .2 Table of Contents at the front of each binder.
 - .3 List of each proposed listed fire stop system and corresponding service penetration type or joint type in a matrix spreadsheet schedule, indicating floor and wall system, including rating for each.
 - .4 Location of penetrations:
 - .1 Drawings showing the location of each penetration with a unique penetration identification number [and associated listing number.
 - .2 Schedules listing each penetration with a unique identification number, their associated listing number, organized by floor, wall and ceiling area and indicating each room number.
 - .5 System Design Listings:
 - .1 Submit CAN/ULC-S115 design listings for each listed fire stop system and each application identified.
 - .2 When more than one product is specified for the listed fire stop system or more than one packing/damming material is indicated, identify the item that will be used on this Project.
 - .6 Certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.
 - .6 Samples: submit to Owner's Representative and Consultant minimum one week before commencing on site work:
 - .1 Duplicate 300 x 300 mm samples of each system showing actual fire stop materials proposed for Project including anchors/fasteners and damming materials.
 - .2 Duplicate samples of each type of label proposed for the identification of fire stops.
 - .7 Engineering Judgments:
 - .1 Where there is no specific tested listed fire stop system available from the manufacturer for a particular fire stop configuration, review systems from other manufacturers to obtain a listed fire stop system.
 - .2 Submit an Engineering Judgment (EJ) from the system manufacturer if there are no listed systems available from other manufacturers.
 - .3 Prepare and submit an EJ in accordance with best practices established in the following documents:
 - .1 IFC Guidelines for Evaluating Engineering Judgments .
 - .2 IFC Guidelines for Evaluating Engineering Judgments - Perimeter Fire Barrier Systems .



- .4 For each EJ submitted, include:
 - .1 Project name, number and location.
 - .2 A description of the proposed system with detailed drawing.
 - .3 Installation instructions.
 - .4 Complete descriptions of critical elements for the fire stop configuration.
 - .5 Copies of all referenced system design listings on which the EJ is based on.
 - .6 EJ issuer name and contact information.
 - .7 Date of issue of EJ with authorization signature of issuer.
 - .8 Manufacturer letter stating their opinion, with supporting justification, that the EJ will perform as a fire stop system were it to be subjected to the appropriate standard fire test method for the required fire rating duration.
- .8 Once the EJ has been reviewed, submit the EJ to the authority having jurisdiction for final approval.
- .9 EJ shall be issued only by fire stop manufacturer's qualified technical personnel or in concert with the manufacturer by a knowledgeable registered Professional Engineer, a Fire Protection Engineer or an independent testing agency that provides testing and listing services for fire stop systems similar to the EJ being contemplated.
- .10 EJ shall be based upon interpolations of previously tested fire stop systems that are either sufficiently similar in nature or clearly bracket the conditions upon which the Engineering Judgment is to be given. Additional knowledge and technical interpretations based upon accepted engineering principles, fire science and fire testing guidelines (e.g.: ASTM E2032) may also be used as further support data.
- .11 EJ shall be based upon knowledge of the elements of the construction to be protected and understanding of the probable behaviour of that construction and the recommended fire stop system protecting it were they to be subjected to the adequate standard fire test method for the required fire rating duration.
- .12 EJ shall be limited to the specific conditions and configurations upon which EJ was rendered and should be based upon reasonable performance expectations for the recommended fire stop system under those conditions.
- .13 EJ shall be accepted only for a single specific job and location and should not be transferred to any other job or location without thorough and appropriate review of all aspects of the next job or location's circumstances.
- .14 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work.

1.7 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual. Include:
 - .1 WHMIS Safety Data Sheets (SDS).
 - .2 Product data and manufacturer's installation and maintenance instructions for each product/system used on this project.
 - .3 Approved system design listings and Engineering Judgments.
 - .4 Matrix schedule listing all system design listings and Engineering Judgments with a



- description of their penetration or joint type.
- .5 Certifications:
 - .1 Proof of training for each worker that performed installation on the Project.
 - .2 Proof of company as a FCIA - Member in Good Standing.
 - .3 Certification of company as a ULC Qualified or FM 4991 Approved Firestop Contractor, including the Designated Responsible Individual (DRI) certificate.
 - .4 Accreditation of third-party inspection firm.
 - .6 Manufacturer's site reports.
 - .7 Warranty information on fire stop installations.
 - .8 Life expectancy of each product installed as part of Project. For each system, list the installation date of products and the expected expiration date (month/year).
- .3 Record Documentation:
- .1 Maintain a daily log of all activities on site during the course of construction. Submit a copy of all daily logs after completion of fire stopping work.
 - .2 As-built Drawings:
 - .1 Submit marked-up set of drawings to provide referencing system identifying the location of each fire stop.
 - .2 Identify each penetration type fire stop with their penetration identification number.
 - .3 Provide detailed drawings of system design listings for each type of fire stop (i.e.: through-penetration, membrane penetration, blank opening, construction joint, building perimeter).
 - .3 Fire Stop Schedules:
 - .1 Submit complete fire stop schedules for floors, walls and ceilings.
 - .2 Indicate all penetration fire stops and joint fire stops through each reference wall, floor and ceiling in the schedules.
 - .3 Cross-reference fire stop schedules with as-built drawings and indicate design listing numbers associated to each penetration fire stop and joint fire stop.

1.8 QUALITY ASSURANCE

- .1 Provide systems selection and analysis, installation and inspection of fire stop systems in accordance with the recommended practices detailed in the following guides:
 - .1 FCIA Firestop Manual of Practice (MOP) .
- .2 Qualifications:
 - .1 Contractor specializing in selection and installation of fire stops with five years documented experience approved by manufacturer. Submit a list of five successfully completed projects of similar scale and type.
 - .2 Company recognized as a Member in Good Standing with the Firestop Contractors International Association (FCIA) . Submit written proof of current membership.
 - .3 Training: workers, including site supervisor, to have completed:
 - .1 Manufacturer training on the products/systems installed as part of this Section.
 - .2 Training under the FCIA Firestop Containment Worker Education Program.



- .4 Certified Firestop Contractor: company certified with one of the following programs:
 - .1 ULC Qualified Firestop Contractor Program. Submit signed copy of ULC Qualified Firestop Contractor Program certificate.
 - .2 FM 4991 Approved Firestop Contractor . Submit signed copy of FM 4991 Approval certificate.
- .3 Mock-ups:
 - .1 Construct mock-up of fire stop systems in accordance with Section 01 43 00 - Quality Assurance.
 - .2 Before commencement of construction, provide mock-up of each proposed listed fire stop system for review by Owner's Representative and Consultant. Mock-up shall include work by other trades to demonstrate the required finish work, such as steel stud / gypsum board trade framing out multi-penetrations openings.
 - .3 Install proposed identification labels for each penetration.
 - .4 Locations for mock-ups as directed by the Owner's Representative.
 - .5 Once a mock-up is completed and materials had adequate time to properly cure, provide minimum of 48 hours written notification to Owner's Representative and Consultant to conduct review.
 - .6 Manufacturer's representative and inspection firm to be present during review of mock-ups.
 - .7 Correct mock-up deficiencies as directed by Owner's Representative, Consultant and manufacturer.
 - .8 When accepted, mock-ups will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.
 - .9 Owner's Representative may perform destructive tests to each mock-up to ensure the system meets or exceeds the approved system design listing.

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings, manufacturing date, shelf life expiry date.
- .2 Storage and Protection:
 - .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective, expired or damaged materials with new.
 - .3 Coordinate delivery of materials with scheduled installation dates to allow minimum storage time on site.
 - .4 Comply with recommended procedures, precautions and measures described in WHMIS Safety Data Sheets (SDS).



1.10 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Install fire stops when ambient and substrate temperatures are within the limits prescribed by the manufacturer and when the substrate is dry and without risk of condensation.
 - .2 Maintain manufacturer's recommended ambient and substrate temperatures for 48 hours before and 72 hours after installation.
- .2 Ventilate fire stops in accordance with manufacturers' instructions by natural means or where this is inadequate using forced air circulation.

1.11 WARRANTY

- .1 For the Work of this Section 07 84 00 - Fire Stopping, the warranty period is extended to 24 months.
- .2 Manufacturers shall warrant work of this section against defects and deficiencies in the product material for a period of 24 months. Promptly correct any defects or deficiencies, which become apparent within warranty period at no expense.
- .3 Contractor shall warrant workmanship on materials and installation for a period of 24 months. Promptly correct any defects or deficiencies which become apparent within warranty period at no expense.

2 PRODUCTS

2.1 MANUFACTURERS

- .1 Provide products from a single manufacturer, to the greatest extent possible, to perform all fire stopping work. Materials of different manufacturers will not be permitted without written authorization from Consultant.
- .2 Where there is no specific tested listed fire stop system available from the manufacturer for a particular fire stopping application, provide a listed system from an alternative manufacturer to avoid providing an Engineering Judgment.
- .3 Where a facility has a standard firestopping supplier, contractor shall carry this supplier to match remainder of the existing fire stopping installations.

2.2 DESIGN/PERFORMANCE CRITERIA

- .1 Fire stop and smoke stop systems and systems providing a barrier to smoke spread consisting of a material or combination of materials installed to maintain the integrity of the fire resistance rating of a fire separation in accordance with the requirements of NBC-2015 .
- .2 Non-rated fire separations: provide L-Rated smoke protection fire stop system for application on both sides of separation.
- .3 Acoustic insulation properties, as shown on drawings or in schedules.
- .4 Dynamic joints: where required, fire and smoke stop systems to be designed to accommodate a defined amount of movement to account for expansion or contraction in construction joints and mechanical piping, for movement in structural elements and to accommodate for movement and sound and vibration control in mechanical installations.
- .5 Insulated pipes and ducts: listed fire stop system designed and tested with actual



insulation materials penetrating the fire separation, as indicated on the system design listing.

- .6 Use in wet areas: water based products are unacceptable in wet areas or areas that may be subject to occasional water exposure or flooding during and after construction.
- .7 Architectural considerations: when exposed to view, fire stop system to consider architectural finish, potential traffic, and exposure to moisture and heat.

2.3 MATERIALS

- .1 Fire stop and smoke stop systems: in accordance with CAN-ULC-S115.
 - .1 Asbestos-free materials and systems capable of maintaining effective barrier against the passage of flame, smoke and water and the transmission of heat in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended, as indicated on System Design Listing .
 - .2 Fire stop system rating: to match fire resistance rating of fire separation.
 - .3 Service penetration assemblies and fire stop components: certified by test laboratory to CAN/ULC-S115.
- .2 Fire and smoke stop systems at openings intended for re-entry such as cables: provide elastomeric seal or non-shrink foam cement mortar.
- .3 Fire and smoke stop systems at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: provide elastomeric protection.
- .4 Fire and smoke stops behind and around mechanical and electrical boxes within wall, floor and ceiling assemblies: provide elastomeric seal.
- .5 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .6 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .7 Packing/damming materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .8 Fire stop insulation: pre-formed, semi rigid, non-combustible mineral wool, pre-cut in 1220 mm lengths to required depth and width.
- .9 Junction box / outlet sealing putty: intumescent putty, pre-formed in pads.
- .10 Sealants: good adhesion without use of primer, high visibility safety colours.
 - .1 Flame spread rating: maximum 25 .
 - .2 Smoke development classification: maximum 50.
 - .3 For vertical joints: non-sagging.
 - .4 For horizontal joints: single component, self-levelling.

2.4 FIRE STOP IDENTIFICATION

- .1 Identification labels and markings to be indelible for the expected service life of the installation.
- .2 Fire Stopped Penetrations:
 - .1 Provide identification labels at each penetration.



- .2 Identification labels: adhesive plastic stickers, tamper-evident frangible stickers, embossed metal tags with metal fastening device with the following information:
 - .1 Penetration number.
 - .2 Floor number.
 - .3 Room number.
 - .4 Product name and number.
 - .5 System Design number.
 - .6 Fire Rating Required: in hours.
 - .7 Fire Stop Contractor's Name and phone number.
 - .8 Installer's Name.
 - .9 Date of Installation.
 - .10 Re-penetrated by: Company, Installer and Date.
- .3 Label shall state that the fill material around the penetration is a fire stop system and it shall not be disturbed except by authorized personnel.
- .3 Fire Separation (Barrier) Markings:
 - .1 Provide identification for all vertical fire separations.
 - .2 Identification markings: adhesive tamper evident stickers or stencil painted with lettering at least 75 mm in height with a minimum 10 mm stroke in contrasting colour.
 - .3 Marking to incorporate the assembly's fire-resistance rating and the following suggested wording, "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS", or other accepted wording.
- .4 Include horizontal red painted line, 75 mm in width, between identification markings.

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 datasheets.

3.2 EXAMINATION

- .1 Verify substrate conditions are acceptable for product installation in accordance with manufacturer's instructions and approved system design listings for each condition.
- .2 Verify each opening/annular space to ensure it does not exceed the maximum and minimum dimensions indicated on the approved system design listing.
- .3 Verify that all joints, service penetrating elements and supporting devices/hangers have been properly installed as indicated on approved system design listings. All temporary lines and markings have been removed to meet the approved system design listings.
- .4 Verify that the proposed fire stop system is composed of components that are compatible with each other, the substrates forming the openings, and the items, if any, penetrating the fire stop under conditions of application and service, as demonstrated by the fire stop manufacturer based on testing and site experience.



- .5 Pipe and duct insulation: confirm that the proposed fire stop system has been tested with the actual insulation penetrating the fire separation on site, as indicated in the approved system design listing. Maintain insulation around pipes and ducts penetrating the fire separation.
- .6 Ensure no additional items have been installed through opening that does not appear on the approved system design listing.
- .7 Ensure areas that are to be fire stopped are accessible for proper application and conditions are suitable for installation of the fire stop system. Areas to remain accessible for inspection.
- .8 Report in writing to Consultant any defective surfaces or conditions affecting the fire stop system installation, immediately and before commencing any installations.
- .9 Proceed only once defected surfaces or conditions have been corrected.
- .10 Beginning of installation means acceptance of site conditions.

3.2 PREPARATION

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
 - .1 Ensure that substrates and surfaces are clean, dry and frost free.
 - .2 Ensure substrates and surfaces are free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
- .2 Prepare surfaces in contact with fire stop and smoke stop materials 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.
- .5 Protect adjacent work areas and finish surfaces from damage during product installation.
- .6 Ensure multi-penetration openings have been framed and boarded out, all around the annular opening as indicated in the system design listing before prepping the opening.

3.3 INSTALLATION

- .1 Install fire stop and smoke stop materials and components in accordance with manufacturer's certified tested system listing.
- .2 Coordinate with other sub-trades to ensure that all pipes, conduits, cables, and other items, which penetrate fire separations, have been permanently installed before installation of fire stop systems.
- .3 Schedule work to ensure that fire separations and all other construction that conceals penetrations are not erected before installation of fire and smoke stop systems
- .4 Protect holes or gaps made by through penetrations, poke through termination devices, and un-penetrated openings or joints to ensure that both continuity and integrity of fire separation are maintained.
- .5 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing per manufacturer's instructions.
- .6 Tool or trowel exposed surfaces to neat finish.



- .7 Remove excess compound promptly as work progresses and upon completion.
- .8 Protect gaps around recessed components (e.g.: panels, electrical boxes, outlets) with sealing putty in accordance with manufacturer's instructions.
- .9 Do not use damaged or expired material.
- .10 Joint Fire Stops:
 - .1 For sealant applications, install joint fillers to support fire stop materials during application. Position joint fillers to ensure fire stop material cross-sectional shape and thickness relative to the joint width allows for optimum sealant movement, while developing the required fire-resistance rating.
 - .2 Install fire stops using techniques recommended by the manufacturer:
 - .1 Fully wetting joint substrates to optimize adhesion.
 - .2 Completely filling recesses provided for each joint configuration.
 - .3 Providing uniform, cross-sectional shapes and thickness relative to joint width that optimize movement capability.
 - .4 Tooling non-sag fire stop materials immediately after their application and before the time skinning begins. Form smooth, uniform beads of configuration indicated or required to:
 - .1 Provide required fire-resistance rating.
 - .2 Eliminate air pockets.
 - .3 Ensure contact and adhesion with sides of joint..
 - .3 Joint Systems and Perimeter Fire Containment Systems:
 - .1 For systems with dynamic joints, ensure movement capabilities of the installation meet or exceed the movement expectations of the system design listing and manufacturer's installation instructions.

3.4 IDENTIFICATION

- .1 General :
 - .1 Clean substrate before applying identification.
 - .2 Final location of identification to be determined on site.
 - .3 Identification is not required on both sides of the fire separation.
- .2 Fire Stopped Penetrations:
 - .1 Install identification label adjacent to each wall/floor service penetrations fire stopped Provide one identification label per single opening or per grouping cluster.
 - .2 Securely apply identification to substrate by providing adequate adhesive.
 - .3 Secure tags with metal fasteners or hang with metal chain or wire.
 - .4 Identification shall be completely filled out and installed before requesting substantial performance.
- .3 Fire Separations (Barriers):
 - .1 Provide identification at least 4,500 mm of the end of each wall and at intervals not exceeding 9,000 mm along wall/floor joint fire stops.
 - .2 Markings to be installed within ceiling spaces, 600 mm below horizontal fire separation or roof structure unless otherwise indicated.



- .3 For occupied areas with exposed ceilings: review location of identification with Owner's Representative before proceeding.

3.5 REPAIRS AND MODIFICATIONS

- .1 Identify damaged or re-entered seals requiring repair or modification.
- .2 Remove loose or damaged materials. If penetrating items are to be added, remove sufficient material to insert new elements and to avoid damaging the balance of the seal.
- .3 Ensure that surfaces to be sealed are clean and dry.
- .4 Use only materials that are suitable for repair of original seal, as approved by manufacturer. Do not mix products from different manufacturers.
- .5 Repair all damage resulting from fire stop destructive testing.

3.6 SITE QUALITY CONTROL

- .1 Inspections: notify Owner's Representative when ready for inspection and before concealing or enclosing fire stop materials and service penetration assemblies.
- .2 Manufacturer's Field Services:
 - .1 Mock-ups: manufacturer to provide written confirmation that the fire stop system installed meets or exceeds the system design listing requirements for each mock-up application.
 - .2 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Site Reports as described in PART 1 - SUBMITTALS.
 - .3 Provide manufacturer's site services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .4 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.7 FIRE STOPPING LOCATIONS

- .1 Provide fire stop and L-Rated smoke-resistant fire stop systems at:
 - .1 Penetrations through fire-resistance and smoke-resistance rated masonry, concrete, and gypsum board partitions and walls.
 - .2 Penetrations through fire-resistance rated floor slabs/systems, ceilings and roof.
 - .3 Edge of floor slabs at curtain wall and precast concrete panels.
 - .4 Edge of fire-resistant floor or roof assemblies and exterior wall assemblies.
 - .5 Joints at top and bottom of fire-resistance rated masonry and gypsum board partitions. Joints to allow for independent movement.
 - .6 Joints at top and bottom of fire-resistance rated walls where they meet non-rated fire separation assemblies.
 - .7 Intersection of fire-resistance rated masonry, concrete and gypsum board partitions.
 - .8 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
 - .9 Expansion joints in fire-resistance rated floors, walls, ceilings and roof assemblies.
 - .10 Perimeter gaps at curtain wall or other exterior wall assembly and horizontal fire-



separation.

- .11 Openings and sleeves installed for future use through fire separations.
 - .12 Around mechanical and electrical assemblies/devices penetrating fire separations.
 - .13 Mechanical and electrical recessed boxes in walls and partitions.
 - .14 Rigid ducts: fire stopping to consist of bead of fire stop material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.
- .2 Provide fire stop and L-Rated smoke-resistant fire stop systems at locations shown on drawings and as indicated on drawing schedules or details.

3.8 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 Remove equipment, excess materials and debris and clean adjacent surfaces immediately after application. Use methods and cleaning materials approved by manufacturer.
- .3 Protect fire stops during and after curing period from contact with contaminating substances. Repair all damage.
- .4 Remove temporary dams after initial set of fire stop and smoke stop materials.

END OF SECTION



1 GENERAL

1.1 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 all equipment, systems, accessories 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 Ontario, Canada.
 - .2 Indicate on drawings:
 - .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.
 - .6 Equipment lead times.
 - .7 List of spare parts.
 - .8 Flow diagrams, controls schematic, wiring diagrams.
 - .9 Part load (0-100% in 10% increments) and full load efficiencies.
 - .10 Performance/capacity.
 - .11 Construction of equipment.
 - .12 Product warranty.
 - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .4 Coordination Shop Drawings:
 - .1 Submit complete consolidated and coordinated shop drawings for all new systems, and for existing systems that are in the same areas.
 - .2 The coordination/shop drawings shall include plan views, elevations and sections of all systems in AutoCAD format and shall be on a scale of not less than 1:50. Clearly identify and dimension the proposed locations of the equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance.
 - .3 Provide detailed coordination/shop drawings of all piping and duct systems.
 - .4 Do not install equipment foundations, equipment or piping until coordination/shop drawings have been approved.



- .5 Rigging Plan:
 - .1 Provide documentation of the capacity and weight of the rigging and equipment intended to be used. The plan shall include the path of travel of the load, the staging area and intended access, and qualifications of the operator and signal person.
 - .2 Confirm equipment staging areas and crane locations with the Owner's Representative prior to preparation of the plan.
 - .3 Indicate extents of the fencing, signage, barrier and temporary provisions on the plans.
 - .4 Include necessary permitting (road closure, traffic control, etc) for all required rigging and craning of the equipment.

1.2 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for all equipment for incorporation into manual.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Owner's Representative and Consultant before final inspection.
 - .2 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.
 - .3 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.
 - .4 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.
 - .5 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual Owner's Representative and Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.



- .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
 - .1 Consultant will provide 1 set of reproducible mechanical drawings – “Issued for Construction” in AutoCAD 2020 format. Contractor shall be responsible for all revisions, modifications and additions to AutoCAD drawing as required to accurately reflect as-built conditions.
 - .2 Transfer information weekly to reproducible, revising reproducible to show work as actually installed.
 - .3 Adhere to Owner’s CAD Guidelines, obtain copy of the guidelines from Owner’s Representative.
 - .4 Make drawings available to Owner’s Representative and Consultant for reference purposes and inspection.
- .8 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings in AutoCAD 2020 format.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - “AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED” (Signature of Contractor) (Date).
 - .3 Submit to Owner’s Representative and Consultant 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.
 - .6 As-built drawings shall be prepared in accordance with Owner’s CAD Guidelines, obtain copy of the guidelines from Owner’s Representative.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish spare parts as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One filter cartridge for hydronic system and one set of filter media for each filter bank for air systems in addition to final operating set.\
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers including but not limited to boiler burner cleaning kit, chiller tube cleaning kit, etc.



- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.5 CODES, REGULATIONS AND STANDARDS

- .1 All mechanical work shall be in compliance with the latest editions of the applicable codes, regulations and bylaws, including:
 - .1 Ontario Building Code
 - .2 Ontario Fire Code
 - .3 Canadian Standards Association
 - .4 Canadian Gas Association
 - .5 ASHRAE
 - .6 ASME
 - .7 NFPA
 - .8 SMACNA
 - .9 NECB
 - .10 Local Municipal Bylaws and Regulations
 - .11 Owner Specific Standards and Guidelines
- .2 Refer to Section 01 41 00 – Regulatory Requirements for complete list.
- .3 Where discrepancies between contract documents and references codes/standards are identified, Contractor shall request clarification from Consultant prior to proceeding with work.
- .4 Referenced codes, standards, regulations and guidelines are noted as a minimum requirement and shall not be used to alter, reduce or modify requirements of the contract documents.

1.6 PERMITS AND APPROVALS

- .1 Contractor shall be responsible for all costs associated with permitting and approvals by Authorities Having Jurisdiction (AHJ), including but not limited to:
 - .1 Application and obtaining of permits
 - .2 Permit fees
 - .3 Inspection fees



- .4 Demonstration
- .2 Contractor shall be responsible for coordinating and scheduling progress inspection prior to work concealment and final acceptance.
- .3 Provide sufficient notice for inspections, provide qualified and licensed technicians to demonstrate work to inspectors.
- .4 Complete all repairs and adjustments to satisfaction of AHJ and schedule for follow-up inspection as required to complete the project.
- .5 Collect and submit all inspection certificates and permit closeout letters for all disciplines, include in closeout manuals.

1.7 TEST REPORTS

- .1 Contractor shall complete all required testing as specified in the contract documents.
- .2 Provide sufficient notice (minimum 10 working days) to Owner's Representative, Consultant, Commissioning Authority, inspectors and Authorities Having Jurisdiction (AHJ). Tests may be witnessed in their entirety or partially at discretion of these parties.
- .3 Make repairs, adjustments and troubleshoot issues when test results are not acceptable.
- .4 Submit all test reports for review and approval to the Consultant, including but not limited to:
 - .1 Pressure testing of piping systems and equipment (boilers, heat exchangers, etc)
 - .2 Piping flushing, cleaning and chemical treatment
 - .3 Water and Air Systems Balancing (TAB)
 - .4 Ductwork and equipment leakage test reports
 - .5 Equipment start-up reports
 - .6 Sprinkler system certificates and Contractor's Fire Protection Engineer's NFPA 13 compliance letter
 - .7 Standpipe system certificates and Contractor's Fire Protection Engineer's NFPA 14 compliance letter
 - .8 Controls point to point verification report and sensor calibration report
 - .9 Manufacturer's troubleshooting and service reports documenting encountered issues and corrective steps taken
 - .10 Approvals by AHJ (TSSA, ESA, etc)

1.8 QUALITY ASSURANCE

- .1 All systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. All construction personnel shall be experienced and qualified specialists in industrial and institutional HVAC.
- .2 Products Criteria:
 - .1 The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. All controllers and software shall be of the latest version with the latest version of the firmware. Refer other specification sections for any exceptions and/or additional requirements.



- .2 All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
- .3 The products and execution of work specified shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply.
5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be of the same manufacturer and model number, or if different models are required they shall be of the same manufacturer and identical to the greatest extent possible (i.e., same model series).
6. Assembled Units: Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
8. Use of asbestos products or equipment or materials containing asbestos is prohibited.
- .3 Systems Welding:
 - .1 All welding shall be completed in accordance with Section 23 05 17 – Pipe Welding.
 - .2 Submit required certificates, procedures, and credentials prior to any work.
- .4 Testing, Adjusting and Balancing:
 - .1 All systems shall be tested, adjusted and balanced in accordance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.
 - .2 Work shall be completed by certified agencies, submit certificates and credentials for all personnel.
 - .3 Submit test instrumentation information and calibration certificates prior to any work.
- .5 Systems Commissioning
 - .1 Carry out commissioning of all installed systems and existing systems where new systems are integrated in accordance with Section 01 91 13 – General Commissioning Requirements.

2.1 GENERAL

- .1 All materials shall be new in accordance with the specifications of contract documents.
- .2 All products shall be listed and approved by relevant authorities.
- .3 All equipment and materials shall be transported, stored, craned, rigged and moved in accordance with manufacturer's instructions; any damages to equipment and/or parts of equipment shall be replaced by Contractor at no cost to Owner.



2.2 ACCESS PANELS/DOORS

- .1 Provide access panels at all locations of concealed equipment, fittings requiring access for operation, maintenance and repair including but not limited to balancing dampers, fire dampers, smoke dampers, fire/smoke dampers, motorized dampers, sensors, filters and other components and devices requiring maintenance/service access.
- .2 Access doors shall be located to provide complete access to concealed equipment and devices.
- .3 Construction:
 - .1 Plaster or wet wall: 16 ga steel flush with surface complete with gasket and concealed flange.
 - .2 Masonry or drywall: 16 ga steel flush with surface complete with gasket and concealed flange.
- .4 Finish:
 - .1 Tiled or marble surfaces: type 304 stainless steel, #4 satin polish.
 - .2 Other areas: prime coated steel, finished to match adjacent.
- .5 Options and accessories:
 - .1 Continuous concealed hinges.
 - .2 Adjustable anchoring straps to suit installation.
 - .3 Mineral wool insulation (for fire rated panels).
 - .4 Self latching screw driver operated slam latch.
 - .5 Automatic panel closer.
 - .6 Inside latch release.
- .6 Sizing:
 - .1 Access panels/doors shall be of adequate size to facilitate access to all components. The following are minimum recommended sizes:
 - .1 Hand access: 300x300mm (12"x12")
 - .2 Body entry access: 600x600mm (24"x24")
- .7 Fire rating
 - .1 Access doors/panels installed in fire rated floor and wall assemblies shall have similar fire rating and corresponding ULC label.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Owner's Representative.
 - .2 Inform Consultant 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 Consultant.



- .2 Carry out field inspections of the proposed work and existing conditions affecting work prior to tender submission. Additional inspections may be arranged thru Owner's Representative. No additional costs will be considered for additional work where these conditions would have been discovered by such inspections. Report any potential challenges and issues which may impact proposed work to the Consultant for clarification within Q&A period, during Tender phase.

3.2 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.

3.3 SYSTEM CLEANING

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.
- .2 Refer to Section 01 74 00 – Cleaning.

3.4 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer, codes and bylaws.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer, codes and bylaws without interrupting operation of other system, equipment, components.
- .3 Contractor shall coordinate installation of each equipment components with all trades prior to any work to avoid service obstruction to equipment. Any infractions of service clearances be responsibility of the contractor and must be corrected prior to substantial completion.

3.5 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.
 - .1 Discharge to be visible.
- .4 Drain valves: 20mm (NPS 3/4) gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.6 AIR VENTS

- .1 Install automatic air vents at all 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.

3.7 DIELECTRIC COUPLINGS

- .1 Provide on connections between dissimilar metals.
- .2 50mm (NPS 2) and under: provide insulating unions.



- .3 65mm (NPS 2 1/2) and over: provide insulating flanges.
- .4 Isolation shall be provided where piping may come in contact with dissimilar metals including hangers, supports, joists and studs.

3.8 PIPEWORK INSTALLATION

- .1 Install pipework to relevant codes and regulations.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use gate valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves on chilled water and related condenser water systems only.
 - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .9 Install plug cocks or ball valves for glycol service.
 - .10 Use chain operators on valves 65mm (NPS 2 1/2) and larger where installed more than 2,400 mm above floor in Mechanical Rooms.
 - .11 Provide extended valve stems to clear insulation and allow for uncompromised valve operation without damaging insulation.



- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.9 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Provide minimum 50mm (2") extended sleeves above floors prone to collection of water including but not limited to mechanical rooms, janitor closets, plenums, shafts.
- .6 Where passing thru fire rated assemblies, seal space between sleeve and piping with listed non-combustible insulation to meet fire rating of given assembly.
- .7 Provide tight fitting clamps on each side of the sleeve and finish with chrome plated escutcheons at penetrations in finished surfaces and millwork.
- .8 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181
- .9 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for fire stopping.
 - .2 Maintain the fire-resistance rating integrity of the fire separation.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.10 ESCUTCHEONS

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

3.11 PREPARATION FOR FIRE STOPPING

- .1 Coordinate the installation of fire stopping around pipes, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Pipes subject to movement: conform to fire stop system design listing to ensure pipe movement without damaging fire stopping material or installation.
- .3 Insulated pipes: ensure integrity of insulation and vapour barriers.



3.12 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 00 - Cleaning supplemented as specified in relevant mechanical sections.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.
- .4 Provide minimum 50mm (NPS 2) bypass piping complete with ball valve at the end of each loop or circuit to facilitate complete flushing of piping network. Coordinate locations of the bypasses with the chemical treatment vendor.
- .5 Repeat flushing and cleaning of piping systems as required to achieve adequate water quality.

3.13 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

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

3.14 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Departmental Representative. Provide detailed Methods of Procedures (MOP) for all connections to the existing systems.
- .2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.
- .3 Unless otherwise noted, connections to the existing live piping systems shall be completed via hot tapping means to minimize system shut downs. Pipe freezing shall also be used when isolation valve is not available to prevent disruption of the piping network.
- .4 Be responsible for damage to existing plant by this work.

3.15 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit reports.
- .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.



- .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.

3.15 MECHANICAL AND ELECTRICAL COORDINATION

- .1 All motor control centres, starters, power wiring and conduit shall be provided by Division 26.
- .2 Where packaged mechanical equipment is shipped with integrated starter, Division 26 shall provide power wiring in conduit. Refer to schedules and relevant specifications for details.
- .3 All remote disconnect switches, service receptacles shall be provided by Division 26.
- .4 All mechanical control wiring shall be provided by this division, except for life safety and fire alarm systems.
- .5 All motors for mechanical systems shall be provided by this division.
- .6 Wiring to smoke dampers, combination fire and smoke dampers, damper end switches shall be provided by Division 26.
- .7 All relays required for mechanical systems shall be provided by this division.
- .8 Electric heat tracing systems for piping systems and basin heaters for cooling tower sumps shall be provided by this division, with power provisions by Division 26.
- .9 All relays and mechanical systems shutdowns by fire alarm systems shall be provided by Division 26.
- .10 Mechanical contractor shall coordinate with Division 26 for all power requirements to mechanical control systems; Division 26 to provide power wiring and transformer where required.

3.16 DEMONSTRATION

- .1 Owner's Representative may 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.
- .5 Contractor shall record these demonstrations on video tape for future reference.

3.17 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.



3.18 PROTECTION

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

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 and 23. Refer to Division 26 for quality of materials and workmanship.
 - .4 Variable Frequency Drives

1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1, 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 Safety Data Sheets (SDS).
- .4 National Energy Code for Buildings (NECB)
- .5 National Electrical Manufacturers Association (NEMA).
 - .1 NEMA MG-1 National Electrical Manufacturers Association – Motors and Generators.
- .6 ANSI/IEEE 112 - Test Procedures for Motors / Generators.
- .7 UL 1004 - Motors, Electric.
- .8 UL 674 - Motors, Generators, Electric, for Use in Hazardous Locations: Class I, Groups C and D; Class II, Groups E, F, and G.

1.3 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with Canadian Environmental Protection Act (CEPA), Canadian Environmental Assessment Agency (CEAA), Transportation of Dangerous Goods Act (TDGA) and applicable Provincial regulations.
- .2 Motors shall have CSA certification and UL listing.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.



2 PRODUCTS

2.1 GENERAL

- .1 Motors shall be premium efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.
- .2 Motors not to exceed speeds above 1,800 RPM unless otherwise noted.
- .3 Motors shall be located to allow for replacement of bearings.
- .4 Provided extended lube lines and alemite fitting outside of fan enclosure to facilitate lubrication.
- .5 Motors used for variable speed applications shall be inverted duty rated suitable for operation at variable torque loads over wide speed range.
- .6 Motors shall be rated for 1.15 service factor in 40°C (105°F) ambient conditions.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 373 W (1/2 HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W (1/2 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, 208 V or 600V, unless otherwise indicated. Confirm electric voltage, phase and starter requirements with Division 26.
- .4 Motors shall be Open Drip Proof (ODP) to totally enclosed fan cooled (TEFC) enclosure type.
- .5 Standard of Acceptance: Baldor, WEG, US Motors or US Motors.

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW (10 HP): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW (10 HP) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.



- .8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

- .1 Provide removable guards for unprotected drives and unprotected fan inlets/outlets.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm (1.5") dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.
- .7 Guards shall be powder coated and finished painted bright yellow.

2.5 GROUNDING

- .1 All motors used in variable speed applications shall be provided with micro fiber shaft grounding ring, AEGIS SGR or equivalent. Ensure shaft is free from debris, coating, paint prior to installation. Install in accordance with manufacturer's instructions and test for a conductive path to ground using an ohmmeter. Ensure readings are under 1 ohm.
- .2 Ground motors to common earth ground with drive with grounding strap according to applicable standards and motor/VFD installation instructions.

2.6 VARIABLE FREQUENCY DRIVED (VFD)

- .1 Provide complete variable frequency drives (VFD) for the fans and pumps designated on the schedules to be variable speed. Separate schedules are not issued for the variable frequency drives. Refer to the air handling unit, return fan, cooling tower and pump schedules as applicable. All standard and optional features shall be included within the VFD enclosure. VFD enclosure shall be in heavy gauge metal NEMA 1 enclosure. The entire package shall be UL and CSA approved.
- .2 The VFD shall be tested to UL 508C. The appropriate cUL label shall be applied.



- .3 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.
- .4 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
- .5 The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients.
- .6 The VFD's full load output current rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.
- .7 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
- .8 VFD shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.
- .9 Supply all VFD with the latest version of firmware, upgrade all existing VFD's in field as required.
- .10 All VFDs to be remote mounted on either Unistrut stand or wall. VFDs mounted directly to the motor will not be accepted.
- .11 A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
- .12 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.
- .13 Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
- .14 Drive to be seismic certified. Seismic importance factor of 1.5 rating is required. Rating certification based upon actual shake table test data as defined by ICC AC 156.
- .15 Hand, Off and Auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
- .16 Standard Control and Monitoring Inputs and Outputs:
 - .1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
 - .2 Two terminals shall be programmable to act as either a digital output or additional digital inputs.
 - .3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status. Each relay shall have an adjustable on delay / off delay time.



- .4 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting. Each shall be independently selectable to be used with either an analog voltage or current signal.
- .5 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
- .6 A programmable low-pass filter for either or both analog inputs must be included to compensate for noise.
- .7 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,
- .17 One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
- .18 Serial communications - The VFD shall include a standard communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
 - .1 BACnet MS/TP, Johnson N2, Siemens P1 and Modbus RTU
- .19 Bypass
 - .1 Provide a manual 3-contactor bypass, on all VFDs, consisting of a door interlocked main fused disconnect padlock able in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode. Supply VFD specific only fuses
 - .2 Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.
 - .3 Provide a complete factory wired and tested electronic bypass system, consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.
 - .1 Include a interlocked door, pad-lockable circuit breaker or disconnect switch to disconnect all input power to the drive and bypass system.
 - .2 Supply fast acting fuses exclusive to and in front of the VFD only.
 - .3 The electronic bypass shall have its own keypad with, Drive, Bypass, Hand, Off, Auto, Reset operator keys.
 - .4 The keypad shall also have the following LED indication, Ready, Enable, Drive running, Bypass running, Drive fault, Bypass fault, Bypass H-O-A mode, Auto transfer to bypass selected, Drive selected, Bypass selected.



- .5 All external safety interlocks shall remain fully functional whether the system is in Hand, Auto or Bypass modes.
 - .6 The electronic bypass shall be fully operable from the Serial Communications system which shall have capability to monitor the VFD/Bypass mode, check status of H-O-A, Bypass fault, and Override and also force the motor into Bypass mode.
- .19 Standard of acceptance: Danfoss, ABB.

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 Install devices in accordance with manufacturer's recommendations.
- .4 Install the drive not more than 10 metres from the motor. The length of wiring connection shall not exceed 10 metres. Provide support for the variable frequency drive in the vicinity of the motor as required. Contractor to provide a written report to the Consultant indicating the lengths of wiring installed between the drive and the driven motor for all systems connected to variable frequency drives.
- .5 VFD Start-up - The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
 - .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 and provide reports.



3.4 WARRANTY

- .1 The complete VFD shall be warranted by the manufacturer for a period of 24 months from date of shipment. The warranty shall include parts, labour, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer and not a third party. A written warranty statement shall be provided with the submittals.
- .2 The warranty shall include all parts, labour, travel time, and expenses.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .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 REFERENCE STANDARDS

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .2 CSA Group (CSA)
 - .1 CAN/CSA B139, Installation Code for Oil Burning Equipment.
- .3 Green Seal Environmental Standards (GSES)
 - .1S tandard GS-11, Environmental Standard for Paints and Coatings.
- .5 National Research Council Canada (NRC)
 - .1 National Fire Code of Canada (NFC).

1.2 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2 PRODUCTS

2.1 MATERIAL

- .1 Paint: zinc-rich to CAN/CGSB-1.181
 - .1 Primers, Paints and Coating: in accordance with manufacturer's recommendations for surface conditions.

2.2 ACCESS PANELS/DOORS

- .1 Provide access panels at all locations of concealed equipment, fittings requiring access for operation, maintenance and repair including but not limited to isolation valves, balancing valves, air vents, motorized valves, flow metering devices.
- .2 Access doors shall be located to provide complete access to concealed equipment and devices.
- .3 Construction:
 - .1 Plaster or wet wall: 16 ga steel flush with surface complete with gasket and concealed flange.
 - .2 Masonry or drywall: 16 ga steel flush with surface complete with gasket and concealed flange.
- .4 Finish:
 - .1 Tiled or marble surfaces: type 304 stainless steel, #4 satin polish.
 - .2 Other areas: prime coated steel, finished to match adjacent.



- .5 Options and accessories:
 - .1 Continuous concealed hinges.
 - .2 Adjustable anchoring straps to suit installation.
 - .3 Mineral wool insulation (for fire rated panels).
 - .4 Self latching screw driver operated slam latch.
 - .5 Automatic panel closer.
 - .6 Inside latch release.
- .6 Sizing:
 - .1 Access panels/doors shall be of adequate size to facilitate access to all components. The following are minimum recommended sizes:
 - .1 Hand access: 300x300mm (12"x12")
 - .2 Body entry access: 600x600mm (24"x24")
- .7 Fire rating
 - .1 Access doors/panels installed in fire rated floor and wall assemblies shall have similar fire rating and corresponding ULC label.

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 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.

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada or CAN/CSA B139.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer, CAN/CSA B139 or as indicated without interrupting operation of other system, equipment, components.

3.4 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.
 - .1 Discharge to be visible.
- .4 Drain valves: 20mm (NPS 3/4) gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install automatic air vents to at all 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.
- .4 Pipe discharge from all relief valves, air vents in glycol systems back to glycol tank.

3.6 DIELECTRIC COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 50mm (NPS 2) and under: isolating unions or bronze valves.
- .4 Over 50mm (NPS 2): isolating flanges.

3.7 PIPEWORK INSTALLATION

- .1 Install pipework to CAN/CSA B139, CAN/CSA B149 and other applicable standards.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.



- .3 Install with stems above horizontal position unless indicated.
- .4 Valves accessible for maintenance without removing adjacent piping.
- .5 Install globe valves in bypass around control valves.
- .6 Use gate or ball valves at branch take-offs for isolating purposes except where specified.
- .7 Install butterfly valves on chilled water and related condenser water systems only.
- .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
- .9 Install plug cocks or ball valves for glycol service.
- .10 Use chain operators on valves 65mm (NPS 2 ½) and larger where installed more than 2,400 mm above floor in Mechanical Rooms.
- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .17 Provide insulation and jacketing in accordance with Section 23 07 19 – HVAC Piping Insulation.
- .18 Provide identification of all piping systems and equipment in accordance with Section 23 05 53 – Identification for HVAC Piping and Equipment.

3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated. Provide adequate support and reinforcement at all sleeve locations.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm (1/4 in) minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation. Size to allow for movement for expansion.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Wet floors: terminate 50mm above finished floor c/w floor plate and caulking.
 - .3 Other floors: terminate 25 mm above finished floor.
 - .4 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181
 - .5 Provide chrome plated escutcheons at all penetrations thru finished surfaces or millwork.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for fire stopping.



- .2 Maintain the fire-resistance rating integrity of the fire separation.
- .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
- .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

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

3.10 PREPARATION FOR FIRE STOPPING

- .1 Coordinate the installation of fire stopping around pipes, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Pipes subject to movement: conform to fire stop system design listing to ensure pipe movement without damaging fire stopping material or installation.
- .3 Insulated pipes: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.
- .2 Provide min 65mm (NPS 2 1/2) bypass piping at end of each loop complete with isolation to facilitate thorough cleaning and flushing of the entire system. Coordinate locations of the bypasses with chemical treatment vendor prior to installation.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

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

3.13 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Owner's Representative.
- .2 Request written approval by Owner's Representative 10 working days minimum, prior to commencement of work.



- .3 Be responsible for damage to existing plant by this work.

3.14 CORING

- .1 Provide core drilling for installation of plumbing systems.
- .2 X-ray or scan floor and wall assemblies prior to core drilling, consult with Consultant on any noted interferences. X-ray shall only be carried out after hours, coordinate with Owner's Representative and provide minimum 10 business days' notice.
- .3 Coring and cutting of structural components shall only be completed once approved by Structural Engineer.
- .4 Repair adjacent finishes and any damages as a result of this work to satisfaction of Owner's Representative and Consultant.
- .5 Verify obstructions and interference on the other side of the floor and wall assemblies prior to coring. If any obstructions are noted, contractor shall locate alternate core locations and propose to Consultant for review and approval. Proceed with coring at alternate locations only once approved by Consultant.

3.15 PIPING ARRANGEMENT

- .1 Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. The coordination/shop drawings shall be submitted to Consultant for review.
- .2 Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, receptacles and other services and utilities. Equipment coordination/shop drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted to Consultant for review. Follow manufacturer's published recommendations for installation methods not otherwise specified.

3.16 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1, Power Piping.
 - .2 ANSI/ASME B31.3, Process Piping.
 - .3 ANSI/ASME Boiler and Pressure Vessel Code:
 - .1 BPVC 2007 Section I: Power Boilers.
 - .2 BPVC 2007 Section V: Nondestructive Examination.
 - .3 BPVC 2007 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1M/C1.1, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1, Safety in Welding, Cutting and Allied Process.
 - .3 AWS W1, Welding Inspection Handbook..
- .4 CSA Group (CSA)
 - .1 CSA W47.1, Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA-W117.2, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2, Certification of Welding Inspectors.

1.2 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Welders:
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Submit welder's qualifications and welding procedures to Consultant within 15 days of project award and prior to any work.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
 - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
 - .2 Inspectors:
 - .1 Inspectors qualified to CSA W178.2.



- .3 Certifications:
 - .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.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2 PRODUCTS

2.1 ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series

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 QUALITY OF WORK

- .1 Welding: in accordance with ANSI/ASME B31.1, B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and special procedures specified elsewhere in Mechanical Division and applicable requirements of provincial authority having jurisdiction.

3.3 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 50mm (NPS 2) and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Owner's Representative before work is started.



- .2 Formulate "Inspection and Test Plan" in co-operation with Owner's Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

- .1 General:
 - .1 Perform examinations and tests by specialist qualified to 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
 - .3 Inspect and test welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests and/or spot or full gamma ray radiographic (hereinafter referred to as "radiography") tests. As per applicable reference standard or as specified.
- .2 Hydrostatically test welds to 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 Consultant of total of up to 15% of welds, selected at random by Consultant by radiographic tests.
- .5 Full radiographic tests for steam piping systems:
 - .1 Spot radiography:
 - .1 Conduct spot radiographic tests of up to 10% 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, submit report describing observations and recommendations.
 - .4 Failure of radiographic tests:
 - .1 Extend tests to welds by welder responsible when those welds fails tests.
 - .2 Repair or replace all failed welds, joints as required.

3.6 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code
- .2 In addition, chilled water systems below 1,034 kPa (100 psi):
 - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.



- .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
- .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.
- .5 Repair cracks and defects in excess of 0.8 mm in depth.
- .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic tests.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

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

3.8 WELDING SMOKE MANAGEMENT AND RESTRICTIONS

- .1 Welding, soldering, cutting, grinding or any other work resulting in fumes, smoke or dust particles inside mechanical plenums or rooms used as a return air plenum for HVAC systems is not permitted during regular hours when HVAC systems are in operation to prevent recirculation of smoke and dust particles. Welding in these areas shall be completed during afterhours, once equipment is shut down. All surfaces must be thoroughly cleaned by qualified personnel using soap and steam prior to reinstating equipment in operation.
- .2 Welding in contained spaces such as service shafts, tunnels, crawl spaces, etc shall only be carried out once effective means of smoke evacuation is provided. Contractor shall be responsible for assessing existing site conditions and preparing smoke management plan prior to welding operations, submit plan to Owner's Representative and Consultant for approval prior to any work. These measures may include but not be limited to temporary floor/wall openings, air transfer fans, HEPA filtration and scrubber units, fume extraction equipment, temporary power provisions, temporary generator, hoarding, fencing, fire alarm bypasses, fire watch, etc as required to provide effective management and evacuation of welding fumes.
- .3 Contractor shall be responsible for coordinating with welding personnel and other sub-trades to prepare smoke management plant, supply labour and materials for execution.
- .4 Contractor shall be solely responsible for all costs associated with the requirements in this section.

3.9 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition.
 - .2 ASME B40.100, Pressure Gauges and Gauge Attachments.
 - .3 ASME B40.200, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-14.4, Thermometers, Liquid-in-Glass, Self-Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.2 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

2 PRODUCTS

2.1 GENERAL

- .1 Meters and gauges shall be selected such that normal operating range is within 40-60% of the gauge scale range.
- .2 Air and water metering devices shall be selected to ensure adequate velocity across the meter such that meter accuracy is maintained across entire operating range. Meter accuracy shall be field verified by TAB contractor at 25%, 50%, 75% and 100% of the design air/water flow.
- .3 Pressure and thermometer gauges shall have both imperial and metric units.
- .4 Provide wells for all gauges and meters.
- .5 Refer to schematics and details for location of devices.

2.2 PIPING THERMOMETERS

- .1 Thermometers shall be 225mm (9in) scale size with +/- 1 scale division accuracy, dual (Celsius/Fahrenheit) scale, durable cast aluminum case, 304 stainless steel adjustable angle stem, white background with black temperature/scale markings, clear glass window.
- .2 Standard of acceptance: Terrice, Winters or Weiss.



2.3 PIPING PRESSURE GAUGES

- .1 Pressure gages shall be 115mm (4.5in) diameter dial size, ASME B40.100 Grade 1A, +/- % accuracy, dual (kPa/psi) scale, cast aluminum case, clear glass window, white background with black pressure/scale markings, clear glass window, suitable for maximum 100°C (212°F) service temperature, c/w CRN registration.
- .2 Provide impulse dampeners and needle valve upstream of each gauge.
- .3 Gauges for fire protection service shall have ULC listing.
- .4 Gauges for steam service shall be c/w coil syphons.
- .5 Standard of acceptance: Trerice, Winters or Weiss.

2.4 THERMOMETER WELLS

- .1 Copper or bronze for copper piping systems.
- .2 Brass for steel piping systems.

2.5 FLOW VERIFICATION AND METERING DEVICE

- .1 Carbon steel ASTM-120 body and insert, venturi style flow metering device, size to match line size.
- .2 Accuracy: +/-3%.
- .3 Pressure drop shall not exceed 6 kPa (0.9psi) at design flow.
- .4 Pressure/Temperature rating: 1,654kPa (240 psi) / 120°C (250°F).
- .5 Standard of acceptance: IMI Flow Design VF.

3 EXECUTION

3.1 GENERAL

- .1 Install in accordance with manufacturer's recommendations in easily visible locations.
- .2 In locations with difficult access or at heights more than 2.4m above floor, provide remote reading thermometers and pressure gauges.
- .3 Protect from damage during installation.
- .4 Test and verify operation of all gauges, thermometers and meters.
- .5 Accuracy of all flow meters shall be field verified by TAB contractor at 25%, 50%, 75% and 100% of the design flow. Submit report for consultant's review.

3.2 THERMOMETERS

- .1 Install in wells on piping systems as noted on schematics, details and at inlet/outlets of:
 - .1 Boilers
 - .2 Chillers – on condenser and chilled water sides
 - .3 Heating and cooling coils
 - .4 Heat exchangers
 - .5 Energy transfer stations
 - .6 Fluid coolers
 - .7 At locations of sensors



- .2 Provide stem extensions for installations on insulated piping systems.

3.3 PRESSURE GAUGES

- .1 Install in piping systems as noted on schematics, details and as follows:
 - .1 At each pump – suction upstream of strainer, suction downstream of strainer, discharge
 - .2 Upstream and downstream of PRV's
 - .3 Inlet and outlet of heating and cooling coils
 - .4 Differential pressure station
 - .5 Inlet and outlet of boilers
 - .6 Inlet and outlet of chillers – on condenser and chilled water sides
 - .7 Inlet and outlet of heat exchangers
 - .8 Across strainer/filter assemblies

3.4 INSTALLATION OF DIFFERENTIAL PRESSURE TAPS AND PIPING

- .1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.
- .2 Tubing: straight, supported throughout its length, sloped 5%-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

3.5 INSTALLATION OF TRANSMITTERS NOT FORMING INTEGRAL PART OF PRIMARY ELEMENT

- .1 Mount on pipe stand installed and located to ensure no damage by passing traffic.

3.6 INSTALLATION OF SIGNAL TRANSMISSION CABLE

- .1 Ground shielding at one point only.
- .2 Protect against RF interference.
- .3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

3.7 START-UP

- .1 Manufacturer's representative shall carry out start-up and commissioning of all metering devices and BTU/energy meters.
- .2 Submit report for Consultant's review.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1, Power Piping.
- .2 ASTM International (ASTM)
 - .1 ASTM A125, Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - .4 ASTM A653 G90 SS Gr. 33 - Specification for Steel Sheet, Zinc Coated(Galvanized) by the Hot Dipped Process
 - .5 ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - .6 ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .7 ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip Galvanized) on Iron and Steel Hardware
 - .8 ASTM D 1929 - Standard Test Method for Determining Ignition Temperature of Plastics
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada (NPC).
- .7 Underwriter's Laboratories of Canada (ULC).
- .8 NFPA
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems
- .9 Canadian Standards Association
 - .1 CSA B139, Installation code for oil-burning equipment.
 - .2 CSA B149.1, Natural gas and propane installation code.

2 PRODUCTS

2.1 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.
- .2 Performance Requirements:
 - .1 Design supports, platforms, catwalks, hangers to withstand seismic events in accordance with the requirements of the Provincial Building Code.

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58. ANSI B31.1 and
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.
- .3 Provide dielectric insulation at all points of contact between dissimilar metals.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized or 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 50mm (NPS 2) maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 13 mm UL listed and FM approved.
 - .2 Cold piping 65mm (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, UL listed and FM approved to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping 50mm (NPS 2) maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed and FM approved to MSS SP69.
 - .2 Cold piping 65mm (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 and FM approved.
- .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 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed and FM approved to MSS SP69
- .5 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 22 mm or 28 mm rod.
- .7 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .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 UL listed and FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for riveting 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: galvanized, with formed portion plastic coated epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed and FM approved.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 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 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 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.

2.7 VARIABLE SUPPORT SPRING HANGERS

- .1 Vertical movement: 13 mm 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. Provide certificate of calibration for each hanger.
- .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.

2.8 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements. Submit detailed calculations with shop drawings stamped by licensed Engineer in Province of Ontario.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 HOUSE-KEEPING PADS

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 150 mm larger than equipment; chamfer pad edges.
- .2 Provide elevated pads for air handling systems where required to ensure proper p-trap construction, coordinate with sub-trades prior pad pouring.

2.11 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel.
- .2 Submit detailed calculations with shop drawings stamped by licensed Engineer in Province of Ontario.

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, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 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.
- .7 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 Ontario Building Code.
- .2 Fire protection: to NFPA and Ontario Fire Code.
- .3 Gas and fuel oil piping: up to 12mm (NPS 1/2): every 1.8 m.
- .4 Copper piping: up to 12mm (NPS 1/2): every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm (12in) of each elbow.

Maximum Pipe Size: NPS	Maximum Pipe Size: mm	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	32	2.4 m	1.8 m
1-1/2	40	3.0 m	2.4 m
2	50	3.0 m	2.4 m
2-1/2	65	3.7 m	3.0 m
3	75	3.7 m	3.0 m
3-1/2	-	3.7 m	3.3 m
4	100	3.7 m	3.6 m
5	-	4.3 m	-
6	150	4.3 m	-
8	200	4.3 m	-
10	250	4.9 m	-



Maximum Pipe Size: NPS	Maximum Pipe Size: mm	Maximum Spacing Steel	Maximum Spacing Copper
12	300	4.9 m	-

- .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 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.

3.7 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: 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.

2 PRODUCTS

2.1 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.

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use size #5.
 - .2 Equipment in Mechanical Rooms: use size # 9.
 - .3 Rooftop/outdoor equipment: use size#9.
 - .4 Equipment concealed above ceiling or inside walls: use size#2 secured to ceiling or wall.
 - .5 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Owner's Representative and Consultant.

2.4 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Natural and propane gas: to CSA/CGA B149.1. Piping shall be painted in yellow colour with markers indicating service ("natural gas" or "propane gas") and service pressure ("XX psi" or "XX in w.c."). Paint shall encompass entire surface area of the pipe, apply paint prior to installation at roof level. All piping installed at roof level and other exterior areas shall be weatherproof.
 - .2 Sprinklers: to NFPA 13.
 - .3 Standpipe and hose systems: to NFPA 14.

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 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm 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 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Owner's Representative and Consultant.
 - .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
Raw water	Green	RAW WATER
River water	Green	RIVER WATER
Sea water	Green	SEA WATER
City water	Green	CITY WATER
Treated water	Green	TREATED WATER
Brine	Green	BRINE
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
High temp HW Htg. supply	Yellow	HTHW HTG. SUPPLY
High temp HW Htg. return	Yellow	HTHW HTG. RETURN
Make-up water	Yellow	MAKE-UP WTR



Contents	Background colour marking	Legend
Boiler feed water	Yellow	BLR. FEED WTR
Steam []kPa	Yellow	[] kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	STEAM VENT
Intermittent blow-off	Yellow	INT. BLOW-OFF
Continuous blow-off	Yellow	CONT. BLOW-OFF
Chilled drinking water	Green	CH. DRINK WTR
Drinking water return	Green	CH. DRINK WTR. CIRC
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Contaminated lab waste	Yellow	CONT. LAB WASTE
Acid waste	Yellow	ACID WASTE (add source)
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
No. [] fuel oil suction	Yellow	# [] FUEL OIL
No. [] fuel oil return	Yellow	# [] FUEL OIL
Engine exhaust	Yellow	ENGINE EXHAUST
Lubricating oil	Yellow	LUB. OIL
Hydraulic oil	Yellow	HYDRAULIC OIL
Gasoline	Yellow	GASOLINE
Natural gas	to Codes	
Propane	to Codes	
Gas regulator vents	to Codes	
Distilled water	Green	DISTILL. WTR
Demineralized water	Green	DEMIN. WATER
Chlorine	Yellow	CHLORINE
Nitrogen	Yellow	NITROGEN
Oxygen	Yellow	OXYGEN
Compressed air (<700kPa)	Green	COMP. AIR [] kPa
Compressed air (>700kPa)	Yellow	COMP. AIR [] kPa
Vacuum	Green	VACUUM
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS



Contents	Background colour marking	Legend
Carbon dioxide	Red	CO2
Instrument air	Green	INSTRUMENT AIR

2.6 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm (2 inch) high stencilled letters and directional arrows 150 mm (6 inch) long x 50 mm (2 inch) high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.
- .3 Identification to include air flow type (supply air, exhaust air, return air, etc), airflow direction and associated system (RTU-X, AHU-X, EF-X, SF-X, RF-X, etc).

2.7 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm 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.

2.8 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.
- .3 Provide label on ceiling tile or access door to identify each control valves and devices.

2.9 CONCEALED DEVICES

- .1 Provide 25mm (1 inch) high nameplates for all devices and equipment concealed above ceiling (plaster, t-bar, etc) and within walls or chases.
- .2 Labels shall be color coded for each system's type as follows:
 - .1 Red – fire and fire/smoke dampers
 - .2 Yellow – HVAC terminals (VAV, fan powered boxes, coils, etc), devices (fans, dampers, etc), control and isolation valves
 - .3 Green – plumbing and drainage
- .3 Confirm colours and locations with Owner's Representative prior to installation.

2.10 SYSTEM DIAGRAMS

- .1 Provide one A1 size (841x594mm) laminated color control system diagram on 12mm thick backboard for each mechanical system including heating water, chilled water, condenser water, glycol, air handling.
- .2 Install system diagram inside mechanical room or control room, confirm location with Owner's representative prior to installation.

2.11 LANGUAGE

- .1 Identification in English.



3 EXECUTION

3.1 TIMING

- .1 Provide identification only after painting has been completed.

3.2 INSTALLATION

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

3.3 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.

3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m 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 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 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.
- .9 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.

3.5 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 Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.



- .3 Number valves in each system consecutively.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .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 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
 - .1 Handbook, HVAC Applications ASHRAE Handbook, Chapter 39, Testing, Adjusting, and Balancing and Chapter 49, Sound and Vibration Control
 - .2 Standard 111, Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
- .2 National Environmental Balancing Bureau (NEBB):
 - .1 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .2 Procedural Standards for the Measurement of Sound and Vibration.
 - .3 Standard for Whole Building Technical Commissioning of New Construction.
- .3 Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - .1 HVAC SYSTEMS Testing, Adjusting and Balancing TABB- TAB Procedural Guide.

1.3 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit to Consultant within 90 days of award of contract the following information on TAB agency:
 - .1 Names of personnel responsible for TAB, their qualifications and experience
 - .2 Certificates of calibration for all test equipment, must be valid within 3 months of the TAB activities.
 - .3 TAB procedures
 - .4 Sample TAB report and forms
- .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.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.
- .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.
- .9 Qualifications
 - .1 TAB agency and lead technician shall be AABC or NEBB certified, in good standing and valid certificates for the duration of the entire project.

1.4 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 water and air systems and equipment to regulate flow rates to match design.
- .4 Adjust and balance domestic cold, hot and recirculation systems.
- .5 Carry out equipment and duct leakage testing.
- .6 Establish differential pressure setpoint(s) for all hydronic systems and static pressure setpoint(s) for all air systems, coordinate setpoints with controls contractor.
- .7 Test and verify accuracy of all air and water metering devices across entire operating range and at minimum at 25%, 50%, 75% and 100% of the design flows. Provide report to Consultant. Where accuracy does not match specified tolerances, coordinate with the respective contractor or manufacturer to arrange for calibration or replacement of devices as required. Re-test devices following repairs, calibration or replacement to verify accuracy.
- .8 Test and adjust minimum outdoor air damper to match specified air flows for each system, coordinate setpoints with controls contractor.
- .9 Provide final marking on permanent labels of final settings and corresponding values (flows, pressure, etc) of all HVAC systems.
- .10 Carry out intermediate test(s) and final test as required, provide reports to Consultant.

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.



- .3 Ensure cleaning of the systems has been completed and all air system filter media and water systems strainers, suction guides have been replaced with clean units.

1.6 PRE-TAB REVIEW

- .1 Review Contract Documents before project construction is started and confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Consultant 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 Owner for verification of TAB reports.

1.9 START OF TAB

- .1 Notify Owner's Representative and Consultant minimum 10 working days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 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 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.



- .3 Liquid 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.
 - .7 Bypass valves in closed position.
 - .8 Verify expansion tank charge pressure and ensure tank is not waterlogged.
 - .9 Verify pressure reducing valve settings.
 - .10 Verify system is free of air and air vents are installed and properly operating.

1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 Air handling units, exhaust fans: plus 10%, minus 0%
 - .2 Hydronic systems: plus 10%, minus 5%
 - .3 Exhaust hoods: plus 10%, minus 0%
 - .4 Minimum outside air: plus 10%, minus 0%
 - .5 Grilles, diffusers, registers: plus 10%, minus 5%
 - .5 Terminal units: plus 10%, minus 5%

1.11 INSTRUMENTS

- .1 Prior to TAB, submit to Consultant 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 3 months of TAB. Provide certificate of calibration to Consultant.

1.12 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.13 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Consultant, 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.



1.14 TAB REPORT

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Air Systems
 - .1 Project record drawings.
 - .2 System schematics.
 - .3 Fan curves and operating conditions plotted, include fan speed, kW, Amps, Voltage
 - .4 Instrumentation procedures
 - .5 Static profile for each air handling system
 - .6 Distribution air flows (registers, grilles, terminal units, mains and duct branch to each zone)
 - .7 Coils entering and leaving dry bulb and wet bulb temperatures
 - .8 Outside, return, supply, exhaust air flows for each air handling system in various modes of operation including economizer off (min OA), economizer on (max OA)
 - .9 Verification of all air flow metering devices accuracy at 25%, 50%, 75% and 100% of the design air volumes
 - .10 Verification of all temperature, humidity and CO2 sensors accuracy
 - .11 Description of noted, corrected and uncorrected deficiencies and applicable explanatory comments on the test results and variance between the design and actual values. Include recommendations for further action.
 - .2 Water Systems
 - .1 Project record drawings.
 - .2 System schematics.
 - .3 Pump curves and operating conditions plotted, include fan speed, kW, Amps, Voltage
 - .4 Instrumentation procedures
 - .5 Distribution water flows (terminal units, main – primary/secondary loops, each zone connected to secondary loop,)
 - .6 Flow and pressure differential at each equipment (boiler, chiller, cooling tower, heat exchanger).
 - .7 Secondary loop differential pressure and bypass control valve differential pressure setpoints.
 - .8 Differential pressure across system components including strainers, air separators, control valves and major equipment (chillers, boilers, heat exchangers)
 - .9 Verification of all water temperature and differential pressure sensors accuracy
 - .10 Verification of all water flow metering devices at 25%, 50%, 75% and 100% of the design air volumes
 - .11 Description of noted, corrected and uncorrected deficiencies and applicable explanatory comments on the test results and variance between the design and actual values. Include recommendations for further action.



- .3 Submit 6 copies of TAB Report to Consultant for verification and approval, in English in D-ring binders and PDF soft copy (via email), complete with index tabs.

2 PRODUCTS

2.1 NOT USED

- .1 Not used.

3 EXECUTION

3.1 VERIFICATION

- .1 Reported results subject to verification by Consultant.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Consultant.
- .4 Pay costs to repeat TAB as required to satisfaction of Consultant.

3.2 SETTINGS

- .1 After TAB is completed to satisfaction of Consultant, 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.

3.3 COMPLETION OF TAB

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

3.4 AIR AND WATER SYSTEMS

- .1 Standard: TAB to most stringent of AABC, NEBB or SMACNA.
- .2 Do TAB of systems, equipment, components, controls specified Division 23.
- .3 Measurements: to include as appropriate for systems, equipment, components, controls: air/water velocity, static pressure, flow rates, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .4 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

3.5 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.
- .2 Laboratory fume hoods:
 - .1 Standard: Treasury Board of Canada Handbook of Occupational Health and safety, 4th edition and applicable Provincial standards.
 - .2 TAB procedures: as described in standard.



- .3 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions during winter, summer design conditions at all times.
- .4 Zone pressure differences:
 - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with systems in every possible combinations of normal operating modes.
- .5 Smoke management systems:
 - .1 Test for proper operation of all smoke and fire dampers, interlock with fan systems, sensors, detectors, installed as component parts of air systems specified Division 23.
- .6 Measurement of noise and vibration from equipment specified in Division 23.

3.5 PHASING

- .1 TAB activities to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.
- .2 Systems serving areas outside of the project scope shall not be adversely affected. Provide measure existing parameters to document system capacity of these areas.

3.6 POST-OCCUPANCY TAB

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in occupied zone areas as directed by Owner's Representative or Consultant.
- .2 Participate in systems checks twice during Warranty Period as follows:
 - .1 First check: approximately 3 months after acceptance
 - .2 Second check: within 1 month of termination of Warranty Period
- .3 Complete necessary adjustments of systems as required to meet design operating conditions, submit proposed measures and adjustments to Consultant for review and approval prior to implementation.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 ASTM International (ASTM)
 - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .9 ASTM C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings.



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

1.2 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:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.3 ACTION AND INFORMATIONAL 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 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.
- .5 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, and have listings of the agencies and standards of this specification.
 - .2 Instructions: submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and have at least 3 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 in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.



- .3 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.
- .3 Waste Management and Disposal:
 - .1 Waste Management and Disposal: separate waste materials for reuse, and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .3 Divert unused metal materials from landfill to metal recycling facility.
 - .4 Dispose of unused adhesive material at official hazardous material collections site.

2 PRODUCTS

2.1 GENERAL

- .1 Fire and smoke rating shall be in accordance with CAN/ULC-S102 and as follows:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.
- .2 Insulating materials including coatings, adhesives and sealers shall have UV protection and waterproof construction.
- .3 Oversize insulation for all heat traced piping, valves and specialties.
- .4 Provide thermal insulation at all contacts between surfaces prone to condensation and other building materials (for example, between chilled water heat exchanger base and concrete pad) to prevent thermal bridging.

2.3 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C335
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.
 - .2 Maximum "k" factor: to CAN/ULC-S702
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52 Ma
 - .3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C547.
- .5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.



- .2 Jacket: to CGSB 51-GP-52 Ma
- .3 Maximum “k” factor: to CAN/ULC-S702 and ASTM C547.
- .6 TIAC Code A-6: flexible unicellular tubular elastomer
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52 Ma
 - .3 Maximum “k” factor at 24°C (75°F) mean temperature:
 - .1 25mm (1 in) and under: 0.0354 W/mK (0.245 BTU in/hr sq ft)
 - .2 32mm (1-1/2 in) to 50mm (2 in): 0.040 W/mK (0.28 BTU in/hr sq ft)
 - .4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.
 - .5 Adhesive shall be supplied by manufacturer.
- .7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements
 - .1 Insulation: to ASTM C533.
 - .2 Maximum “k” factor: to ASTM C533.
 - .3 Design to permit periodic removal and re-installation.
 - .4 **Do not use calcium silicate on aluminum or stainless steel piping.**

2.4 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm (2 in) wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm (1/16 in) diameter stainless steel.
- .5 Bands: stainless steel, 19mm wide (3/4 in), 0.5 mm (1/64 in) thick.

2.5 CEMENT

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

2.6 VAPOUR RETARDER LAP ADHESIVE

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

2.7 INDOOR VAPOUR RETARDER FINISH

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

2.8 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.9 JACKETS

- .1 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 or as directed by Consultant.
- .3 Minimum service temperatures: -20 degrees C.
- .4 Maximum service temperature: 65 degrees C.
- .5 Moisture vapour transmission: 0.02 perm.
- .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.
- .8 Special requirements:
 - .1 Indoor: use PVC or canvas.
 - .2 Outdoor: use aluminum or stainless steel.
- .2 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921
 - .2 Lagging adhesive: compatible with insulation.
- .4 Aluminum:
 - .1 To ASTM B209
 - .2 Thickness: 0.50 mm (1/64 in) sheet.
 - .3 Finish: corrugated
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm (2 in) laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm (3/4 in) wide, 0.5 mm (1/64 in) thick at 300 mm (12 in) spacing.
- .5 Stainless steel:
 - .1 Type: 304 or 316.
 - .2 Thickness: 0.25 mm
 - .3 Finish: smooth.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm (2 in) laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm (3/4 in) wide, 0.5 mm thick at 300 mm (12 in) 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 Ensure heat tracing system has been installed, where specified, prior to installation of insulation.

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 (3in).
- .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.
- .6 Ensure installation of the insulation permits operation of all devices, including valve handles.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, flow measuring elements, strainers, balancing valves, control valves, flanges, unions at equipment and other specialties requiring access.
- .2 Design: to permit movement of expansion joint and to permit periodic removal, replacement, servicing and inspection without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: PVC (indoor), aluminum or stainless steel (outdoor).

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 Insulation thickness shall comply with Ashrae 90.1 requirements.
- .2 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .3 TIAC Code: A-1.
 - .1 Securements: 18 ga stainless steel wire on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .4 TIAC Code: A-3.
 - .1 Securements: Tape at 300 mm (12 in) on centre.



- .2 Seals: VR lap seal adhesive, VR lagging adhesive.
- .3 Installation: TIAC Code: 1501-C.
- .5 TIAC Code: A-6.
 - .1 Securements: in accordance with manufacturer's instructions.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-CA.
- .6 TIAC Code: C-2 with vapour retarder jacket.
 - .1 Securements: 18 ga stainless steel wire on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .7 TIAC Code: A-2.
 - .1 Securements: 18 ga stainless steel wire on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-H.
- .8 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	°C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Steam	up to 175	[A-1]	38	50	65	75	90	90
Steam, Saturated and Super heated	over 175	[A-1]	38	65	65	75	90	90
Condensate Return	60 - 94	[A-1]	25	38	38	38	38	38
Pumped Condensate return	up to 94	[A-1]	25	38	38	38	38	38
Boiler Feed Water		[A-1]	25	25	25	25	25	25
Hot Water Heating	60 - 94	[A-1]	25	38	38	38	38	38
Hot Water Heating	up to 59	[A-1]	25	25	25	25	38	38
Glycol Heating	60 - 94	[A-1]	25	38	38	38	38	38
Glycol Heating	up to 59	[A-1]	25	25	25	25	38	38
Domestic HWS		[A-1]	25	25	25	38	38	38
Chilled Water	4 - 13	[A-3]	25	25	25	25	25	25
Chilled Water or Glycol	below 4	[A-3]	25	25	38	38	38	38
Chilled Water Pump Casing	4 - 13	[A-3]	25	25	25	25	25	32
Condenser Water			25	25	25	25	38	38



Application	°C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Outdoors ¹								
Condenser Water Indoors			Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Refrigerated Drinking Water		[A-3]	25	25	25	25	25	25
Domestic CWS		[A-3]	25	25	25	25	25	25
Domestic CWS with vapour retarder		[C-2]	25	25	25	25	25	25
Refrigerant liquid	4 - 13	[A-6]	25	25	25	25	25	25
Refrigerant hot gas and suction	below 4	[A-6]	25	25	38	38	38	38
RWL and RWP		[C-2]	25	25	25	25	25	25
Cooling Coil cond. drain		[C-2]	25	25	25	25	25	25
Diesel generator exhaust system		[A-2]	38	65	65	75	90	90

1 – insulation shall be applied only if the piping system is heat traced

.9 Finishes:

- .1 Exposed indoors: canvas or PVC, white finish – confirm with consultant for each project.
- .2 Exposed in mechanical rooms: canvas or PVC, white finish – confirm with consultant for each project.
- .3 Concealed, indoors: canvas on valves, fittings. No further finish.
- .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation
- .5 Outdoors: water-proof aluminum or stainless steel jacket. Complete insulation and jacketing following heat tracing system installation and verification (where specified). Provide “Heat Tracing – Do Not Step On Piping” for all exposed heat traced piping in addition to standard identification.
- .6 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
- .7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.8 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Clean any dirt, deposits or debris from all insulation jacketing due to construction prior to project handover.

END OF SECTION



1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.
- .3 Related Requirements
 - .1 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .2 Section 23 21 13 - Hydronic Systems.
 - .3 Section 23 25 00 - HVAC Water Treatment.
 - .4 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

1.2 REFERENCE STANDARDS

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

1.3 ACTION AND INFORMATIONAL 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, limitations, proposed chemical solutions for each system, cleaning procedures.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Instructions: submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: separate waste materials for reuse, and recycling in accordance with Division 01.



2 PRODUCTS

2.1 CLEANING SOLUTIONS

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.
- .4 Coordinate all materials and procedures with basebuilding water treatment provider.

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: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
 - .2 Where Owner has a contract with water treatment provider, retain basebuilding water treatment vendor for all cleaning work. Obtain contact information from Owner.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .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.
 - .7 Sample photos for each system of the initial water quality, interim water quality observed during cleaning work and final water quality.
- .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 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (5 psi) - does not apply to diaphragm type expansion tanks.
 - .3 Use water meter to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60°C (140°F) for at least 36 hours. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to maximum design 82°C (180°F) minimum. Circulate for minimum of 12 hours, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38°C (100°F). Drain as quickly as possible. Refill with clean water. Circulate for a minimum of 6 hours at design temperature. 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).
 - .9 Repeat cleaning procedures as required to achieve adequate water quality.
- .8 Glycol Systems:
 - .1 In addition to procedures specified above perform specified procedures.
 - .2 Test to prove concentration will prevent freezing to minus 40°C (- 40°F). Test inhibitor strength and include in procedural report. Refer to ASTM E202
- .9 Steam Systems: in addition to general requirements as specified above, perform following:
 - .1 Remove internal components of steam traps until flushing and warm-up have been completed.
 - .2 Open drip points to atmosphere. If needed for protection of personnel or environment, install flexible hose and direct discharge to safe location.
 - .3 Starting at drip point closest to source, verify removal of condensate, then re-install steam trap internal parts. Repeat sequence down the line.
 - .4 Water hammer: determine source and eliminate cause.
- .10 Steam boilers:
 - .1 Isolate boilers from piping system.
 - .2 Fill to normal operating level. Add cleaner. Fire to 50% of design operating steam pressure. Maintain for a minimum of 24 hours, during which blow down boiler every 4 hours including water columns, controls, skimmer lines and valves, test cocks, blowdown valves. Add water to return to operating level.



- .3 Allow boiler to cool, then drain, flush and inspect.
- .4 Reconnect to piping system.
- .5 Refill boiler with clean softened water and immediately add chemical inhibitors.
- .6 Apply heat slowly and raise to normal design operating steam pressure. Maintain for a minimum of 4 hours.
- .7 Discharge condensate from steam system to sewer for 96 hours after initial operation. During this period continue chemical treatment of boilers with inhibitors to ensure complete removal of oils, grease and millscale from steam and condensate return piping steam.
- .8 Drain steam condensate until it is clean and free from suspended matter. Ensure proper operation of steam traps.
- .9 Allow boiler to cool, drain, open inspection ports and wash out with clean water.
- .10 If boiler is not used immediately, refill with softened water, add sodium sulphite, bring up to pressure. Test for residual sulphite.
- .11 After cleaning is completed and system is filled, perform relevant start-up procedures as specified for hydronic systems:

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 and as directed by Commissioning Authority.
 - .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 slow over a 48 hour period.
 - .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .12 Adjust pipe supports, hangers, springs as necessary.
 - .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
 - .15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .16 Check operation of drain valves.



- .17 Adjust valve stem packings as systems settle down.
- .18 Fully open balancing valves (except those that are factory-set).
- .19 Check operation of over-temperature protection devices on circulating pumps.
- .20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .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 REFERENCE STANDARDS

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .2 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M, AMD1 Specification Filler Metals for Brazing and Braze Welding.
- .3 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .2 ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .3 ANSI/ASME B16.4, Gray-Iron Threaded Fittings Classes 125 and 250.
 - .4 ASME B16.5, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
 - .5 ANSI/ASME B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - .6 ANSI B16.18, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .7 ANSI/ASME B16.22, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
 - .8 ASME B16.9, Factory-Made Wrought Buttwelding Fittings.
 - .9 ASME B18.2.1, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).
 - .10 ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
 - .11 ASME B31.1, Power Piping.
 - .12 ASME B31.3, Process Piping.
 - .13 ASME B31.9, Building Services Piping.
 - .14 BPVC-VIII B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 1.
 - .15 BPVC-VIII-2 B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 2 - Alternative Rules.
 - .16 BPVC-VIII-3 B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 3 - Alternative Rules High Press Vessels.
- .4 ASTM International (ASTM)
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A49, Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
 - .3 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .4 ASTM A126, Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.



- .5 ASTM A182/A182M, Standard Specification for Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
- .6 ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
- .7 ASTM A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
- .8 ASTM A216/A216M, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
- .9 ASTM A536, Standard Specification for Ductile Iron Castings.
- .10 ASTM B32, Standard Specification for Solder Metal.
- .11 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
- .12 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .13 ASTM B85/B85M, Standard Specification for Aluminum-Alloy Die Castings.
- .14 ASTM B88M, Standard Specification for Seamless Copper Water Tube.
- .15 ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .16 ASTM E202, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .5 CSA Group (CSA)
 - .1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .6 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
 - .1 MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-61, Pressure Testing of Steel Valves.
 - .3 MSS-SP-67, Butterfly Valves.
 - .4 MSS-SP-70, Grey Iron Gate Valves, Flanged and Threaded Ends.
 - .5 MSS-SP-71, Grey Iron Swing Check Valves Flanged and Threaded Ends.
 - .6 MSS SP-78, Cast Iron Plug Valves, Flanged and Threaded Ends.
 - .7 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
 - .8 MSS SP-82, Valve Pressure Testing Methods.
 - .9 MSS-SP-85, Grey Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 RELATED REQUIREMENTS

- .1 23 05 00 - Common Work Results for HVAC
- .2 23 05 15 - Common Installation Requirements for HVAC Pipework
- .3 23 05 17 - Pipe Welding
- .4 23 05 19 – Meters and Gauges for HVAC Piping



- .5 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .6 23 05 53 - Identification for HVAC Piping And Equipment
- .7 23 05 93 - Testing, Adjusting and Balancing for HVAC
- .8 23 07 19 – HVAC Piping Insulation
- .9 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems
- .10 23 21 13 – Hydronic Specialties
- .11 23 25 00 - HVAC Water Treatment

1.3 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Pipe and equipment supports. Submit calculations for variable spring and constant support hangers.
 - 2. Pipe and tubing, with specification, class or type, and schedule.
 - 3. Pipe fittings, including miscellaneous adapters and special fittings.
 - 4. Flanges, gaskets and bolting.
 - 5. Couplings and fittings.
 - 6. Valves of all types.
 - 7. Strainers.
 - 8. Flexible connectors for water service.
 - 9. Pipe alignment guides.
 - 10. Expansion joints.
 - 11. Expansion compensators.
 - 12. All specified hydronic system components.
 - 13. Water flow measuring devices.
 - 14. Gauges.
 - 15. Thermometers and test wells.
- .3 As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.

1.3 EXTRA STOCK MATERIALS

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



2 PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To 150mm (NPS 6): Schedule 40.
 - .2 200mm (NPS 8) and over: 10mm wall thickness.
 - .3 For use in following systems:
 - .1 Heating water
 - .2 Glycol heating
 - .3 Chilled water
 - .4 Condenser water
 - .5 Chemical feed
 - .6 Relief vent piping
 - .7 Pressure drains
- .2 Copper pipe: to ASTM B88M-86, Type K or Type L hard drawn copper tubing
 - .1 For use in following systems:
 - .1 Type L: heating water, chilled water and pressure drains
 - .2 Type K: air vent overflow

2.2 PIPE JOINTS: STEEL PIPING

- .1 50mm (NPS 2 and under): screwed fittings with PTFE tape.
- .2 65mm (NPS 2-1/2 and over): welded fittings and flanges to CSA W48.
- .4 Flanges: plain or raised face, weld neck to ANSI/AWWA C111/ A21.11.
- .5 Orifice flanges: slip-on raised face, 2,100 kPa.
- .6 Flange gaskets: to ANSI/AWWA C111/ A21.11.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

2.3 PIPE JOINTS: COPPER

- .1 Solder, tin-antimony, 95:5: to ASTM B32

2.3 FITTINGS: STEEL

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class 125.
 - .2 Steel: to ASME B16.5
- .3 Butt-welding fittings: steel, to ASME B16.9
- .4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

2.4 FITTINGS: COPPER

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



- .2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22
- .3 Cast iron threaded fittings: to ANSI/ASME B16.4
- .4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18

2.5 VALVES

- .1 General
 - .1 All valves shall be of same manufacturer.
 - .2 Valves used on insulated piping systems shall be provided with valve handle extensions.
 - .3 Valves shall be supplied with lock shields where noted.
 - .4 All valves shall have a valid and current CRN number.
 - .5 Provide chain operators for valves 150mm (NPS 6) and larger where centerline of valve body is located at 2,400mm (8ft) above finished floor or platform.
- .2 Connections:
 - .1 50mm (NPS 2) and smaller: screwed ends.
 - .2 65mm (NPS 2-1/2) and larger: flanged ends.
- .3 Valve application - unless otherwise noted elsewhere, provide valves as follows:
 - .1 Gate valves: isolation for equipment, control valves and pipeline above 50mm (NPS 2).
 - .2 Butterfly valves: isolation for cells or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers)
 - .3 Globe valves: throttling, flow control, emergency bypass.
 - .4 Ball valves: isolation for equipment and pipelines under 50mm (NPS 2).
- .3 Gate valves: to MSS-SP-70, MSS-SP-80;
 - .1 50mm (NPS 2) and under:
 - .1 Class 125, rising stem, wedge disc.
 - .2 65mm (NPS 2-1/2) and over:
 - .1 Class 125, 1,400kPa (200 psi) CWP, Outside Screw and Yoke (OS&Y), rising stem, solid wedge disc to ASTM B62 up to 75mm (NPS 3) and cast iron with bronze disc ring for 100mm (NPS 4) and larger, disc secured to stem through integral forged connection, bronze trim, renewable bronze seat rings screwed into body, nickel plated steel stem, integral seat rings.
 - .2 Operators: manual.
 - .3 Standard of acceptance: Kitz 72, Toyo 421
- .3 Butterfly valves: to MSS-SP-67
 - .1 Valve, 1380 kPa / 200WOG rating. Butterfly valves shall be lugged type, epoxy coated ductile iron body, stainless steel disc, PTFE (with EPDM backing) bonded seat, stainless steel stem with top and bottom bushings of dissimilar material.
 - .2 Valves supplied for glycol service shall be c/w stainless steel trim.
 - .3 Valve shall have bubble tight shut-off to 200psi when downstream flange is removed (full dead-end service).



- .4 Disk shall be secured to stem through integral key connection, valves with disks secured with set screw, bolt or pin will not be accepted.
- .5 Operators: lever lock handle for valve sizes 150mm (NPS 6) and smaller, and worm gear operator with hand wheel for valves 200mm (NPS 8) and larger.
- .6 Provide min 50mm (2") valve handle extension kit for all valves on insulated piping systems.
- .7 Standard of acceptance - Alternate not acceptable
 - MAS L-D-4-S-PE-LH (LEVER)
 - MAS L-D-4-S-PE-G (GEAR)
- .4 Globe valves: to MSS-SP80, MSS-SP85
 - .1 50mm (NPS 2) and under:
 - .1 MSS SP-80, bronze, 1035 kPa (150 psig), union bonnet with metal plug type disc.
 - .2 65mm (NPS 2-1/2) and over:
 - .1 MSS S-85, 861 kPa (125 psig), flanged, iron body, bronze trim.
 - .3 Standard of acceptance: Kitz Fig 125FCJ, Toyo 212 or Crane 1703.
- .5 Ball Valves:
 - .1 50mm (NPS 2) and under:
 - .1 Body and cap: forged brass
 - .2 Pressure rating: 600psi non-shock cold water, oil or gas
 - .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 forged brass chrome plated ball and PTFE seats.
 - .7 Stem seal: PTFE with external packing nut.
 - .8 Operator: removable lever handle.
 - .2 Standard of acceptance: Kitz 58, Grinell 3700 or Crane F9222
- .6 Balancing Valves:
 - .1 Sizes: calibrated balancing valves, as specified this section.
 - .2 50mm (NPS 2 and under):
 - .1 Y-pattern globe manual balancing valves, 2,070kPa (300 psi) working pressure, precision machined venturi built into the valve body, screwed connections, brass allow CW617 body and bonnet, brass allow B16 stem and disc, EPDM elastomers, ABS handwheel.
 - .2 Standard of acceptance: Armstrong CBV series, IMI STAD-PN25 or RWV 9517.
 - .3 65mm (NPS 2 1/2 and above):
 - .1 1,720 kPa (250psi) working pressure, flanged connections, cast iron valve body to ASTM A48, bronze disk, high strength engineered resin seat, brass stem to ASTM B16, EPDM o-ring, brass body meter ports with EPDM check and gasket cap, brass plug drain tappings.
 - .2 Standard of acceptance: Armstrong CBV-FS, IMI STAF-SG or RWV 9574P.



- .4 Valves shall be sized in accordance with manufacturer's instructions.
- .5 Valves shall be supplied with documentation and calibration charts.
- .7 Drain valves:
 - .1 Gate, Class 125, non-rising stem, solid wedge disc.
 - .2 Standard of acceptance: Kitz 03, Toyo 220 or Crane 1703.
- .8 Swing check valves: to MSS-SP-71.
 - .1 50mm (NPS 2) and under:
 - .1 Class 125, screwed ends, swing, bronze disc.
 - .2 Standard of acceptance: Kitz 22, Toyo 236 or Crane 1707.
 - .2 65mm (NPS 2-1/2) and over:
 - .1 Class 125, cast iron body, bronze disc.
 - .2 Standard of acceptance: Kitz 78, Toyo 435 or Crane 373.
- .9 Silent check valves:
 - .1 50mm (NPS 2) and under:
 - .1 Class 125, screwed ends, renewable bronze trim, stainless steel spring.
 - .2 Standard of acceptance: Grinell 3600 or Apco CSC.
 - .2 65mm (NPS 2-1/2) and over:
 - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .2 Standard of acceptance: Nibco W910 or Apco CSC.

2.6 GAUGES AND FLOW METERING DEVICES

- .1 Provide in accordance with Section 23 05 19 – Meters and Gauges for HVAC Piping.

3 EXECUTION

3.1 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .2 Ream pipe ends and remove all burs.
- .3 Protect piping during storage and transportation. Remove all scale, dirt and other materials prior to piping assembly.
- .4 All piping above 65mm (NPS 2 1/2) shall be flanged and welded. **Use of grooved piping systems is not permitted.**
- .5 Ensure all valves, fittings and equipment are serviceable.
- .6 Coordinate installation of all pipework with electrical, IT/communications, control, structural and other trades to avoid interferences. General contractor shall prepare interference drawings in accordance with the specifications.
- .7 All elbows shall be long radius.
- .8 Provide eccentric reducers at pipe size changes, flat section on top, to avoid air entrapment and aid in venting and drainage.
- .9 Provide dielectric fittings and isolation on all connections between dissimilar metals.



- .10 Provide air vents at all high points in the systems.
- .11 Provide instrumentation in accordance with the specifications and schematics.
- .12 Avoid installation of piping within exterior walls, provide insulation to protect piping where installation in exterior walls cannot be avoided.
- .13 Fire stop all pipe penetrations thru fire rated floor and wall assemblies.
- .14 Installation of piping (pipe welds, hangers/supports, expansion fittings, insulation, etc) in concealed areas shall be reviewed by Owner's Representative or Consultant prior to Concealment. Contractor shall schedule inspections with the Project Team minimum (5) business days in advance. Failure to do so may result in additional work associated with cutting and patching to expose installed piping systems, at no additional cost to Owner.
- .15 Install exposed piping in neat manner, parallel to walls or ceiling. Unless otherwise noted, install piping at highest practical level to maximize vertical clearances considering access for all equipment and specialties (valves, air vents, etc). Run all piping adjacent to building structure to minimize bulkheads and furrings.
- .16 Flash and weatherproof all pipe penetrations thru roofs and weatherproofed wall/floor assemblies. Repairs of roofing membrane shall be completed only by basebuilding roofing contractor, obtain contact information from Owner's Representative prior to any work.

3.2 VALVES

- .1 All valves shall be installed such that they can be easily accessed for use, servicing and maintenance.
- .2 Provide pre-formed insulation jackets on all fittings (circuit balancing valves, strainers, flow meters, etc) requiring access for operation, adjustments, and servicing.
- .3 Equipment isolation – install valves as close to equipment being isolated as possible, provide unions and drain fittings on each line between isolation valve and equipment connection.
- .4 Provide drain fittings at all equipment isolation locations, at all piping branch connections to mains and at all low points in the system to allow for partial and complete drainage of the systems.
- .5 All isolation valved 65mm and above shall be BUTTERFLY, Main isolation valves on the branches to the building shall be GATE.

3.3 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated. Coordinate location of each device with the TAB contractor prior to installation.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.
- .4 Install in accordance with manufacturer's recommendations, observing minimum required upstream (min 5 pipe diameters) and downstream (min 2 pipe diameters) clearances. Refer to manufacturer's instructions for specific requirements.
- .5 Provide copies of calibration charts for each devices.
- .6 Provide pre-formed foam removable insulation jacket for each device.
- .7 Provide laminated tag indicating device ID (number), line size, service, design position (handwheel marking) and corresponding flow (L/s [GPM]).



- .8 Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar.
- .9 Ensure easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided.
- .10 Valve shall be installed in upright position prevent sediment build-up in metering ports.

3.4 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

3.5 TESTING

- .1 Test system in accordance with Section 23 05 00 - Common Work Results for HVAC.
- .2 For glycol systems, retest with ethylene glycol to ASTM E202, inhibited, for use in building system] after cleaning. Repair leaking joints, fittings or valves.

3.6 BALANCING

- .1 Balance water systems to within plus or minus 5 % of design output.
- .2 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.7 GLYCOL CHARGING

- .1 Include mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.
- .3 Provide all required glycol (50% water/50% propylene glycol) for system fill, top up glycol where leaks are noted or systems are partially or fully drained during construction and commissioning.

3.8 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 13 - Performance Verification HVAC Systems.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 – 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 00 - Cleaning.

3.10 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.
- .2 ASTM International (ASTM)
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M, Standard Specification for Grey Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 CSA Group (CSA)
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .4 Provincial Boiler, Pressure Vessel and Compressed Gas Regulations.

1.2 RELATED REQUIREMENTS

- .1 23 05 00 - Common Work Results for HVAC
- .2 23 05 15 - Common Installation Requirements for HVAC Pipework
- .4 23 05 17 - Pipe Welding
- .5 23 05 19 - Meters and Gauges for HVAC Piping
- .6 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .7 23 05 53 - Identification for HVAC Piping And Equipment
- .8 23 05 93 - Testing, Adjusting and Balancing for HVAC
- .9 23 07 19 - HVAC Piping Insulation
- .10 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems
- .11 23 21 13 - Hydronic Systems
- .12 23 25 00 - HVAC Water Treatment

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 expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings for all hydronic specialties listed in this section.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.



- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

2 PRODUCTS

2.1 GENERAL

- .1 All products shall have a valid Canadian Registration Number (CRN) as per CSA B51 and Provincial Regulations.

2.2 DIAPHRAGM TYPE EXPANSION TANK

- .1 Horizontal or Vertical (as indicated on drawings) steel pressurized diaphragm type expansion tank.
- .2 Capacity: as indicated.
- .3 Size: as indicated.
- .4 Diaphragm sealed in EPDM suitable for 115°C (239°F) operating temperature.
- .5 Working pressure: 860 kPa (125 psi) with ASME stamp and certification.
- .6 Air pre-charged to initial fill pressure of system. Contractor shall charge in field if pre-charged at other pressure from factory.
- .7 Saddles for horizontal installation, Base mount for vertical installation.
- .8 Supports: provide supports with hold down bolts and installation templates.
- .9 Renewable diaphragm.
- .10 Standard of acceptance: Bell&Gossett, Amtrol, Extrol, Taco, Wessels Company, Armstrong.

2.3 AUTOMATIC AIR VENT

- .1 High capacity, brass body, automatic float type and rated at 1,034 kPa (150 psi) working pressure at 115°C (240°F).
- .2 Standard of acceptance: Bell&Gossett 107A, Taco 426, Maid O Mist 670, Caleffi 501.

2.4 AIR SEPARATOR

- .1 The Air Separator shall be designed, constructed, and stamped in accordance with Section VIII, Division I of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors.
- .2 Flanged connections, type 304 stainless settle strainer with 4.8mm (3/16in) perforations and not less than 51% free area.
- .3 Working pressure/temperature: 860 kPa (125 psi) / 177°C (350°F).
- .4 Standard of acceptance: Bell&Gossett 107A, Armstrong, Taco, Wessels Company.

2.5 AIR SEPARATOR - EXPANSION TANK FITTING

- .1 Complete with adjustable vent tube and built-in manual vent valve.
- .2 Working pressure: 860 kPa (125psi).



2.6 PRESSURE REDUCING VALVE

- .1 Adjustable pressure setting: 206kPa (30psi) relief, 55 kPa (8 psi) to 172 kPa (25 psi) reducing.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.
- .4 Standard of acceptance: Bell & Gossett, Watts, Zurn.

2.7 PRESSURE RELIEF VALVE

- .1 Bronze or iron body construction, ASME section IV construction.
- .2 Capacity – as indicated.
- .3 Standard of acceptance: Watts 174A or 740, Apollo 10-600

2.8 PIPE LINE STRAINER

- .1 15mm (NPS 1/2) to 50mm (NPS 2): bronze body to ASTM B62, screwed connections, Y pattern.
- .2 65mm (NPS 2 1/2) to 30mm (NPS 12): cast iron body to ASTM A278/A278M, Class 30 flanged connections.
- .3 Blowdown connection: 25mm (NPS 1).
- .5 Screen: stainless steel with 1.19mm (mesh 16) perforations. For specific applications, such as chillers, provide 0.841mm (mesh 20) perforations. Consult with the respective equipment manufacturer to confirm recommended screen size prior to preparation of submittals.
- .6 Working pressure: 860 kPa (125 psi).
- .7 Standard of acceptance: Red White 381, Metraflex, Watts 77F.

2.9 SUCTION DIFFUSER

- .1 Body: cast iron with flanged connections.
- .2 Strainer: with built-in, disposable 1.19 mm (mesh 16), low pressure drop screen and 25mm (NPS 1) blowdown connection.
- .3 Permanent magnet particle trap.
- .4 Full length straightening vanes.
- .5 Pressure Grey tappings.
- .6 Adjustable support leg.
- .7 Standard of acceptance: Bell&Gossett, Armstrong, Taco.

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 data sheets.

3.2 GENERAL



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

3.3 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than 25mm (NPS 1) and radiation and as indicated.

3.4 AIR VENTS

- .1 Install automatic high capacity air vents at all high points of systems.
- .2 Install isolation valve on automatic air vent inlet. Run discharge from water system to nearest drain or service sink. Run discharge from glycol system back to glycol tank.

3.5 EXPANSION TANKS

- .1 Adjust expansion tank pressure as indicated to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.
- .3 Ensure tank is not waterlogged prior to project handover.

3.6 PRESSURE SAFETY RELIEF VALVES

- .1 Run discharge pipe to terminate above nearest drain.

3.7 PRESSURE REDUCING VALVES

- .1 Install on all make-up water connections to hydronic systems, complete with full size bypass.
- .2 Adjust pressure to suit design requirements.

3.8 SUCTION DIFFUSERS

- .1 Install on inlet to pumps having suction size greater than 50mm (NPS 2).

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IES Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 CSA Group (CSA)
 - .1 CAN/CSA-B214, Installation Code for Hydronic Heating Systems.
- .4 Electrical Equipment Manufacturers Association of Canada (EEMAC)
- .5 National Electrical Manufacturers' Association (NEMA)
 - .1 NEMA MG 1, Motors and Generators.

1.2 RELATED REQUIREMENTS

- .1 Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
- .2 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

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 pump, circulator, and equipment] and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .3 Shop Drawings:
 - .1 Submit shop drawings and indicate:
 - .1 Dimensions and weights
 - .2 Pump model number, size and capacity
 - .3 Accessories
 - .4 Motor and drive data
 - .5 Performance curves
 - .6 Operating and maintenance requirements
 - .7 List of spare parts

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

1.5 QUALITY ASSURANCE

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



- .2 Pumps shall be equipped with premium efficiency motors.
- .3 All pumps shall be statically and dynamically balanced, operate without unusual noise or vibration. Conduct vibration analysis and complete repairs or replacement of parts or entire pump assemblies with excessive noise and vibration.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic pumps from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2 PRODUCTS

2.1 GENERAL

- .1 Provide pumps as noted on drawings, refer to schedules for performance requirements.
- .2 Pumps shall operate at 1,750RPM unless noted otherwise in the schedules.
- .3 All pumps shall be complete with motors, impellers, drive assemblies, bearings, suction diffusers and other accessories specified. Statically and dynamically balance all rotating parts.
- .4 All pump and motors shall be equipped with a nameplate containing manufacturer, model number, serial number, design pump capacity, horsepower, voltage, frequency, speed, service factor and full load current and motor efficiency.
- .5 All pumps shall be tested prior to shipment.
- .6 For the purposes of the testing, adjusting and balancing, provide replacement impellers or trim supplied impellers to achieve specified flow and head.
- .7 All pumps shall be provided by the same manufacturer.
- .8 All pump motors shall be premium efficiency. Motors for variable speed application shall be inverted dure rated.
- .9 All pumps shall be supplied with flanged connections, provide required reducers and transition fittings for field connections.
- .10 Pumps shall be equipped with separate isolation, check and balancing valve. Triple duty valves are not accepted.
- .11 Pump motors used in variable speed applications shall be provided with shaft grounding rings, refer to Section 23 05 13 – Common Motor Requirements for HVAC Equipment for requirements.

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: brass or bronze with corrosion resistance coating.
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135°C (275°F).
- .5 Coupling: close couples for motors under 7.5HP and split coupled for motors above 7.5HP.
- .6 Motor: premium efficiency in accordance with Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
- .7 Operating conditions: 1,210kPa (175psi) at 110°C (230°F).
- .8 Standard of acceptance: Bell & Gossett, Armstrong.

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 data sheets.

3.2 INSTALLATION

- .1 Install hydronic pumps to: CAN/CSA-B214.
- .2 In line circulators: install as indicated by flow arrows.
 - .1 Support at inlet and outlet flanges or unions.
 - .2 Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement.
 - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
 - .2 Align coupling in accordance with manufacturer's recommended tolerance.
 - .3 Check oil level and lubricate.
- .4 Ensure that pump body does not support piping or equipment.
 - .1 Provide stanchions or hangers for this purpose.
 - .2 Refer to manufacturer's installation instructions for details.
- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.
- .9 Replace damaged and defective parts, materials and equipment.
- .10 Replace or trim pump impellers to achieved specified performance.
- .11 Supply field mounted variable frequency drive for variable flow applications, integral VFD will not be accepted.
- .12 Install pumps to allow for uncompromised access to motor, seals, strainer/suction guide and other components requiring servicing. Ensure servicing can be completed without use of special tools or removal of parts of piping and other systems. Coordinate installations with electrical, controls and other divisions to ensure these services do not restrict access to the pump and components.



- .13 Provide instrumentation in accordance with details and Section 23 05 19 - Meters and Gauges for HVAC Piping.
- .14 Provide pre-formed removable insulation on pump casings, suction guides and all other accessories for pumps used for chilled water distribution.

3.3 START-UP

- .1 General:
 - .1 In accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements; supplemented as specified herein.
 - .2 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 minimum.
 - .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.
 - .11 Eliminate cavitation, flashing and air entrainment.
 - .12 Adjust pump shaft seals, stuffing boxes, glands.
 - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
 - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
 - .15 Verify lubricating oil levels.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).

1.2 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 HVAC water treatment systems and include product characteristics, performance criteria, physical size, diagrams, schematics, power requirements, controls, communication protocol and limitations.
 - .2 Submit 2 copies of WHMIS SDS.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for HVAC water treatment systems for incorporation into manual.

1.4 RELATED REQUIREMENTS

- .1 Section 01 74 00 – Cleaning.
- .2 Section 03 08 16 – Cleaning and Start-up of Mechanical Piping Systems.
- .3 Section 23 21 13 - Hydronic Systems.

2 PRODUCTS

2.1 MANUFACTURER

- .1 Equipment, chemicals, and service provided by one supplier.
- .2 List of acceptable suppliers:
 - .1 EquiChem Technologies
 - .2 AquaLibrium Water Technologies
 - .3 WMC Water Management
 - .4 Chem-Aqua
 - .5 Rochester Midland

2.2 GENERAL

- .1 Provide complete water treatment systems for each closed hydronic system (heating water, chilled water, glycol) and open hydronic system (condenser water).
- .2 Provide all equipment in accordance with the specifications of this section.



- .3 Provide sufficient cleaning agent to complete system flushing and cleaning.
- .4 Provide sufficient chemicals to complete passivation of the entire system.
- .5 Provide sufficient chemicals to achieve desired water quality in each loop. Include follow-up visits and chemical top ups from the date of the system start-up prior to project handover to ensure adequate water quality. Submit reports for Consultant's review.
- .6 Extents of chemical treatment shall include all new and existing distribution piping system (boiler, chiller, heat exchanger, heat pump, glycol, etc) being modified, altered, or replaced.
- .7 Each closed loop system shall include at minimum:
 - .1 One pot feeder
 - .2 One side stream filter
 - .3 Valves, fittings, sight flow indicator and circuit balancing valve
 - .4 Refer to drawing schematics for details

2.3 POT FEEDER

- .1 Welded steel or 5mm seamless pipe, 7.5L (2 US Gallon) capacity, fill cap, 20mm (NPS 3/4) inlet, outlet, vent and drain connections.
- .2 Pressure rating: 2,070 kPa (300psi).
- .3 Temperature rating: 90°C (194°F).

2.4 SIDE STREAM FILTER

- .1 304 stainless steel filter cartridge assembly, sized for 2.5 to 5% of the pump flow rate.
- .2 Pressure rating: 1,034kPa (150psi).
- .3 Supply sufficient filters to complete flushing and cleaning of the system and additional (20) spare filter cartridges for each system.

2.5 TEST EQUIPMENT

- .1 Provide wall mounted cabinet with hinged door and 2 shelves, white enamel paint to house the following test materials:
 - .1 Nitrite test kit
 - .2 Handheld refractometer
 - .3 Portable electronic conductivity meter
 - .4 Hardness test kit
 - .5 Chloride test kit
 - .6 pH slides and reagent
 - .7 Test instructions, test sheets, including recommended range(s)

2.6 TEMPORARY PIPING FOR SYSTEMS FLUSHING

- .1 Chemical treatment vendor shall review entire hydronic system, including connected equipment and establish required water quality and flushing/cleaning procedures parameters for each loop.
- .2 Coordinate location of bypasses with the mechanical contractor to complete flushing and cleaning of the entire distribution, including all existing piping. All piping and other provisions required to carry out complete flushing and cleaning shall be supplied under this



contract.

- .3 Bypass piping shall be at minimum 40mm (NPS 1 1/2) complete with ball valve and 20mm (NPS 3/4) drain fitting. Piping system and materials to match existing piping, where installed on the existing system. Otherwise, shall match new distribution piping.

2.7 CHEMICALS

- .1 Provide 1 years supply of corrosion inhibitor for each system, CorrShield NT4207 or equivalent.

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 HVAC water treatment systems in accordance with ASME Boiler and Pressure Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 CHEMICAL FEED PIPING

- .1 Install crosses at changes in direction. Install plugs in unused connections.

3.4 CLEANING OF MECHANICAL SYSTEM

- .1 In accordance with Section 23 08 16 – Cleaning and Startup of HVAC Piping Systems.

3.5 WATER TREATMENT SERVICES

- .1 Provide water treatment monitoring and consulting services for period of 1 year after system start-up. Service to include:
 - .1 Initial water analysis and treatment recommendations.
 - .2 System start-up assistance.
 - .3 Operating staff training.
 - .4 Visit plant every 14 days during period of operation and as required until system stabilizes, and advise on treatment system performance.
 - .5 Provide necessary recording charts and log sheets for 1 year operation.
 - .6 Provide necessary laboratory and technical assistance.
 - .7 Provide clear, concise, written instructions and advice to operating staff.

3.6 FIELD QUALITY CONTROL

- .1 Start-up:
 - .1 Start up water treatment systems in accordance with manufacturer's instructions.



- .2 Commissioning:
 - .1 Commissioning Agency: to be water treatment supplier.
 - .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After pressure testing, start-up and before TAB of connected systems.
 - .3 Pre-commissioning Inspections: verify:
 - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
 - .2 Suitability of log book.
 - .3 Currency and accuracy of raw water analysis.
 - .4 Required quality of treated water.
 - .4 Commissioning procedures - applicable to Water Treatment Systems:
 - .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.
 - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
 - .3 Establish test intervals, regeneration intervals.
 - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
 - .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
 - .6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
 - .7 Advise Consultant in writing on matters regarding installed water treatment systems.
 - .5 Commissioning procedures - Water Softeners:
 - .1 Demonstrate compliance with specifications by chemical analyses of raw water and treated water.
 - .2 Determine, demonstrate actual softening capacity between regenerations.
 - .3 Establish regeneration intervals and procedures.
 - .4 Train O&M personnel in regeneration procedures.
 - .6 Commissioning procedures - Water side of closed circuit coolers, Cooling Tower Systems:
 - .1 Verify operation of bleed-off system.
 - .2 Establish bleed-off flow rate.
 - .3 Establish rate of chemical feed - continual and periodic.
 - .4 Test system water for chlorides, TDS, suspended solids, algae, slime, inhibitor level, pH, alkalinity, hardness, other impurities and microbiological organisms.
 - .5 Compare with readings of total dissolved and suspended solids metre.
 - .6 Read make-up water metre, compare with chiller load summation (ton-hours).



- .7 Test make-up water for chlorides, hardness.
- .8 Compare test results with readings from TDS metre.
- .9 Record quantity of make-up water, compare with summation of chiller load (in ton-hours).
- .10 Record types, quantities of chemicals applied.
- .7 Commissioning procedures - Closed Circuit Hydronic Systems:
 - .1 Analyze water in system.
 - .2 Based upon an assumed rate of loss approved by Consultant, establish rate of chemical feed.
 - .3 Record types, quantities of chemicals applied.
- .8 Training:
 - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.
 - .2 Train O&M personnel in softener regeneration procedures.
- .9 Certificates:
 - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .10 Commissioning Reports:
 - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required Consultant.
- .11 Commissioning activities during Warranty Period:
 - .1 Check out water treatment systems on regular basis (at minimum 1 per month) and submit written report to Owner's Representative and Consultant.

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

END OF SECTION



Technical Standards and Safety Authority
 345 Carlingview Drive
 Toronto, Ontario M9W6N9
 Tel: 416.734.3300
 Fax: 416.234.9169
 Customer Service: 1.877.682.8772
 www.tssa.org

**Permanent Removal
 of Boilers and Pressure Vessels
 from Operation or Use**
Technical Standards and Safety Act
 Boilers and Pressure Vessels Regulations

Name of the Owner:		Date (dd-mmm-yyyy):
Address of the location where pressure equipment has been used:		
Contact Name :	Signature:	Telephone No.:
Email:	Plant Registration No. (if applicable):	

Reason for Removal

- | | | |
|---|---|---|
| A. <input type="checkbox"/> Scrapped | B. <input type="checkbox"/> Moved within Ontario | C. <input type="checkbox"/> Moved Outside of Ontario |
| D. <input type="checkbox"/> Moved to an Unknown Location | E. <input type="checkbox"/> Change of Ownership | F. <input type="checkbox"/> Decommissioned |

Scrapped: Code nameplate or stamping is removed and destroyed. Equipment cannot be used in future as a boiler or pressure vessel.
Decommissioned: Equipment removed from service and can be used sometime in the future.

If new owner and/or location are known, please provide the name and address. If there is more than one new owner or location, please attach a list cross-referenced with the item number in the chart below.

Name: _____
 Address: _____

No.	Specify: Boiler = B Pressure Vessel = P	Manufacturer	Serial No.	NB National Board No.	OIN Ontario Identification No.	CRN / 5AN Canadian Registration No.	MAWP Maximum Allowable Working Pressure	Year built
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Please complete I. or II. :

I. Attach a nameplate photo (must be completely legible) for each boiler or pressure vessel listed above. For those boilers and pressure vessels identified for scrap, include a photo of the destroyed nameplate as well.

Or II.

Inspector's Name(TSSA Boiler and Pressure Vessel or Power Plant Inspector (print)):	Signature:	Date (dd-mmm-yyyy)
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As required by O.Reg. 220/01, s. 8(1) this form shall be completed and submitted to:
 Technical Standards and Safety Authority, Boilers and Pressure Vessels Program, Director

**Instructions for completing the Permanent Removal
of Boilers and Pressure Vessels from Operation or Use
Form No. PV 09364**

Owners of boilers or pressure vessels, upon permanently removing a boiler or pressure vessel from operation and use, are required to notify the Director of the removal (O.Reg. 220/01, s.8(1)). Notification shall be in writing. The attached form can be used to notify the Technical Standards and Safety Authority of the removal from service at the current plant location.

Completion of the attached form:

- A. Scrapping** – Check this box if the boiler(s) and /or pressure vessel(s) will be scrapped.
Note: The boiler or pressure vessel cannot be used in future as a boiler or pressure vessel once the code nameplate or stamping is removed and destroyed.
- B. Moved Within Ontario** – Check this box if you know that the boiler(s) and/or pressure vessel(s) will be moved to another plant within the Province of Ontario. If the new location is known, indicate the name and address in the space provided.
- C. Moved to Outside of Ontario** – Check this box if you know that the boiler(s) and/or pressure vessel(s) will be moved outside of the Province of Ontario.
- D. Moved to an Unknown Location** – Check this box if the boiler(s) and/or pressure vessel(s) were moved to an unknown location.
- E. Change of Ownership** – Check this box if the boiler(s) and/or pressure vessel(s) will change ownership whether this is for storage or potential resale or re-installation. If the name and address of the new owner is known, indicate such in the spaces provided.
- F. Decommissioned** – Check this box if the boiler(s) and/or pressure vessel(s) are removed from service and can be used in the future.

Option II. – Contact the TSSA Boiler and Pressure Vessel or Power Plant Inspector:

- A (above)** – Contact the TSSA Inspector to witness the destruction of the code nameplate or stamping if the boiler(s) and/or pressure vessel(s) is to be scrapped and to sign the bottom of the attached form.
- B, C, D, E, and F (above)** – When the equipment has been removed, contact the TSSA Inspector for a site visit and to sign the bottom of the attached form to indicate that he/she has verified that the equipment has been removed.
Note: The code nameplate or stamping must not be removed or destroyed if the unit is not going to be scrapped.

Registered Plants (O.Reg. 219/01)

The plant must be re-registered at the time of removal of a boiler or pressure vessel if there are boilers or other equipment operating in the plant that still require to be registered.

Note: If the registered plant is scheduled for closure and all the registered boilers and pressure vessels are to be removed, the current owner must be correctly reflected on the registration until the above procedure is completed. Once all registered equipment has been removed from the plant and this has been verified by the TSSA Power Plant Inspector, the plant registration shall be closed and the facility will not be subject to any further inspections.

Submit completed form to:

Technical Standards and Safety Authority
Boilers and Pressure Vessels Safety Program
345 Carlingview Drive
Toronto, Ontario, M9W 6N9

Please submit the completed form to licencingandregistration@tssa.org for processing.
If you require assistance in completing this form, please call 416.734.3510.



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, 2010.
- .2 CSA Group (CSA)
 - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 RELATED REQUIREMENTS

- .1 N/A.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Preinstallation Meetings:
 - .1 Convene preinstallation meeting one (1) week prior to beginning work of this Section and on-site installation, with Consultant in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building subtrades.
 - .4 Review manufacturer's written installation instructions and warranty requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat exchangers 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 Ontario, Canada.
 - .2 Shop drawings to indicate project layout, including layout and dimensions of heat exchangers and system.
 - .1 Indicate manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools.
- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Manufacturer's Instructions: submit manufacturer's installation instructions.



.7 Manufacturers Reports:

- .1 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - SITE QUALITY CONTROL.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for heat exchangers for incorporation into manual.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Supply following spare parts:
 - .1 Head gaskets: 4.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect heat exchangers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2 PRODUCTS

2.1 EQUIPMENT

- .1 Plate Heat Exchanger:
 - .1 Water to water.
 - .1 Designed, constructed and tested in with accordance 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.
 - .4 Gaskets: as recommended by manufacturer to suit 200 degF fluid temperature.
 - .5 Nozzles: 150mm flange type.
 - .6 Supports: as indicated.
 - .7 Piping connections: as indicated.



- .8 Capacity: as indicated.
- .1 Working pressure: primary 1030 kPa, secondary 1030 kPa.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for heat exchanger installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 General: install level and firmly anchored to supports.
- .3 Tube in shell heat exchangers: arrange piping so that tube bundle can be removed after disconnecting two unions or flanges adjacent to head and without disturbing other equipment and systems.
- .4 Plate exchangers: install in accordance with manufacturer's recommendations.

3.3 APPURTENANCES

- .1 N/A.

3.4 SITE QUALITY CONTROL

- .1 Site Tests and Inspections:
 - .1 Perform tests as directed by Consultant to ensure heat exchangers are functional.
 - .2 Obtain reports within 3 days of review and submit immediately to Consultant.
- .2 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
- .3 Manufacturer's Field Services:
 - .1 Submit 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 Ensure manufacturer's representative is present before and during critical periods of installation and testing.
 - .3 Schedule site visits:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.



3.5 SYSTEM START-UP

- .1 General: perform start-up operations in accordance with Section 01 91 13 - General Commissioning 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.
- .7 General: perform performance verification in accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified.
- .8 Timing: only after all hydronic systems have been successfully completed.
- .9 Primary side:
 - .1 Measure flow rate, pressure drop
 - .2 Secondary side:
 - .1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.
 - .3 Calculate heat transfer from primary and secondary sides.
 - .4 Simulate heating water temperature schedule and repeat above procedures.
 - .5 Verify settings, operation, safe discharge from safety valves and relief valves.
 - .6 Verify settings, operation of operating, limit and safety controls and alarms.
 - .7 Reports:
 - .1 In accordance with Section 01 91 13 - General Commissioning Requirements: Reports, supplemented as specified herein.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

3.7 DEMONSTRATION

- .1 Training: provide training in accordance with Section 01 91 13 - General Commissioning Requirements: Training of Personnel, supplemented as follows:

3.8 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by heat exchanger installation.

END OF SECTION



1 GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 General requirements for Building Automation System (BAS), also referred to as Energy Monitoring and Control System (EMCS) within these specifications.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
 - .1 ANSI/ISA 5.5, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
 - .1 ANSI/IEEE 260.1, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE STD 135, BACNET - Data Communication Protocol for Building Automation and Control Network.
 - .2 Ashrae Guideline 13, Specifying Building Automation Systems.
- .4 CSA Group (CSA).
 - .1 CAN/CSA-Z234.1, Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
 - .1 CEA-709.1, Control Network Protocol Specification.
- .6 Electrical and Electronic Manufacturers Association (EEMAC).
 - .1 EEMAC 2Y-1, Light Grey Colour for Indoor Switch Gear.
- .7 National Fire Protection Association (NFPA)
 - .1 NFPA 70, National Electrical Code
 - .2 NFPA 90A, Standard For The Installation Of Air Conditioning And Ventilating Systems
 - .3 NFPA 92A and 92B Smoke Purge/Control Equipment

1.3 DEFINITIONS

- .1 Point: may be logical or physical.
 - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
 - .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
 - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide [25] character field for each point identifier. "System" is system that point is located on.



- .1 Area descriptor: building or part of building where point is located.
- .2 System descriptor: system that point is located on.
- .3 Point descriptor: physical or logical point description. For point identifier “area”, “system” and “point” will be shortforms or acronyms. Database must provide 25 character field for each point identifier.
- .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in “area”, “system” and “point” descriptors is placed into appropriate point expansion field. Database must provide [32] character field for each point expansion.
- .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
 - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
 - .1 AI (analog input).
 - .2 AO (analog output).
 - .3 DI (digital input).
 - .4 DO (digital output).
 - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
 - .1 Printouts: to ANSI/IEEE 260.1.

1.4 ABBREVIATIONS AND ACRONYMS

- .1 Acronyms used in EMCS:
 - .1 AEL - Average Effectiveness Level
 - .2 AI - Analog Input
 - .3 AIT - Agreement on International Trade
 - .4 AO - Analog Output
 - .5 BACnet - Building Automation and Control Network.
 - .6 BC(s) - Building Controller(s).
 - .7 BECC - Building Environmental Control Centre.
 - .8 CAD - Computer Aided Design.
 - .9 CDL - Control Description Logic.
 - .10 CDS - Control Design Schematic.
 - .11 COSV - Change of State or Value.
 - .12 CPU - Central Processing Unit.
 - .13 DI - Digital Input.
 - .14 DO - Digital Output.
 - .15 DP - Differential Pressure.
 - .16 ECU - Equipment Control Unit.



- .17 EMCS - Energy Monitoring and Control System, also interchangeably refer to as Building Automation System (BAS).
- .18 HVAC - Heating, Ventilation, Air Conditioning.
- .19 IDE - Interface Device Equipment.
- .20 I/O - Input/Output.
- .21 ISA - Industry Standard Architecture.
- .22 LAN - Local Area Network.
- .23 LCU - Local Control Unit.
- .24 MCU - Master Control Unit.
- .25 NAFTA - North American Free Trade Agreement.
- .26 NC - Normally Closed.
- .27 NO - Normally Open.
- .28 OS - Operating System.
- .29 O&M - Operation and Maintenance.
- .30 OWS - Operator Work Station.
- .31 PC - Personal Computer.
- .32 PCI - Peripheral Control Interface.
- .33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
- .34 PID - Proportional, Integral and Derivative.
- .35 RAM - Random Access Memory.
- .36 SP - Static Pressure.
- .37 ROM - Read Only Memory.
- .38 TCU - Terminal Control Unit.
- .39 USB - Universal Serial Bus.
- .40 UPS - Uninterruptible Power Supply.
- .41 VAV - Variable Air Volume.

1.5 SYSTEM DESCRIPTION

- .1 Refer to control schematics for system architecture.
- .2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
 - .1 Building Controllers.
 - .2 Control devices as listed in I/O point summary tables.
 - .3 OWS(s).
 - .4 Data communications equipment necessary to effect EMCS data transmission system.
 - .5 Field control devices.
 - .6 Software/Hardware complete with full documentation.
 - .7 Complete operating and maintenance manuals.
 - .8 Training of personnel.



- .9 Acceptance tests, technical support during commissioning, full documentation.
- .10 Wiring interface co-ordination of equipment supplied by others.
- .11 Miscellaneous work as specified in these sections and as indicated.
- .3 Design Requirements:
 - .1 Design and provide conduit and wiring linking elements of system.
 - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Consultant prior to installation. Controller shall be supplied with spare terminals to allow for 30% future expansion or addition of points.
 - .3 Location of controllers as reviewed by Owner's Representative prior to installation.
 - .4 Provide utility power to all control devised.
 - .5 Metric references: in accordance with CAN/CSA Z234.1.
- .4 Language Operating Requirements:
 - .1 Provide English operator selectable access codes.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality Control:
 - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
 - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
 - .3 Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.
 - .4 In lieu of such evidence, submit certificate from testing organization, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
 - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
 - .6 Permits and fees: in accordance with general conditions of contract.
 - .7 Submit certificate of acceptance from authority having jurisdiction to Consultant.
 - .8 Existing devices intended for re-use: submit test and calibration reports.

1.7 QUALITY ASSURANCE

- .1 Have local office within 50km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.



- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.8 SCOPE OF SERVICES

- .1 Provide required sensors, control devices, network control engine, field general equipment and VAV controllers, zone temperature sensors, wiring in conduit, relays, etc. for a fully functioning system. All materials shall be new, unless otherwise specified
- .2 Provide required sequencing and alarming, refer to drawings for sequences of operation.
- .3 Update front end graphics to reflect all modifications, add new graphics for new zones and systems as required.
- .4 Test, verify and commission all systems.
- .5 Demonstrate operation of all systems to Consultant, Commissioning Authority and Owner.
- .6 Provide required training of Owner’s Facility Team.
- .7 Prepare closeout manuals, update master control binder to reflect all deleted, revised or added systems.

1.9 BAS/CONTROLS RESPONSIBILITY MATRIX

- .1 The demarcation of work and responsibilities between the BAS/Controls Contractor and other related trades shall be as outlined in the following table. General/Prime Contractor shall be solely responsible for all coordination between trades.

Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
BAS low voltage and communication wiring *1 (note 1)	BAS	BAS	BAS	N/A
VAV box controller	BAS	BAS	BAS	26
BAS conduits and raceway	BAS	BAS	BAS	BAS
Automatic dampers (non-factory)	BAS	23	N/A	N/A
Automatic valves	BAS	23	BAS	N/A
VAV boxes	23	23	N/A	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations.	BAS	23	BAS	BAS
BAS Current Switches	BAS	BAS	BAS	N/A
BAS Control Relays	BAS	BAS	BAS	N/A
Power distribution system monitoring interfaces	26	26	BAS	26
Concrete and/or inertia equipment pads and seismic bracing	23	23	N/A	N/A
BAS interface with Chiller controls	BAS	BAS	BAS	BAS
Chiller controls interface with BAS	23	23	BAS	26
Elect. baseboard heating control (note 2)	23	26*2	N/A*2	26
All BAS Nodes, equipment, housings, enclosures and panels.	BAS	BAS	BAS	BAS
Smoke Detectors (note 3)	26	26	26/BAS *3	26



Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
Fire/Smoke Dampers (note 4)	23	23	BAS*4	26
Fire Dampers	23	23	N/A	N/A
Chiller Flow Switches	23	23	BAS	N/A
Boiler wiring	23	23	23	23
Water treatment system	23	23	23	26
VFDs	BAS	26	BAS	26
Refrigerant monitors	BAS	BAS	BAS	26
Computer Room A/C Unit field-mounted controls	23	23	BAS	26
Fire Alarm shutdown relay interlock wiring	26	26	26	26
Fire Alarm smoke control relay interlock wiring	26	26	BAS	26
Fireman's Smoke Control Override Panel	26	26	26	26
Fan Coil Unit controls	BAS	BAS	BAS	26
Cabinet/Unit Heater controls (note 5)	BAS/23*5	26/BAS*5	BAS	26
Packaged RTU space mounted controls	23	BAS	BAS	26
Packaged RTU factory-mounted controls	23	23	BAS	26
Packaged RTU field-mounted controls	BAS	BAS	BAS	26
Cooling Tower Vibration Switches	23	23	26	26
Cooling Tower Level Control Devices	23	23	26	26
Cooling Tower makeup water control devices	23	23	26	26
Starters, HOA switches	26	26	N/A	26
Control damper actuators	BAS	BAS	BAS	26
Water meter (pulse)	23	23	23/BAS *6	23

*1. BAS low voltage and communications wiring: BAS Ethernet communications cable and IP infrastructure furnish and install by BAS Contractor.

*2. Electric Baseboard Heating Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the baseboard units; line voltage controls installed and connected by Division 26 Electrical Contractor. Alternately, controls may be furnished and installed by BAS Contractors for projects requiring Baseboard Heating controls to be integrated into the BAS. Refer to Sequences of Operation on Drawings for more information.

*3. Smoke Detector also wired to shut down AHU/HVAC by BAS Contractor. Duct smoke detectors and fire alarm control modules shall be provided by others. Provide wiring, conduit, and necessary interface with fire alarm system to perform specified sequence of operation

*4. Fire/Smoke Dampers: BAS Contractor to provide and ensure OPEN/CLOSE control of Fire/Smoke dampers as coordinated between BAS HVAC systems sequences, controls and overrides, and the Fire Alarm system control status priorities and overrides. Coordinate with Division 26 to provide duct detectors or fire alarm control modules for air handling unit and exhaust system shutdown and smoke control inputs to the DDC system. In most cases fire alarm control modules will be the most effective and flexible way of achieving this interface. Ensure that the logic matrix for the fire alarm devices to trigger a HVAC response is clearly specified.

*5. Cabinet/Unit Heater Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the Cabinet/Unit Heaters; line voltage stand-alone controls installed and connected by Division 26 Electrical Contractor.



Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
<p>Even for stand-alone controls, it is common for the line voltage TStat and associated interlock wiring to be installed by the BAS. The power to the UH/CUH is performed by the Division 26 contractor. Alternately, controls may be furnished and installed by BAS Contractors for projects requiring Cabinet/Unit Heater controls to be integrated into BAS. Refer to Sequences of Operation on Drawings for more information.</p> <p>*6. Pulse Water Meter – provided and installed by Division 23, BAS Contractor to update graphics and provide BAS integration/monitoring.</p>				

1.9 SEQUENCING

- .1 Provide all required sequencing and BAS integration as specified on drawings.

2 PRODUCTS

2.1 BASEBUILDING VENDOR

- .1 All work in this section shall be completed by basebuilding control contractor
- .2 Contractor shall include for all costs associated with BAS integration, sequencing, update of BAS graphics, commissioning, demonstration of all systems.

2.2 GENERAL REQUIREMENTS

- .1 The BMS shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
- .2 The BMS shall consist of the following:
 - .1 Network Engine(s)
 - .2 Equipment Controller(s)
 - .3 Input/Output Module(s)
 - .4 Local Display Device(s)
 - .5 Portable Operator's Terminal(s)
 - .6 Distributed User Interface(s)
 - .7 Network processing, data storage and communications equipment
 - .8 Other components required for a complete and working BMS
- .3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- .4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
 - .1 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
 - .2 The System shall maintain all settings and overrides through a system reboot.
- .5 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.



- .1 The System shall comply with the following International Code Council (ICC) Codes:
- .2 Building Officials and code Administrators International (BOMA) model code
- .3 International Conference of Building Officials (ICBO) model code
- .4 Southern Building Code Congress International (SBCCI) regulations

2.3 TEMPERATURE, HUMIDITY AND CO₂ SENSORS

- .1 Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements. Exact OEM equivalents of specified sensors and transmitters shall be acceptable if clearly identified in submittals.
- .2 Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- .3 The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD. Thermistor sensors of 10,000 or 2,250 ohms resistance may be substituted based on the application.
- .4 The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion.
- .5 Sensor accuracy shall not exceed:

Point Type	Accuracy
Chilled Water	+ .5°F
Room Temp	+ .5°F
Duct Temperature	+ .5°F
All Others	+ .75°F

- .6 Thermowells
 - .1 Thermowell manufacturer shall have models available in stainless steel, brass body, and copper bulb.
 - .2 When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.
 - .3 Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
 - .4 Thermowells and sensors shall be mounted in a direct mount (no adapter) offering faster installation or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
 - .5 Thermowells constructed of 316 stainless steel shall comply with Canadian Registration Number (CRN) pressure vessel rating.
- .7 Outside Air Sensors
 - .1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall be provided with a solar shield.
 - .2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.



- .3 Temperature transmitters shall be of NEMA 3R (IP54) or NEMA 4 (IP65) construction and rated for ambient temperatures.
- .4 The outdoor sensor shall be capable of being mounted on a roof, pole or side of a building utilizing its preassembled mounting bracket.
- .5 Outside air relative humidity sensors 0-100% full range of accurate measurement. Operating temperature -4 to 140°F (-20 to 60°C).
- .6 Outside air temperature sensors operating temperature range -40 to 140°F, +/- .55°F (+/- .3°C).
- .8 Room Temperature Sensors
 - .1 Room sensors shall be constructed for either surface or wall box mounting.
 - .2 Room sensors shall have the following options when specified:
 - .1 Setpoint warmer/cooler interface to adjust zone temperature.
 - .2 Individual heating/cooling setpoint.
 - .3 Momentary override request for activation of after-hours operation.
 - .4 Two cap touch buttons with seven LED lights to represent current setpoint.
 - .5 BACnet MS/TP protocol communication.
 - .6 White finish.
 - .7 Wire guard in common spaces (hallways, corridors, gymnasiums)
 - .3 Temperature sensor shall be Johnson Controls NSB8BTN140-0.
- .9 Duct Mount Sensors
 - .1 Duct mount sensors shall mount in an electrical box through a hole in the duct, positioned to provide ease of accessibility for repair or replacement.
 - .2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be provided.
- .10 Averaging Sensors
 - .1 For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
 - .2 For plenum applications, such as mixed air temperature measurements, a continuous averaging sensor or a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
 - .3 Capillary supports at the sides of the duct shall be provided to support the sensing string.
 - .4 Acceptable Manufacturers: Johnson Controls, Minco.
- .11 Humidity Sensors
 - .1 The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.
 - .2 The humidity transmitter shall be equipped with non-interactive span and zero



- adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
- .3 The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH at 77°F unless specified elsewhere.
 - .4 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R (IP54) or NEMA 4 (IP65) enclosure with seal tight fittings.
 - .5 A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
 - .6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
 - .7 Acceptable Manufacturers: Johnson Controls and Vaisala.
- .12 CO₂ Sensors
- .1 CO₂ sensors shall have the following features:
 - .1 Jumper selectable:0-20mA, 4-20mA & 0-10 VDC output
 - .2 Liquid Crystal Display (LCD)
 - .3 CO₂ response time (0-63%) of 1 minute
 - .4 Less than 0.083% of full scale/°F temperature dependence of CO₂ output
 - .5 Long term CO₂ stability ±5% of full scale for 5 years
 - .6 CO₂ measurement accuracy of ±(40ppm + 2.0% of reading)
 - .7 CO₂ non-linearity of less than 1.0% of full scale
 - .8 Relay output module
 - .9 Analog temperature module with linear 0-10 VDC output for 32-122F
 - .2 The CO₂ sensors shall have the ability to monitor and output the following variables as required by the systems sequence of operations:
 - .1 Zone CO₂
 - .3 The CO₂ shall transmit the information back to the controller via jumper selectable 0-20mA, 4-20mA & 0-10 VDC output signals:
 - .1 The CO₂ sensors shall provide a maximum output current of 25mA; Maximum output voltage of 12.5V.
 - .2 The CO₂ sensors shall be FCC compliant to CFR47 Part 15 subpart B Class A.
 - .4 Acceptable Manufacturers: Veris CDE Series.



2.3 DIFFERENTIAL PRESSURE SENSOR

- .1 Differential Pressure Transmitters
 - .1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - .2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - .3 Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
 - .4 A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
- .2 Low Differential Water Pressure Applications (0" - 20" WC):
 - .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 - .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - .3 .01-20" WC input differential pressure range, 4-20 mA output
 - .4 Maintain accuracy up to 20 to 1 ratio turndown
 - .5 Reference Accuracy:+0.2% of full span
 - .6 Acceptable Manufacturers:Setra and Mamac.
- .3 Medium to High Differential Water Pressure Applications (Over 21" WC):
 - .1 The differential pressure transmitter shall meet the low-pressure transmitter specifications with the following exceptions:
 - .2 Differential pressure range 10" WC to 300 PSI
 - .3 Reference Accuracy:+1% of full span (includes non-linearity, hysteresis, and repeatability)
 - .4 Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
 - .5 Acceptable Manufacturers:Setra and Mamac.
- .4 Building Differential Air Pressure Applications (-1" to +1" WC):
 - .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.



- .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1.00 to +1.00 WC input differential pressure ranges. (Select range appropriate for system application)
 - 4-20 mA output
 - Maintain accuracy up to 20 to 1 ratio turndown
 - Reference Accuracy:+0.2% of full span
- .3 Acceptable Manufacturers:Johnson Controls or approved equal

2.4 POWER MONITORING DEVICES

- .1 Current Measurement (amps)
 - .1 Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
 - .2 Current Transformer – A split core current transformer shall be provided to monitor motor amps.
 - .3 Operating frequency – 50 - 400 Hz
 - .4 Insulation – 0.6 Kv class 10Kv BIL
 - .5 UL recognized
 - .6 Five amp secondary
 - .7 Select current range as appropriate for application
 - .8 Acceptable manufacturers:Setra
- .2 Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
 - .1 6X input over amp rating for AC inrushes of up to 120 amps
 - .2 Manufactured to UL 1244
 - .3 Accuracy:+.5%, Ripple +1%
 - .4 Minimum load resistance 30kOhm
 - .5 Input 0-20 amps
 - .6 Output 4-20 mA
 - .7 Transducer shall be powered by a 24 VDC regulated power supply (24 VDC +5%)
 - .8 Acceptable manufacturers:Setra

2.5 STATUS SAFETY SWITCHES

- .1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the Building Automation System (BAS) when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.



- .2 Current Sensing Switches
 - .1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - .2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
 - .3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - .4 Acceptable manufacturers:Johnson Controls or approved equal
- .3 Air Filter Status Switches
 - .1 Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
 - .2 A complete installation kit shall be provided, including:static pressure tops, tubing, fittings, and air filters.
 - .3 Provide appropriate scale range and differential adjustment for intended service.
 - .4 Acceptable manufacturers:Johnson Controls, Cleveland Controls
- .4 Air Flow Switches
 - .1 Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
 - .2 Acceptable manufacturers:Johnson Controls, Cleveland Controls
- .5 Air Pressure Safety Switches
 - .1 Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
 - .2 Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
 - .3 Acceptable manufacturers:Johnson Controls, Cleveland Controls
- .6 Water Flow Switches
 - .1 Water flow switches shall be equal to the Johnson Controls P74.
- .7 Low Temperature Limit Switches
 - .1 The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - .2 The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - .3 For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
 - .4 The low temperature limit switch shall be equal to Johnson Controls A70.



2.6 CONTROL VALVES

- .1 Ball Valves, 15mm (NPS 1/2) through 50mm (NPS 2):
 - .1 Ball Valves shall have forged brass bodies.
 - .2 Valves shall have available either Chrome Plated Brass Balls or 300 Series Stainless Steel Balls in all sizes.
 - .3 Valves shall have available either Nickel Plated Brass Stems or 300 Series Stainless Steel Stems with a blow-out proof stem design in all sizes.
 - .4 Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.
 - .5 Stem seals shall be double EPDM O-rings.
 - .6 Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psi maximum differential pressure and shall be inserted against the casting of the valve.
 - .7 All ball valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F (95°C) fluid temperature.
 - .8 All ball valves with sweat end connections or press end connection shall be rated to 300 psig maximum static pressure at 203°F (95°C) fluid temperature.
 - .9 All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
 - .10 Ball Valves with stainless steel balls and stems shall be rated for use with 15 psig saturated steam.
 - .11 Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
 - .12 Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
 - .13 Valves shall be maintenance free.
 - .14 Valves shall be provided with a 5 year equipment warranty.
 - .15 Valves shall be rated for 200 psi differential closeoff pressure.
 - .16 Valve actuators shall be UL-recognized or CSA-certified.
 - .17 Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.
- .2 Ball Valves, 50mm (NPS 2 1/2) through 100mm (MPS 4) – flanged:
 - .1 Ball valves shall have forged brass bodies with ASME Class 150 ductile iron flanges.
 - .2 Valves shall be manufactured from 300 series stainless steel balls and the flanges shall rotate independently until tightened down which is an advantage during installation.
 - .3 Valves shall have 300 series steel stems with a blow-out proof stem design.
 - .4 Stem seals shall have double EPDM O-rings.
 - .5 Valves have graphite reinforced PTFE seats with EPDM O-ring backing.
 - .6 Flow characterization disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure.



- .7 Flow characteristics shall be of equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
- .8 Valves shall be rated for service with hot water, chilled water and 50% glycol solutions and are rated for use with 25 psig (kPa) saturated steam.
- .9 Two-way valves shall be rated for 100 psid close off pressure and three-way valves shall be rated for maximum of 50 psid close off pressure.
- .10 Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
- .11 Valves shall be maintenance free.
- .12 Valves shall be provided with a 5 year warranty. Valves sold in the APAC region shall comply with an 18 month warranty policy.
- .13 Valves shall be CE marked as Johnson Controls declares these valves are in compliance with essential requirements and other relevant provisions of the Pressure Equipment Directive (PED). APAC actuators shall be excluded from this regulatory information.
- .14 Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.

2.7 CONTROL RELAYS

- .1 Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
- .2 Mounting Bases shall be snap-mount.
- .3 DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
- .4 Contacts shall be rated for 10 amps at 120VAC.
- .5 Relays shall have an integral indicator light and check button.
- .6 Acceptable manufacturers: Johnson Controls, Lectro

2.8 EXPANSION I/O MODULE (XPM)

- .1 The XPM provides additional input and output interfaces for use in digital controllers.
- .2 The XPM shall communicate with controllers over the FC Bus or the SA Bus.
- .3 The XPM shall support BACnet Standard ANSI/ASHRAE 135.
- .4 The XPM shall be BTL listed/certified and carry the BTL Label.
- .5 The XPM shall be tested and certified as a BACnet Smart Actuator (B-SA).
- .6 A BACnet Protocol Implementation Conformance Statement shall be provided for the XPM.
- .7 The Conformance Statement shall be submitted 10 days prior to bidding.
- .8 The XPM shall include pluggable screw terminal blocks for all I/O, SA/FC bus communication, and power wiring connections.
- .9 The XPM shall include three (3) decimal rotary dial switches for setting the BACnet MS/TP device address.
- .10 The XPM shall accommodate the direct wiring of analog and binary I/O field points with the following resolution:
 - .1 Inputs – 24-bit analog-to-digital converter
 - .2 Outputs – +/- 200 mV accuracy in 0-10 VDC applications



- .11 The XPM shall support the following types of inputs and outputs:
 - .1 0-10 VDC analog input
 - .2 4-20 mA analog input
 - .3 0-600k ohms analog input
 - .4 Dry contact binary input
- .12 Binary Inputs – shall be configured to monitor either of the following:
 - .1 Dry Contact Maintained Mode
 - .2 Pulse Counter Mode
- .13 Analog Outputs – shall be configured to output either of the following:
 - .1 0-10 VDC analog output
 - .2 4-20 mA analog output
- .14 Binary Outputs – shall output the following:
 - .1 24 VAC Triac
- .15 Configurable Outputs – shall be capable of the following:
 - .1 0-10 VDC analog output
 - .2 24 VAC Triac binary output
- .16 The XPM shall include troubleshooting LEDs to indicate the following conditions:
 - .1 Power – to indicate if the device is powered or not powered
 - .2 Fault – to indicate if the device is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
 - .3 SA/FC Bus – to indicate if bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - .4 EOL – to indicate if the end of line termination is on or off.
- .17 Provide Johnson Controls XPM as required.

2.9 FIELD EQUIPMENT CONTROLLER (FEC)

- .1 The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol or optionally via N2Open.
The FEC shall support BACnet Standard ANSI/ASHRAE 135 on the controller network.
The FEC shall be BTL listed/certified and carry the BTL Label.
The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
The Conformance Statement shall be submitted 10 days prior to bidding.
- .2 The FEC shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.



- .3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
- .4 The FEC shall be assembled in a plastic housing with flammability rated to UL94-5VB.
- .5 The FEC shall include troubleshooting LEDs to indicate the following conditions:
 - .1 Power On
 - .2 Power Off
 - .3 Download or Startup in progress, not ready for normal operation
 - .4 No Faults
 - .5 Device Fault
 - .6 Field Controller Bus – Normal Data Transmission
 - .7 Field Controller Bus – No Data Transmission
 - .8 Field Controller Bus – No Communication
 - .9 SA Bus – Normal Data Transmission
 - .10 SA Bus – No Data Transmission
 - .11 SA Bus – No Communication
- .6 The FEC shall accommodate the direct wiring of analog and binary I/O field points with the following minimum A/D and D/A conversion resolution.
 - .1 Provide a minimum 15 bit A/D resolution for analog inputs.
 - .2 Provide a minimum 15 bit D/A resolution for analog outputs.
- .7 The FEC shall support the following types of inputs and outputs:
 - .1 Universal Inputs – shall be configured to monitor any of the following:
 - .2 Analog Input, Voltage Mode
 - .3 Analog Input, Current Mode
 - .4 Analog Input, Resistive Mode
 - .5 Binary Input, Dry Contact Maintained Mode
 - .6 Binary Input, Pulse Counter Mode
 - .7 Binary Inputs – shall be configured to monitor either of the following:
 - .8 Dry Contact Maintained Mode
 - .9 Pulse Counter Mode
 - .10 Analog Outputs – shall be configured to output either of the following:
 - .11 Analog Output, Voltage Mode
 - .12 Analog Output, current Mode
 - .13 Binary Outputs – shall output the following:
 - .14 24 VAC Triac
 - .15 Configurable Outputs – shall be capable of the following:
 - .16 Analog Output, Voltage Mode
 - .17 Binary Output Mode



- .8 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
 - .1 The FC Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.
 - .2 The FC Bus shall support communications between the FECs and the Network Engine.
 - .3 The FC Bus shall also support peer-to-peer communications between non-supervisory devices, allowing these devices to communicate system data with each other directly, bypassing the supervisory network engine on the bus.
 - .4 The FC Bus shall support a minimum of 100 equipment controllers and/or expansion modules in any combination.
 - .5 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
 - .6 The FEC shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.
 - .7 The SA Bus shall be a MS/TP Bus supporting BACnet Standard Protocol SSPC-135.
 - .8 The SA Bus shall support a minimum of 10 devices per trunk.
 - .9 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- .9 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

2.10 NETWORK ENGINES (SNE)

- .1 The Network Engine shall be a fully user-programmable, supervisory controller. The Network Engine(s) shall monitor the network of distributed equipment controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Engine(s).
- .2 Automation network – The Network Engine(s) shall reside on the automation network and shall support a subnet of system controllers.
- .3 User Interface – Each Network Engine shall have the ability to deliver a web-based User Interface using the Site Management Portal functionality previously described. All computers connected physically or virtually to the automation network shall have access to the web-based user interface.
 - .1 The web-based user interface software shall be embedded in the Network Engine(s). Systems that require a local copy of the system database on the user's device are not acceptable.
 - .2 The Network Engine(s) shall support a minimum of two (2) concurrent users.
 - .3 The web-based user interface shall have the capability to access all system data through a single Network Engine.
 - .4 Remote users connected to the network using a Virtual Private Network (VPN) shall also have total system access through one Network Engine.
 - .5 Systems that require the user to address more than one Network Engine to access all system information are not acceptable.



- .6 The Network Engine shall have the capability of serving web-based user interface graphics. The graphics capability shall be embedded in the Network Engine.
- .7 Systems that only support user interface graphics from a central database or require the graphics to reside on the user's device are not acceptable.
- .8 Systems that require workstation software or modified web browsers for system queries are not acceptable.
- .9 The web-based user interface shall support the following functions using a supported web browser:
 - Configuration
 - Commissioning
 - Data Archiving
 - Monitoring
 - Commanding
 - System Diagnostics
- .4 Processor – The Network Engine(s) shall be microprocessor-based with a minimum word size of 32 bits. The Network Engine(s) shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. Network Engine(s) size and capability shall be sufficient to fully meet the requirements of this Specification.
- .5 Memory – Each Network Engine shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
- .6 Secure Boot – The Network Engine(s) shall prevent malicious or unauthorized software applications from loading during the system startup process.
- .7 User Authentication – The Network Engine(s) shall support local user authentication.
- .8 Password Security – Access to the Network Engines' embedded user interface shall require a password of 8 to 50 characters including a minimum of one lower case letter, one upper case letter, one number, and one special character. An alarm shall be generated after three unsuccessful attempts within 15 minutes, and the user shall be denied access until permission is renewed by a system administrator.
- .9 Network Security – Communication between the Network Engine and other system networked devices including additional Network Engines, Application and Data Servers, Open Data Servers (BACnet listed OWS), and user interface clients shall be encrypted and support HTTPS with Transport Level Security (TLS) Version 1.2. Self-signed certificates are to be provided with the option of configuring trusted certificates.
- .10 Hardware Real Time Clock – The Network Engine(s) shall include an integrated, hardware-based, real-time clock, with a supercapacitor to maintain time for a minimum of 72 hours during a power loss. Controllers using a battery to maintain time during a power loss shall not be acceptable.
- .11 Diagnostics – The Network Engine(s) shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Engine(s) shall provide both local and remote annunciation of any detected component failures or repeated failures to establish communication.



- .12 Power Failure – In the event of the loss of normal power, the Network Engine(s) shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - .1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - .2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
- .13 Certification – The Network Engine(s) shall meet and be listed to the UL 916 Standard for Energy Management Equipment and be FCC Compliant to CFR47, Part 15, Subpart B, Class A.
- .14 Device Integration – The Network Engine(s) shall support integrating networked devices using the following communication protocols on the device/controller network:
 - .1 The Network Engine(s) shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135 on the controller network.
 - .2 The Network Engine(s) shall support Remote Field Bus integration via a BACnet IP to MS/TP router.
 - .3 The Network Engine(s) shall be tested and BTL listed/certified as a BACnet Building Controller (B-BC).
 - .4 A BACnet Protocol Implementation Conformance Statement shall be provided for the Network Engine(s).
 - .5 The Protocol Implementation Conformance Statement shall be submitted 10 days prior to bidding.
 - .6 The Network Engine(s) shall support third party N2 Open devices.
- .15 The Network Engine(s) shall include the following multi-color, flashing LEDs to indicate important operating conditions and status:
 - .1 Heartbeat – to indicate each of the following states:operational (normal), powered but not operational, starting up, shutting down, or no power applied
 - .2 Fault – to indicate if fault conditions have been detected
 - .3 Ethernet Activity – to indicate if Ethernet Traffic is occurring or not occurring.
 - .4 Ethernet Link Speed – to indicate the speed of Ethernet Link (10, 100, or 1000 Mbps)
 - .5 Site Director – to indicate if the Network Engine has been designated as the Site Director
 - .6 BACnet/IP – to indicate if the Network Engine is transmitting BACnet messages over BACnet/IP to other devices, including other Network Engines
 - .7 USB -1 – to indicate if a supported device is connected, no device is connected, or an unsupported device is connected on USB port 1
 - .8 USB-1 – to indicate if a supported device is connected, no device is connected, or an unsupported device is connected on USB port 2
 - .9 FC BUS-# – to indicate if communication is occurring on FC Bus port # (1 or 2)



- .10 FC EOL-# – to indicate if the end-of-line termination switch # (1 or 2) is on or off
- .16 The Network Engine shall support up to 100 supervised devices across all supported integrations.
- .17 Communication Ports – The Network Engine(s) shall provide the following ports for connecting networkable devices:
 - .1 Two (2) USB ports
 - .2 One (1) RS-485 port
 - .3 One (1) Ethernet port
- .18 Network Engine shall be Johnson Controls SNE1100 or approved equal, provide required quantities to support proposed system upgrades.

2.11 GENERAL PURPOSE EQUIPMENT CONTROLLER (CGM)

- .1 The General Purpose Equipment Controller (CGM) shall be a fully programmable, digital controller that communicates via the BACnet MS/TP protocol.
- .2 The CGM shall support BACnet Standard ANSI/ASHRAE 135.
- .3 The CGM shall be BTL listed/certified.
- .4 The CGM shall be tested and certified as a BACnet Advanced Application Controller (B-AAC).
- .5 A BACnet Protocol Implementation Conformance Statement shall be provided for the CGM.
- .6 The Conformance Statement shall be submitted 10 days prior to bidding.
- .7 The CGM shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
- .8 CGM controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
- .9 The CGM shall be assembled in a plastic housing with protection class IP20 (IEC529) and flammability rated to UL94-5VB.
- .10 The CGM shall include an integral real-time clock and support time-based tasks which enables these field controllers to monitor and control:
 - .1 Schedules
 - .2 Calendars
 - .3 Alarms
 - .4 Trends
- .11 The CGM can continue time-based monitoring when offline for extended periods of time from a network.
- .12 The CGM can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment controllers.



- .13 The CGM shall include troubleshooting LEDs to indicate the following conditions:
 - .1 Power—to indicate if the controller is powered or not powered
 - .2 Fault – to indicate if the controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
 - .3 SA Bus – to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - .4 FC Bus – to indicate if FC Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - .5 EOL – to indicate if the end-of-line termination switch is on or off
- .14 The CGM shall have the ability to transfer and apply firmware files to all SA Bus devices (XPM, IOM, and NS8000) connected to it.
- .15 The CGM shall include pluggable and labeled screw terminal blocks for all I/O, FC and SA Bus communication, and power wiring connections.
- .16 The CGM shall accommodate the direct wiring of analog and binary I/O field points with the following resolution.
 - .1 Inputs – 24-bit analog-to-digital converter
 - .2 Outputs – +/- 200 mV accuracy in 0-10 VDC applications
- .17 The CGM shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:
 - .1 Universal Inputs – shall be configurable to monitor any of the following:
 - 0-10 VDC analog input
 - 4-20 mA analog input
 - 0-600k ohms analog input
 - Dry contact binary input
 - .2 Binary Inputs – shall be configurable to monitor either of the following:
 - Dry Contact Maintained Mode
 - Pulse Counter Mode
 - .3 Analog Outputs – shall be configurable to output either of the following:
 - 0-10 VDC analog output
 - 4-20 mA analog output
 - .4 Binary Outputs – shall output the following:
 - 24 VAC Triac
 - .5 Configurable Outputs – shall be capable of the following:
 - 0-10 VDC analog output
 - 24 VAC Triac binary output
- .18 The CGM shall have the ability to reside on a Field Controller Bus (FC Bus).
 - .1 The FC Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.
 - .2 The FC Bus shall support communications between the CGMs and the Network Engine.
 - .3



- .4 The FC Bus shall also support peer-to-peer communications between non-supervisory devices, allowing these devices to communicate system data with each other directly, bypassing the supervisory network engine on the bus.
- .5 The FC Bus shall support a minimum of 100 equipment controllers and/or expansion modules in any combination.
- .6 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the CGM and the furthest connected device.
- .19 The CGM shall include three (3) decimal rotary dial switches for setting the BACnet MS/TP device address.
- .20 The CGM shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.
- .21 The SA Bus shall be a MS/TP Bus supporting BACnet Standard Protocol SSPC-135.
- .22 The SA Bus shall support a minimum of 10 devices per trunk.
- .23 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the CGM and the furthest connected device.
- .24 The CGM shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over a MS/TP Bus.
- .25 Controller shall be Johnson Controls CGM.

2.12 VAV TERMINAL UNIT CONTROLLER (CVM)

- .1 The VAV Box Controller (hereafter referred to as CVM) shall provide both standalone and networked DDC of pressure-independent, VAV terminal units.
- .2 The CVM controller shall be a fully programmable, digital controller that communicates via BACnet MS/TP protocol.
- .3 The CVM shall support BACnet Standard ANSI/ASHRAE 135.
- .4 The CVM shall be BTL listed/certified.
- .5 The CVM shall be tested and certified as a BACnet Advanced Application Controller (B-AAC).
- .6 A BACnet Protocol Implementation Conformance Statement shall be provided for the CVM.
- .7 The Conformance Statement shall be submitted 10 days prior to bidding.
- .8 The CVM shall include 14 preloaded single duct VAV box control applications to allow the CVM to be made fully operational without the need to create a custom program.
- .9 The CVM shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
- .10 CVM controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
- .11 The CVM shall be assembled in a plenum-rated plastic housing with protection class IP20 (IEC529) and flammability rated to UL94-5VB.
- .12 The CVM shall include an integral real-time clock and support time-based tasks which



enables these equipment controllers to monitor and control:

- .1 Schedules
 - .2 Calendars
 - .3 Alarms
 - .4 Trends
- .13 The CVM can continue time-based monitoring when offline for extended periods of time from a network.
 - .14 The CVM shall include an integral differential pressure transducer and damper actuator. An additional configuration option shall be available that also includes an integral potentiometer for actual damper position feedback. All components shall be connected and mounted as a single assembly, removable as one piece.
 - .15 The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
 - .16 The CVM shall determine airflow by a state-of-the-art, digital, non-flow pressure sensor that supports automatic correction for polarity on high- and low-pressure DP tube connections to eliminate high- and low-pressure connection mistakes.
 - .17 The CVM shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
 - .18 The CVM can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment controllers.
 - .19 The CVM shall include troubleshooting LEDs to indicate the following conditions:
 - .1 Power—to indicate if the controller is powered or not powered
 - .2 Fault – to indicate if the controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
 - .3 SA Bus – to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - .4 FC Bus – to indicate if FC Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - .5 EOL – to indicate if the end-of-line termination switch is on or off
 - .20 The CVM shall have the ability to transfer and apply firmware files to all SA Bus devices (XPM, IOM, and NS8000) connected to it.
 - .21 The CVM shall include pluggable screw terminal blocks for all I/O, FC and SA Bus communication, and power wiring connections.
 - .22 The CVM shall accommodate the direct wiring of analog and binary I/O field points with the following resolution.
 - .1 Inputs – 24-bit analog-to-digital converter
 - .2 Outputs – +/- 200 mV accuracy in 0-10 VDC applications
 - .23 The CVM shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:
 - .1 Universal Inputs – shall be configurable to monitor any of the following:



- 0-10 VDC analog input
- 4-20 mA analog input
- 0-600k ohms analog input
- Dry contact binary input
- .2 Binary Outputs – shall output the following:
 - 24 VAC Triac binary outputs
- .3 Configurable Outputs – shall be configurable of outputting the following:
 - 0-10 VDC analog output
 - 24 VAC Triac binary output
- .24 The CVM shall have the ability to reside on a Field Controller Bus (FC Bus).
 - .1 The FC Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.
 - .2 The FC Bus shall support communications between the CVMs and the Network Engine.
 - .3 The FC Bus shall also support peer-to-peer communications between non-supervisory devices, allowing these devices to communicate system data with each other directly, bypassing the supervisory network engine on the bus.
 - .4 The FC Bus shall support a minimum of 100 equipment controllers and/or expansion modules in any combination.
 - .5 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the CVM and the furthest connected device.
- .25 The CVM shall have the capability to execute VAV box control sequences involving direct wired I/O points as well as input and output devices communicating over a MS/TP Bus.
- .26 The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
- .27 Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
- .28 The controller shall provide the ability to download and upload VAV box control application configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group.
- .29 Control setpoint changes initiated over the network shall be written to CVM non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
- .30 The CVM controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
- .31 The CVM controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
- .32 The CVM controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
- .33 The CVM controller shall have on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval,



which may be used to continuously monitor and document system performance. The CVM shall calculate Exponentially Weighted Moving Averages (EWMA) for each of the following metrics, which shall be available to the end user for efficient management of the VAV terminals.

- .1 Absolute temperature loop error
 - .2 Signed temperature loop error
 - .3 Absolute airflow loop error
 - .4 Signed airflow loop error
 - .5 Average damper actuator duty cycle
- .34 The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
- .1 Unreliable space temperature sensor
 - .2 Unreliable differential pressure sensor
 - .3 Starved box
 - .4 Actuator stall
 - .5 Insufficient cooling
 - .6 Insufficient heating
- .35 The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The CVM would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
- .36 The CVM controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.
- .37 The CVM controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
- .38 Refer to drawings for approximate locations and quantities. Field verify exact location and provide all required wiring.
- .39 VAV controller shall be Johnson Controls CV Series.

2.13 AIRFLOW MONITORING

- .1 Fan Inlet Air Flow Measuring Stations
 - .1 At the inlet of each fan and near the exit of the inlet sound trap, airflow sensors shall be provided that shall continuously monitor the fan air volumes or velocity pressure.
 - .2 Each sensor shall be surface mount type. Unit shall be capable of monitoring and reporting the airflow and temperature at each fan inlet location through two or four sensing circuits. If a static pressure manifold is used, it shall incorporate dual offset static tips on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as + 20° in the approaching air stream.
 - .3 Devices creating fan performance degradation, resulting in additional energy consumption, caused from pressure drop associated with probes or mounting



apparatus in the center of the fan inlet are not allowed. The device shall not induce a significant pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Sensor circuit casings shall be constructed of U.L. 94 flame rated high impact ABS and include a stainless steel thermistor cap that maintains the precise calibrated flow over the heated and ambient measurement points.

- .4 Acceptable manufacturers: Johnson Controls, Air Monitor Corp., Tek-Air Systems, Inc., or Dietrich Standard.
- .2 Duct Air Flow Measuring Stations
 - .1 Furnish and install, at locations shown on plans or as in accordance with schedules, an equalized air measuring probe system piped to a high performance pressure transducer or an electronic type airflow temperature measuring station.
 - .2 Each device shall be designed and built in order to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.
 - .3 Assembly shall be AMCA tested and capable of measuring a range from 70 to 5,000 FPM (22 to 1524 MPM).
 - .4 Equalized air measuring assembly shall measure to $\pm 3\%$ average and consist of 6063T5 extruded aluminum step sensing blade(s) with anodized finish, plenum-rated polyethylene pressure tubing, brass barbed fittings, mounting hardware and a glass-on-silicone capacitance sensor pressure transducer capable of measuring up to five field-selectable pressure ranges up to 2.5 in. WC.
 - .5 The transducer shall be accurate to $\pm 0.5\%$, or 0.25% of full scale and be contained in a National Electrical Manufacturer's Association (NEMA) 4 (IP-65) enclosure. Transducer shall be factory mounted and piped to high and low pressure ports through fittings made of brass.
 - .6 All sensor tubing shall terminate in solid brass barbed fittings.
 - .7 Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be present on each unit casing, listing model number, size, area, and airflow capacity.
 - .8 Air straightener shall be provided for sizes over 17 square feet (1.6 sq meter).
 - .9 Airflow measuring station assemblies shall be fabricated of galvanized steel or aluminum casing of appropriate thickness for slip fits or with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 5000 feet per minute.
 - .10 Electronic air measuring station shall be capable of monitoring and reporting the airflow and temperature at each measuring location through one or more measuring probes containing multiple sensor points and a control transmitter that outputs a 4-20 mA linear signal.



- .11 Probe(s) shall be constructed of an airfoil shaped aluminum extrusion containing the sensor circuit(s).
- .12 Each sensor circuit shall consist of coated thermistors, for temperature and velocity, mounted to a Printed Circuit Board (PCB). Multiplexer board shall be encased to prevent moisture damage.
- .13 Control transmitter shall be capable of processing independent sensing points and shall operate on a fused 24 VAC supply.
- .14 Control transmitter shall feature a 16 x 2 character alphanumeric LCD screen, digital offset/gain adjustment, continuous performing sensor/transmitter diagnostics, and a visual alarm to detect malfunctions.
- .15 The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .04" WC at 1000 feet per minute, or .11" WC at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 3-5% as determined by AMCA.
- .16 Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be 1.5 inches to facilitate matching connecting ductwork.
- .17 Where control dampers are provided as part of the airflow measuring station, parallel blade precision controlled volume dampers integral to the station and complete with actuator, and linkage shall be provided.
- .18 Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.
- .19 All air measuring devices shall be tested according to AMCA Standard 610.
- .20 Acceptable manufacturers: Johnson Controls, Air Monitor Corp., Tek-Air, Ruskin, and Dietrich Standard.

2.14 SMOKE DETECTORS

- .1 Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System. Prime or General Contractor shall be responsible for coordination between all trades and provision of all required devices, materials, equipment, other provisions and labour.
- .2 Provide and install in accordance with applicable codes.

2.15 CONTROL DAMPERS

- .1 The bas Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the drawings.



- .2 All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- .3 All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
- .4 Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" WC static pressure when tested in accordance with AMCA Std. 500.
- .5 Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" WC, but no more than 4000 FPM or 6" WC.
- .6 Acceptable manufacturers are Johnson Controls VD-1250, VD1630, or VD-1330, Ruskin CD50 or CD60, and Vent Products 5650 for standard applications.
- .7 For dampers exposed to outdoor air (outdoor, exhaust, relief) dampers shall be thermally broken, equivalent to TAMCO Series 9000 or equivalent.
- .8 One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.
- .9 Acceptable manufacturers: Johnson Controls VD-1620, VD-1320, Ruskin CD36, and Vent Products 5800.
- .10 Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

3 EXECUTION

3.1 GENERAL

- .1 Provide all required labour and materials including sensors, control devices, input/output modules, relays, controllers, control panels, wiring for a fully functioning system.
- .2 Install all equipment and devices in accordance with manufacturer's recommendations and applicable codes and regulations.
- .3 Fully commission all aspects of controls work, provide point-to-point verification reports for all points, pre-commissioning test sheets and provide assistance and demonstration during commissioning phase.
- .4 Provide blue ceiling labels at all VAV locations. Minimum size is 50mm dia.



- .5 Provide access to VAV box including cutting and patching of drywall/plaster ceiling or removal and reinstatement of the acoustic ceiling tile system. Provide new ceiling tiles following installation for areas with acoustic tile system. Repair drywall/plaster ceiling and provide 400x400mm fire rated access panel for future access to VAV and components in areas with drywall/plaster ceilings. Coordinate work with mechanical contractor.

3.2 WIRING

- .1 All conduit, wiring, accessories and wiring connections required for the installation of the BAS, as herein specified, shall be provided by the BAS Contractor unless specifically shown on the Electrical Drawings under Division 24 Electrical. All wiring shall comply with the requirements of applicable portions of Division 24 and all local and national electric codes, unless specified otherwise in this section.
- .2 All BAS wiring materials and installation methods shall comply with BAS manufacturer recommendations.
- .3 The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BAS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BAS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
- .4 Class 2 Wiring
 - .1 All Class 2 (24 VAC or less) wiring shall be installed in conduit unless otherwise specified.
 - .2 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
 - .3 Class 2 signal wiring and 24 VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
- .4 Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.
- .5 BAS Line Voltage Power Source
 - .1 120-volt AC circuits used for the BAS shall be taken from panel boards and circuit breakers provided by Division 26.
 - .2 Circuits used for the BAS shall be dedicated to the BAS and shall not be used for any other purposes.
 - .3 DDC terminal unit controllers may use AC power from motor power circuits.
- .6 BAS Raceway
 - .1 All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
 - .2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
 - .3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.



- .4 Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.
- .7 Penetrations
 - .1 Provide fire stopping for all penetrations used by dedicated BAS conduits and raceways.
 - .2 All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
 - .3 All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
 - .4 Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- .8 BAS Identification Standards
 - .1 Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
 - .2 Cable types specified in Item A shall be color coded for easy identification and troubleshooting.
- .9 BAS Panel Installation
 - .1 The BAS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
 - .2 The BAS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.
- .10 Input Devices
 - .1 All Input devices shall be installed per the manufacturer recommendation.
 - .2 Locate components of the BAS in accessible local control panels wherever possible.

END OF SECTION



The following sequence shall be incorporated with the existing boiler control sequence.

Hot Water Pump 5 and 6 Control:

Hot water pumps 5 and 6 shall operate in a lead/lag fashion and the lead pump shall run continuously when the boiler system is enabled.

- The controller shall measure the differential hot water pressure and modulate the lead pump VFD output to maintain the hot water differential pressure setpoint (determined by the balancer). The lead pump shall run first. On failure of the lead pump, or if locked out by the operator through a designated maintenance switch, the standby pump shall run and the lead pump shall turn off.
- The lead hot water pump shall run for 1 hour after system shutdown.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- equal run time
- weekly schedule

Alarms shall be provided as follows:

- Hot Water Pump 5
 - Pump Status: Mismatch between the pump command and the pump status for 30 minutes.
- Hot Water Pump 6
 - Pump Status: Mismatch between the pump command and the pump status for 30 minutes.

Hot Water Pump 7 and 8 Control:

Hot water pumps 7 and 8 shall operate in a lead/lag fashion and the lead pump shall run continuously when the boiler system is enabled.

- On failure of the lead pump, or if locked out by the operator through a designated maintenance switch, the standby pump shall run and the lead pump shall turn off. The hot water pumps shall run at a constant speed when enabled. Speed determined by the balancer.
- The lead hot water pump shall run for 1 hour after system shutdown.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- equal run time
- weekly schedule

Alarms shall be provided as follows:

- Hot Water Pump 7



- Pump Status: Mismatch between the pump command and the pump status for 30 minutes.
- Hot Water Pump 8
 - Pump Status: Mismatch between the pump command and the pump status for 30 minutes.

Glycol Pump 3 and 4 Control:

Glycol pumps 3 and 4 shall operate in a lead/lag fashion and the lead pump shall run continuously when the boiler system is enabled.

- On failure of the lead pump, or if locked out by the operator through a designated maintenance switch, the standby pump shall run and the lead pump shall turn off. The glycol pumps shall run at a constant speed when enabled. Speed determined by the balancer.
- The lead hot water pump shall run for 1 hour after system shutdown.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- equal run time
- weekly schedule

Alarms shall be provided as follows:

- Glycol Pump 3
 - Pump Status: Mismatch between the pump command and the pump status for 30 minutes.
- Glycol Pump 4
 - Pump Status: Mismatch between the pump command and the pump status for 30 minutes.

Heat Exchanger Temperature Monitoring:

The following temperatures shall be monitored:

- heat exchanger hot water supply temperature
- heat exchanger hot water return temperature
- heat exchanger glycol supply temperature.
- heat exchanger glycol return temperature.

Alarms shall be provided as follows:

- Heat Exchanger Low Glycol Supply Temperature: If the boiler system has been enabled for 1 hour and the glycol supply temperature is less than 37°C for 30 minutes.



New Points:

Point Name	Hardware Points				Software Points			Trend	Alarm	Show on Graphic
	AI	AO	BI	BO	AV	BV	MV			
Heat Exchanger Hot Water Supply Temperature	x							x		x
Heat Exchanger Hot Water Return Temperature	x							x		x
Heat Exchanger Glycol Supply Temperature	x							x	x	x
Heat Exchanger Glycol Return Temperature	x							x		x
Hot Water Differential Pressure	x							x		x
Hot Water Differential Pressure Setpoint					x					
Hot Water Pump 5 Command				x				x		x
Hot Water Pump 5 Output		x						x		x
Hot Water Pump 5 Amperage	x							x		x
Hot Water Pump 5 Status							x	x	x	x
Hot Water Pump 5 VFD Fault							x	x	x	x
Hot Water Pump 5 Maintenance Switch							x	x		x
Hot Water Pump 6 Command				x				x		x
Hot Water Pump 6 Output		x						x		x
Hot Water Pump 6 Amperage	x							x		x
Hot Water Pump 6 Status							x	x	x	x
Hot Water Pump 6 VFD Fault							x	x	x	x



Hot Water Pump 6 Maintenance Switch								x	x			x
Hot Water Pump 5 Kilowatts (BACnet)	x								x			
Hot Water Pump 6 Kilowatts (BACnet)	x								x			x
Hot Water Pump 7 Command					x					x		x
Hot Water Pump 7 Output			x							x		x
Hot Water Pump 7 Amperage	x									x		x
Hot Water Pump 7 Status								x	x		x	x
Hot Water Pump 7 VFD Fault								x	x		x	x
Hot Water Pump 7 Maintenance Switch								x	x			x
Hot Water Pump 8 Command						x				x		x
Hot Water Pump 8 Output				x						x		x
Hot Water Pump 8 Amperage	x									x		x
Hot Water Pump 8 Status								x	x		x	x
Hot Water Pump 8 VFD Fault								x	x		x	x
Hot Water Pump 8 Maintenance Switch								x	x			x
Hot Water Pump 7 Kilowatts (BACnet)	x									x		
Hot Water Pump 8 Kilowatts (BACnet)	x									x		x
Glycol Pump 3 Command						x				x		x
Glycol Pump 3 Output					x					x		x
Glycol Pump 3 Amperage	x									x		x
Glycol Pump 3 Status								x	x		x	x
Glycol Pump 3 VFD Fault								x	x		x	x
Glycol Pump 3 Maintenance Switch								x	x			x



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CSA C22.1-Latest Edition, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 Amendments
 - .3 CAN/CSA-C22.3 No.1, Overhead Systems.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122-Latest Edition, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.2 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

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 and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit for review single line electrical diagrams in glazed frames and locate as indicated.
 - .1 Electrical distribution system in main electrical room.
 - .2 Electrical power generation and distribution systems in power plant rooms.
- .4 Shop drawings:
 - .1 Submit drawings stamped and signed by Certified Electrical Contractor.
 - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .4 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .5 Submit soft copy (PDF) of drawings and product data to authority having jurisdiction.
 - .6 If changes are required, notify Consultant of these changes before they are made.
- .6 Certificates:
 - .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 Consultant.
- .7 Manufacturer's Field Reports: submit to Consultant manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.
- .8 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
 - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
 - .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
 - .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
 - .4 Post instructions where directed.
 - .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
 - .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:



- .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect equipment from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

2 PRODUCTS

2.1 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.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

2.3 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: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of Consultant.
- .2 Porcelain enamel decal signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.6 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
 - .1 Nameplates: lamicoid black face, white 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 6 mm 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 and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages.

2.7 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
- .4 Use colour coded wires in communication cables, matched throughout system.

2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Type	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue



Type	Prime	Auxiliary
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.9 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 indoor switchgear and distribution enclosures light gray.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise

3.3 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed

3.4 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.5 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 150 mm horizontal clearance



between boxes.

- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3,000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.6 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: 1,400 mm.
 - .2 Wall receptacles:
 - .1 General: 300 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1,400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 300 mm.
 - .5 Wall mounted telephone and interphone outlets: 1,500 mm.

3.7 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.8 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) 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 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, 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 generation and distribution system including phasing, voltage, grounding and load balancing.



- .2 Circuits originating from branch distribution panels.
- .3 Lighting and its control.
- .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .5 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 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 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.9 SYSTEM STARTUP

- .1 Instruct Consultant 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.

3.10 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION



1 GENERAL

1.1 SUMMARY

- .1 This Section includes requirements for selective demolition and removal of electrical components including removal of conduit, junction boxes, and panels to source (home run removal) and incidentals required to complete work described in this Section ready for new construction.

1.2 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA S350 M1980 – Latest Edition, Code of Practice for Safety in Demolition of Structures

1.3 DEFINITIONS

- .1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .3 Remove and Salvage: (where Indicated) Detach items from existing construction and deliver them to Owner ready for reuse.
- .4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- .5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Action Submittals: Provide in accordance with Section 01 33 00 - Submittal Procedures before starting work of this Section:
 - .1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19 - Waste Management and Disposal
 - .2 Landfill Records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.



1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: Perform work of this Section in accordance with:
 - .1 Provincial/Territorial Workers' Compensation Boards/Commissions
 - .2 Provincial/Territorial Occupational Health and Safety Standards and Programs

1.7 SITE CONDITIONS

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition on date that tender is accepted.
- .2 Existing Hazardous Substances: Owner has performed a hazardous substances assessment and identified materials requiring abatement as follows:
 - .1 Hazardous substances are as defined in Hazardous Products Act.
 - .2 Hazardous substances will be removed by Contractor as a part of Contract before starting Work in accordance with work results described in Related Requirements listed above.
- .3 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in Work; immediately notify Consultant if materials suspected of containing hazardous substances are encountered and perform following activities:
 - .1 Refer to Section 01 41 00 - Regulatory Requirements] for directives associated with specific material types.
 - .2 Hazardous substances will be as defined in Hazardous Products Act.
 - .3 Stop work in area of suspected hazardous substances.
 - .4 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb.
 - .5 Proceed only after written instructions have been received from Consultant.

1.8 SALVAGE AND DEBRIS MATERIALS

- .1 Demolished items become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain Owner's property.

2 PRODUCTS

2.1 MATERIALS

- .1 Electrical Repair Materials: Use only new materials, CSA or ULC labelled as appropriate and matching components remaining after work associated with components identified for removal or demolition are completed
- .2 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.



3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Consultant will not consider claims for extras for work or materials necessary for proper execution and completion of the contract that could have been determined by a site visit.

3.2 PREPARATION

- .1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:
 - .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
 - .2 Notify Consultant and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
 - .3 Prevent debris from blocking drainage inlets.
 - .4 Protect mechanical systems that will remain in operation.
- .2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the Owner and users is minimized and as follows:
 - .1 Prevent debris from endangering safe access to and egress from occupied buildings.
 - .2 Notify Consultant and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.3 EXECUTION

- .1 Demolition and Removal: Coordinate requirements of this Section as follows:
 - .1 Disconnect electrical circuits and panel feeders; maintain electrical service and main distribution panel as is, ready for subsequent Work.
 - .2 Remove existing luminaires, electrical devices and equipment including associated conduits, boxes, wiring, and similar items unless specifically noted otherwise.
 - .3 Disconnect and remove existing fire alarm system including associated conduits, boxes, wiring, and similar items unless specifically noted otherwise.
 - .4 Disconnect and remove communication systems including associated conduits, boxes, cabling, and similar items unless specifically noted otherwise.
 - .5 Disconnect and remove telephone outlets, associated conduit, cabling and sub terminal backboards and related accessories; maintain telephone service and main terminal backboard as is.
 - .6 Perform demolition work in a neat and workmanlike manner:
 - .1 Remove tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.
 - .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.



- .7 Disconnect panel feeders back to main distribution panel and re label respective circuit breaker as "SPARE".
- .8 Place weatherproof blank cover plates on exterior outlet boxes remaining after demolition and removal activities.
- .9 Remove existing conduits, boxes, cabling and wiring associated with removed luminaires, electrical devices and equipment.
- .10 Grind off conduits and make flush with surface of concrete where conduits are cast into concrete; seal open ends of conduit with silicone sealant and leave in place.
- .11 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.

3.4 CLOSEOUT ACTIVITIES

- .1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre) except where explicitly noted otherwise for materials being salvaged for re use in new construction.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CAN/CSA-C22.2 No.18-Latest Edition, Outlet Boxes, Conduit Boxes and Fittings.
 - .2 CAN/CSA-C22.2 No.65- Latest Edition, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common work results for Electrical

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 wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.



2 PRODUCTS

2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper bars.
 - .7 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable, TECK cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required to: CAN/CSA-C22.2 No.18.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connectors installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and cables] and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65
 - .3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.
 - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2.



3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CSA C22.1-Latest Edition, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 Amendments

1.2 RELATED REQUIREMENTS

- .1 Division 01.
- .2 Section 26 05 00 - Common Work Results for Electrical
- .3 Section 26 05 20 - Wire and Box Connectors - (0-1000 V)
- .4 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings

1.3 PRODUCT DATA

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

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 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Jacketed.
- .3 Neutral supported cable: 1, 2 or 3 phase insulated conductors of Copper and one neutral conductor of Copper steel reinforced, size as indicated. Type: NS90 Insulation: Type NSF-2 flame retardant rated 600 V.

2.2 ARMoured CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Type: ACWU90 jacket over thermoplastic armour and compliant to applicable Building Code classification for this project.
- .5 Connectors: anti short connectors.



2.3 CONTROL CABLES

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: thermoplastic.
 - .2 Sheath: thermoplastic jacket and armour of closely wound aluminum wire.
- .2 Type: low energy 300 V control cable: stranded annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: PVC.
 - .2 Shielding: tape coated with paramagnetic material over each conductor.
 - .3 Overall covering: PVC jackets interlocked armour of aluminum strip.

2.4 NON-METALLIC SHEATHED CABLE

- .1 Non-metallic sheathed copper cable type: NMD90XLPE, size as indicated.

3 EXECUTION

3.1 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform 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.

3.2 GENERAL CABLE INSTALLATION

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .4 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .5 Conductor length for parallel feeders to be identical.
- .6 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .7 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .8 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .9 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.



3.4 INSTALLATION OF ARMoured CABLES

- .1 Group cables wherever possible on channels.

3.5 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

3.6 INSTALLATION OF NON-METALLIC SHEATHED CABLE

- .1 Install cables.
- .2 Install straps and box connectors to cables as required.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CSA C22.1-Latest Edition, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No.41- Latest Edition, Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590ANCE and UL 467).
 - .3 CSA C22.2 No.65- Latest Edition, Wire connectors (Tri-National Standard, with UL 486A-486B NMX-J-543-ANCE).

1.2 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 connectors and terminations and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: obtain inspection certificate of compliance covering high voltage stress from inspection authority and include it with maintenance manuals.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for connectors and terminations for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect connectors and terminations from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.



2 PRODUCTS

2.1 CONNECTORS AND TERMINATIONS

- .1 Copper long barrel compression connectors to CSA C22.2 No.65 as required sized for conductors.
- .2 2, 3 or 4 way joint boxes, dry location type.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for connectors and terminations installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.

3.2 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.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE 837 latest edition, Qualifying Permanent Connections Used in Substation Grounding.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Quality Assurance Submittals:
 - .1 Manufacturer's Instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence and cleaning procedures.

1.3 DELIVERY, STORAGE AND HANDLING

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

2 PRODUCTS

2.1 MATERIALS

- .1 Conductors: bare, stranded, tinned soft annealed copper wire, size No. 4/0 AWG and 2/0 AWG for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors, ground connections.
- .2 Conductors: bare, PVC insulated coloured green, stranded tinned soft annealed copper wire, size No. 4 AWG for grounding cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers.
- .3 Bolted removable test links.
- .4 Accessories: non-corroding, necessary for complete grounding system, type, size material as indicated, including:
 - .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.
- .5 Wire connectors and terminations: as indicated.
- .6 Zig-zag grounding transformer: indoor, 3 phase, star connected, 15 kVA, 600 V, air cooled, iron core.
- .7 Cable sheath isolating sleeves.



3 EXECUTION

3.1 INSTALLATION

- .1 Install continuous grounding system including, electrodes, conductors, connectors and accessories as indicated and to requirements of local authority having jurisdiction.
- .2 Ground fences to grounding system independent of station ground.
- .3 Install connectors and cadweld in accordance with manufacturer's instructions.
- .4 Protect exposed grounding conductors during and after construction.
- .5 Make buried connections, and connections to electrodes, structural steel work, using permanent mechanical connectors to ANSI/IEEE 837.
- .6 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .7 Use No. 4/0 AWG bare copper cable for main ground bus of substation and No. 2/0 AWG mhd bare copper cable for taps on risers from main ground bus to equipment.
- .8 Use tinned copper conductors for aluminum structures.
- .9 Do not use bare copper conductors near un-jacketed lead sheath cables.
- .10 Install grounding resistor bank.
- .11 Install zig-zag grounding transformer.

3.2 EQUIPMENT GROUNDING

- .1 Install grounding connections as indicated to typical station equipment including: metallic water main, line sky wire, neutral, gradient control mats. Non current carrying parts of: transformers, generators, motors, circuit breakers, reclosers, current transformers, frames of gang-operated switches and fuse cutout bases. Cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers. Meter and relay cases. Any exposed building metal, within or forming part of station enclosure. Sub-station fences, pothead bodies. Outdoor lighting.
- .2 Ground hinged doors to main frame of electrical equipment enclosure with flexible jumper.
- .3 Connect metallic piping (water, oil, air, etc.) inside station to main ground bus at several locations, including each service location within station. Make connections to metallic water pipes outside station to assist in reduction of station ground resistance value.

3.3 NEUTRAL GROUNDING

- .1 Connect transformer neutral and distribution neutral together using 1000 V insulated conductor to one side of ground test link, the other side of the test link being connected directly to main station ground. Ensure distribution neutral and neutrals of potential transformers and service banks are bonded directly to transformer neutral and not to main station ground.
- .2 Interconnect electrodes and neutrals at each grounding installation.
- .3 Connect neutral of station service transformer to main neutral bus with tap of same size as secondary neutral.
- .4 Ground transformer tank with continuous conductor from tank ground lug through connector on ground bus to primary neutral. Connect neutral bushing at transformer to primary neutral in same manner.



3.4 SITE QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

END OF SECTION



1 GENERAL

1.1 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 hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

1.2 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2 PRODUCTS

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hangers and supports installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.



3.2 INSTALLATION

- .1 Secure equipment to hollow or solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using cliSps, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 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.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1 m on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 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.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, 20th Edition.

1.2 RELATED REQUIREMENTS

- .1 26 05 00 - Common Work Results for Electrical

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit drawings stamped and signed by Certified Electrical Contractor.

2 PRODUCTS

2.1 SPLITTERS

- .1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Terminations: main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

2.2 JUNCTION AND PULL BOXES

- .1 Construction: welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on flat covers.

2.3 CABINETS

- .1 Construction: welded sheet steel, hinged door, handle, lock 2 keys and catch
- .2 Type E Empty: surface return flange mounting.
- .3 Type T Terminal: surface return flange mounting containing 19 mm fir plywood backboard.



3 EXECUTION

3.1 SPLITTER INSTALLATION

- .1 Mount plumb, true and square to building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Install terminal block as indicated in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1

3.3 IDENTIFICATION

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name, voltage and phase.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, 20th Edition.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common work results for Electrical

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit samples for devices as requested by the consultant in accordance with Section 01 33 00 - Submittal Procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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.
- .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 GALVANIZED STEEL OUTLET BOXES

- .1 One-piece electro-galvanized construction.
- .2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .4 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5 Extension and plaster rings for flush mounting devices in finished plaster and tile walls.

2.3 MASONRY BOXES

- .1 Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.



2.4 CONCRETE BOXES

- .1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 FLOOR BOXES

- .1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex single receptacles. Minimum depth: 73 mm for receptacles and communication outlets.
- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 25 mm conduit. Minimum size: 73 mm deep.

2.6 CONDUIT BOXES

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

2.7 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.

2.8 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 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

2.9 SERVICE FITTINGS

- .1 'High tension' receptacle fitting made of 2 piece stainless steel with brushed aluminum housing finish for 1 or 2 duplex receptacles. Bottom plate with two knockouts for centered or offset installation..
- .2 Pedestal type 'low tension' fitting made of 2 piece stainless steel with brushed aluminum housing finish to accommodate one or two amphenol jack connectors.

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 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.



.6 Identify systems for outlet boxes as required.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CAN/CSA C22.2 No. 18-Latest Edition, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45- Latest Edition, Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56- Latest Edition, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83- Latest Edition, Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2- Latest Edition, Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-[05], Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

2 PRODUCTS

2.1 CABLES AND REELS

- .1 Provide cables on reels or coils.
 - .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.
- .3 Identify cables for exclusively dc applications.
- .4 Reel and mark shielded cables rated 2,001 volts and above.



2.2 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .4 Rigid conduit: to CSA C22.2 No. 211.2
- .5 Flexible metal conduit: to CSA C22.2 No. 56, aluminum, liquid-tight flexible metal.
- .6 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3.

2.3 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
 - .1 Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1 m on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.5 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.6 FISH CORD

- .1 Polypropylene.



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 datasheets.

3.2 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 and in unfinished areas.
- .3 Use rigid hot dipped galvanized steel threaded conduit except where specified otherwise.
- .4 Use epoxy coated conduit in corrosive areas.
- .5 Use electrical metallic tubing (EMT) above 2.4 m not subject to mechanical injury.
- .6 Use rigid PVC conduit underground.
- .7 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions].
- .8 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in mechanical rooms and outdoor.
- .9 Use explosion proof flexible connection for connection to explosion proof motors.
- .10 Install conduit sealing fittings in hazardous areas.
 - .1 Fill with compound.
- .11 Minimum conduit size for lighting and power circuits: 19 mm.
- .12 Install EMT conduit from computer room branch circuit panel to outlet boxes located in sub floor.
- .13 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .14 Mechanically bend steel conduit over 19 mm diameter.
- .15 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .16 Install fish cord in empty conduits.
- .17 Run 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel.
 - .1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.
- .18 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .19 Dry conduits out before installing wire.
- .20 Coordination installation with mechanical division, do not obstruct equipment and ensure adequate clearance are available for servicing of all equipment.



3.3 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 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.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

3.5 CONDUITS IN CAST-IN-PLACE CONCRETE

- .1 Locate to suit reinforcing steel.
 - .1 Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.
 - .1 Use cold mastic between sleeve and conduit.
- .5 Conduits in slabs: minimum slab thickness 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

- .1 Run conduits 25 mm and larger below slab and encase in 75 mm concrete envelope.
 - .1 Provide 50 mm of sand over concrete envelope below floor slab.

3.7 CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.8 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CAN/CSA-C22.2 No.47-Latest Edition, Air-Cooled Transformers (Dry Type).
 - .2 CSA C9-Latest Edition, Dry-Type Transformers.
 - .3 CAN/CSA-C802.2-Latest Edition, Minimum Efficiency Values for Dry Type Transformers.
- .2 National Electrical Manufacturers Association (NEMA)

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

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 dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dry type transformers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.



2 PRODUCTS

2.1 DESIGN DESCRIPTION

- .1 Design.
 - .1 Type: ANN.
 - .2 3 phase, power and voltage requirements as indicated.
 - .3 Voltage taps: standard.
 - .4 Insulation: Class B, 150 degrees C temperature rise.
 - .5 Basic Impulse Level (BIL): standard.
 - .6 Hipot: standard.
 - .7 Average sound level: standard
 - .8 Impedance at 17 degrees C: standard
 - .9 Enclosure: NEMA 3, removable metal front panel.
 - .10 Mounting: as indicated.
 - .11 Finish: in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .12 Copper windings.
 - .14 Harmonic Mitigating Phase Shifting transformers as indicated on drawings.
 - .15 KL-Rated Transformers as indicated on drawings.
 - .16 Voltage Regulation to be 4% or better.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Label size: 7.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for dry type transformers installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.



3.2 INSTALLATION

- .1 Mount dry type transformers up to 75 kVA as indicated.
- .2 Mount dry type transformers above 75 kVA on floor.
- .3 Ensure adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.
- .7 Make primary and secondary connections in accordance with wiring diagram.
- .8 Energize transformers after installation is complete.
- .9 Make conduit entry into bottom 1/3 of transformer enclosure.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by dry type transformers installation.

END OF SECTION



1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets
- .2 Section 26 24 16.01 - Panelboards Breaker Type
- .3 Section 26 28 16.02 - Moulded Case Circuit Breakers
- .4 Section 26 28 23 - Disconnect Switches - Fused and Non-Fused

1.2 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 service equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect service equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

2 PRODUCTS

2.1 EQUIPMENT

- .1 Fused disconnect switch: in accordance with Section 26 28 23 - Disconnect Switches - Fused and Non-Fused, rating as indicated.
- .2 Panelboard breaker type: in accordance with Section 26 24 16.01 - Panelboards Breaker Type.
- .3 Cabinet type 'A' for utility revenue metering, Junction box, Pull box, Splitter box: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets, size as indicated.



3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for service equipment installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

- .1 Install service equipment.
- .2 Connect to incoming service.
- .3 Connect to outgoing load circuits.
- .4 Install ground fault equipment.
- .6 Make provision for power supply authority's metering.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA C22.2 No.29, Panelboards and Enclosed Panelboards.

1.2 RELATED REQUIREMENTS

- .1 26 05 00 - Common Work Results for Electrical

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 Certified Electrical Contractor
 - .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 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location 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.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.



2 PRODUCTS

2.1 PANELBOARDS

- .1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand
- .2 Panelboards: bus and breakers rated for symmetrical interrupting capacity or as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Minimum of 2 flush locks for each panel board.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Copper bus with neutral of same ampere rating of mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked enamel.
- .11 Isolated ground bus.

2.2 BREAKERS

- .1 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .2 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .3 Lock-on devices for breakers installed where indicated..
- .4 Lock-on devices for fire alarm, emergency, intercom, stairway, exit and night light circuits.

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 panelboards installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Where panels of different systems (i.e. Standard and Vital Power) supply a common patient care area, ground busses in panels to be interconnect with a minimum #6 AWG ground conductor.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 – 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 00 - Cleaning.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by panelboards installation.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA C22.2 No.42-Latest Edition, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CAN/CSA C22.2 No.42.1- Latest Edition, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA C22.2 No.55- Latest Edition, Special Use Switches.
 - .4 CSA C22.2 No.111- Latest Edition, General-Use Snap Switches (Bi-national standard, with UL 20).

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

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 wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.



2 PRODUCTS

2.1 SWITCHES

- .1 15 A, 120 V or 347 V, single pole or double pole, three-way, four-way switches to: CSA C22.2 No.55 and CSA C22.2 No.111.
- .2 Manually-operated general purpose AC switches with following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White toggle default, or as specified.
- .3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads and heating loads.
- .4 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
 - .1 White urea moulded housing default, or as specified.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 White urea moulded housing default, or as specified.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.

2.3 SPECIAL WIRING DEVICES

- .1 Special wiring devices:
 - .1 Clock hanger outlets, 15 A, 125 V, 3 wire, grounding type, suitable for No. 10 AWG for installation in flush outlet box.
 - .2 Electric shaver outlets, 15 A, 125 V, AC with 20 VA isolating transformer with stainless steel cover plate marked RAZOR ONLY.
 - .3 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic jewel flush type.



2.4 COVER PLATES

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel 1 mm thick cover plates or plastic white cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
- .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .6 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

2.5 SOURCE QUALITY CONTROL

- .1 Cover plates from one manufacturer throughout project.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wiring devices installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical or as indicated.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical or as indicated.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
 - .4 Install GFI type receptacles as indicated.
- .3 Cover plates:
 - .1 Install suitable common cover plates where wiring devices are grouped.



- .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

END OF SECTION



1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 28 23 – Disconnect Switches Fused and Non Fused.
- .2 Section 26 05 00 - Common Work Results for Electrical

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide fuse performance data characteristics for each fuse type. Performance data to include: average melting time-current characteristics.
- .3 Shop Drawings:
 - .1 Provide shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit drawings stamped and signed by Certified Electrical Contractor

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in storage cabinet, moisture free location.

1.4 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Six spare fuses of each type and size installed up to and including 600 A.

2 PRODUCTS

2.1 FUSES - GENERAL

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.

2.2 FUSE TYPES

- .1 Class L fuses - over 600 A.
 - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type L2, fast acting.
- .2 Class J fuses - up to and including 600 A and for other high inrush circuits.
 - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type J2, fast acting.
- .3 Class C fuses - for short circuit protection and not overload protection.



3 EXECUTION

3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label “Use only UL Class RK1 fuses for replacement” on equipment
- .5 Install spare fuses in fuse storage cabinet.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CAN/CSA-C22.2 No.4-, Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).
 - .2 CSA C22.2 No.39, Fuseholder Assemblies.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.
- .2 Section 26 28 13.01 - Fuses - Low Voltage.

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 disconnect switches - fused and non-fused and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect disconnect switches - fused and non-fused from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.



2 PRODUCTS

2.1 DISCONNECT SWITCHES

- .1 Fusible and/or Non-fusible disconnect switch in CSA enclosure 3R, to CAN/CSA-C22.2 No.4., standard size or as indicated.
- .2 Provision for padlocking in off switch position by 3 locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section 26 28 13.01 - Fuses - Low Voltage.
- .5 Fuseholders: to CSA C22.2 No.39, relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 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 for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA C22.2 No.14-Latest Edition, Industrial Control Equipment.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 1-Latest Edition, Industrial Control and Systems: General Requirements.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

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 control devices and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by certified electrical contractor.
 - .2 Include schematic, wiring, interconnection diagrams.

1.4 QUALITY ASSURANCE

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for control devices for incorporation into manual.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.



2 PRODUCTS

2.1 AC CONTROL RELAYS

- .1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.
- .2 Convertible contact type: contacts field convertible from NO to NC, electrically held, poles qty as indicated. Coil rating: as required. Contact rating: as indicated.
- .3 Sealed contact type: contacts field convertible from NO to NC, electrically held, poles qty as indicated. Coil rating: as required. Contact rating: as indicated.

2.2 RELAY ACCESSORIES

- .1 Standard contact cartridges: normally-open - convertible to normally-closed in field.

2.3 SOLID STATE TIMING RELAYS

- .1 Construction: AC operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.
- .2 Operation: on-delay or off-delay.
- .3 Potentiometer: self contained to provide time interval adjustment.
- .4 Supply voltage: 120 V AC, 60 Hz.
- .5 Temperature range: minus 20 degrees C to plus 60 degrees C.
- .6 Output contact rating: maximum voltage 300 V AC or DC. Current: NEMA ICS 1, as indicated.
- .7 Timing ranges: minimum 1.0 s, maximum 60 s.

2.4 INSTANTANEOUS TRIP CURRENT RELAYS

- .1 Enclosure: CSA Type 1
- .2 Contacts: NO, NC automatic reset with adjustable tripping point.
- .3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor.
- .4 Contact rating: NEMA ICS 1, power requirements as indicated.

2.5 OPERATOR CONTROL STATIONS

- .1 Enclosure: CSA Type 1, surface mounting:

2.6 PUSHBUTTONS

- .1 Illuminated, Standard. Operator flush, mushroom type. Green, with 1-NO and 1-NC contacts rated at 120 V, AC, labels as indicated. Stop pushbuttons coloured red, labelled "emergency stop".

2.7 INDICATING LIGHTS

- .1 Standard, full voltage, LED type, push-to-test, lens colour: as indicated, supply voltage: as indicated, lamp voltage: as required, labels as indicated.



2.8 CONTROL AND RELAY PANELS

- .1 CSA Type 1 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.9 CONTROL CIRCUIT TRANSFORMERS

- .1 Single phase, dry type.
- .2 Primary: 208 V, 60 Hz AC.
- .3 Secondary: 120 V, AC OR 24 V
- .4 Rating: as required.
- .5 Secondary fuse: as required.
- .6 Close voltage regulation as required by magnet coils and solenoid valves.

2.10 THERMOSTAT (LINE VOLTAGE)

- .1 Wall mounted, for exhaust fan control.
- .2 Full load rating: match requirement of the fan.
- .3 Temperature setting range: 0 degrees C to +40 degrees C.
- .4 Thermometer Range: -10 degrees C to +50 degrees C.
- .5 Markings in 5 degrees increments.
- .6 Differential temperature fixed at 10 degrees C.

3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for control devices installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and Consultant.

3.2 INSTALLATION

- .1 Install pushbutton stations, control and relay panels, control devices and interconnect as outlined.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.



3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

END OF SECTION



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-2002, Part 4: Electromechanical contactors and motor-starters.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit drawings stamped and signed by Certified Electrical Contractor.
 - .2 Provide shop drawings for each type of starter to indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout and components.
 - .4 Enclosure types.
 - .5 Wiring diagram.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit operation and maintenance data for each type and style of motorstarter for incorporation into maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.



2 PRODUCTS

2.1 MATERIALS

- .1 Starters: to IEC 947-4 with AC4 utilization category

2.2 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include fused disconnect switch motor circuit interrupter with operating lever on outside of enclosure to disconnect, and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Selector switches: standard labelled as indicated.
 - .2 Indicating lights: standard type and Colour as indicated.
 - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

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 ACCESSORIES

- .1 Pushbutton: heavy duty, oil tight as required.
- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

2.5 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.6 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Magnetic starter designation label, white plate, black letters, engraved as indicated.



3 EXECUTION

3.1 INSTALLATION

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire, starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches and 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.

3.3 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION